Irony of the Method

Foundations of Theoretical and Experimental Physics with Special Emphasis on the Contact Problem in Mechanics, Fields, and Particle Interactions

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The Method of Physics is not built on the basis of hypotheses about the world. It is based on the axioms of the requirements of universal reproducibility of predictions. Thus, the Method does not require confirmation in experiments: experiments are carried out in the framework of the concepts of the Method and, therefore, they are doomed to agreement with the theory (derived solely from the axioms). Critical analysis of such structures (of the Method) as time intervals, the reference systems, and distances leads to a series of rather unusual conclusions…

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Preface. What is the question?

> Mathematical science affords us a brilliant example, how far, independently of all experience, we may carry our a priori knowledge… Deceived by such a proof of the power of reason, we can perceive no limits to the extension of our knowledge. The light dove cleaving in free flight the thin air, whose resistance it feels, might imagine that her movements would be far more free and rapid in airless space.
>
> I. Kant, *Critique of Pure Reason*

The Method of reasoning is regarded an important part of our civilization. However, its very existence is paradoxical. Indeed, it is unlimited repeatability that is in its heart. But repeatability on its own doesn't as yet belong to the Method. The knowledge of a town is verily not in the competence of the Method, despite providing suitable recommendations for us to search for a house. But the town might change in time, and then such knowledge becomes useless. On the contrary, constructions and rules of the Method are claimed to be *universal*, that is, valid always and everywhere. But then, an available set of universal rules is unavoidably meager, since it is formed at the expense of disregarding everything that is uncertain, unreliable, or vulnerable by means of restricting full-fledged thinking to mere logic. The utmost form of *unambiguous* repeatability is number. A hundred of people — this is when there is no importance as to how people actually differ from each other. Even if random processes are under question, then the result is being presented in terms of their probabilities, and their — repeatable! — distributions are what is actually obtained. Repeatability is required as long as — explicitly or implicitly — one bears in mind some practical use of past experience. However, there are no completely repeatable situations in real life. Moreover, they are just unrepeatable events that are of utmost interest in it. Now, what for — and just when — are we in true need of this Method?

Since prehistoric times there have been highly valued, along with wise (sometimes) and sly (always) leaders, strong and bold warriors, skilled and nimble hunters, also those able to predict weather, to recognize a beast, while being led by hardly noticeable or completely unnoticeable for others signs, to ignite fire, to invent a tool. Frequently, these people were directed by intuition, incomprehensible even for themselves ("it seems to me" or "my bones are aching feeling bad weather"), and then their skill disappeared with them, but sometimes they managed to explain their knowledge at least to a disciple, and then it had a chance to be preserved. Thus in this way the Method has been coming into existence, and for later purposes some other people, the "philosophers", have endeavored to put all this into a system (in great many different ways), in order to make it systematically easier to understand and remember. For the large part in later-developed "natural sciences", experiment has replaced experience, and the combinations of experiments and theories have become a commonly accepted way of acquiring knowledge.

"Pure" conditions of experiments along with the prescription to use solely their combinations in applications are called upon to ensure just this universal repeatability, while getting rid of uncertainty, "turbidity" of real life, which still manages somehow to use the predictions of the Method. A confidence deserving experiment must present an unambiguous result, as well as a theory — an unambiguous deduction. The main concern and skill of the experimenter consist in this that some definite statements might be drawn from his result, whereas he mostly observes on his display (set-up) something non-repeatable, from which no definite conclusions could be drawn, and he has to update his devices and the performance of the experiment in such a way as to reach reliable repeatability. Many say that a theory is to be checked with the experiment, but then the performance of experiments is being controlled by theoretical concepts. All this is to be used further on in practice, but there is a question as to what extent the result of an experiment is ultimately conditioned by initial theoretical concepts. But what if these concepts are so restrictive that there is no need in the experiment itself: its result cannot be different being governed by the very statement of the problem, or can it?

It is commonly believed that upon perfection of experimental devices and corresponding refinement of the theory, every "reasonable" question will receive a trustworthy answer. Upon penetrating deeper still into the "structure" of matter, we shall eventually learn and understand everything about Nature. In this approach, physics and the whole science is thought of as something existing of its own being an object of unprejudiced and uninterested study.

The entire society gets accustomed to such an opinion, which has acquired the status of Kipling's "Bandar-Log criterion": "We all say so, and so it must be true". Now, the very success of technologies becomes dependent on themselves, just like advertising produces artificial needs. Such a development might turn out to be too one-sided and vulnerable with respect to future failures (apart from those inherent in the society itself), following just from the Method, while the label "reasonable" as applied to a question is often called upon to forbid curiosity that is not sanctioned by the Method.

It is desirable therefore to scrutinize the very structure of the Method, viz., its language, because the questions are always asked using a language, hence the answer is partially contained in the question itself. Since, if you are being answered in an unknown language, you will regard the answer as mere "noise". However, the language of the Method is quite different from the languages of primitive tribes, so it is to be asked on a much deeper ground as to why it is just such and to what degree its answers are determined by the requirement of repeatability alone. It turns out that this requirement is so restrictive that, at least in physics which is the example we will confine ourselves to, that we even should not expect from Nature her own answer. The answer is always completely determined by the very question, so, in principle, one could dispense with experiments at all.

The only general answer of Nature to the questions of theory is "everything might occur", whereas the Method likens to a stencil, revealing from the unlimited variety of Nature that is compatible with the structure of its own pattern as it gets finer and more sophisticated in the course of development. This has long been stated by Kant, Bergson and others. Pushkin's "monotonous beautiness" is well applicable to the theories of the Method and should be explained by the own pattern of the stencil. However, the stencil is by no means arbitrary, but, on the contrary, it meets the most important requirements of the user, while the meagerness of its constructions ("How can everything be described with so simple formulae?") results from the severe restriction due to the condition of repeatability and the difficulty of its observing, as it will become clear in the second part of this book after the explanation, in the first part, of the possibility to realize the constructions of the Method basing it solely on this condition.

One should say that physicists by no means discover the laws of Nature, which has no laws of its own, but only particular cases, while to say that this and this is not important, and then it is possible to predict what is left — this is of concern to science. Suffices it to inquire why abstract mathematical constructions, initially by no means answering the questions from physicists, later on became required, to find that both merely consider equal situations, namely, what could be unambiguously predicted. In other words, the user is being advised to "search under lamp", since nothing can be found in the dark anyway, at least if we observe repeatability. But then, whenever you succeed in rendering a practical problem acceptable for the Method, the efficacy of solutions is guaranteed, and all our high valued technology is based on it.

The image of the World, as provided by the Method, is not really a picture but rather a drawing — in projections and with dimensions. A picture creates different impressions in different people and in different times, therefore being devoid of complete universality. If not only the picture, but also its impression would always be identical, only then would it belong to the Method — though no longer to art. The products of the Method play an important though auxiliary role. So, the image in the mirror might provide slightest details, but the problem for the Method is to make a good mirror, and this is independent of the real (whole) countenance to be image-processed.

In the first part of this book, the basic geometrical structure of the Method is discussed to realize some particular ways in order to reach repeatability, which form the essence thereof is called *physics*. In order to facilitate understanding by a reader not accustomed to calculations, we present no formulae. These will be replaced by multiple figures along with qualitative explanations of the presented constructions. Infrequent cases, in which the absence of the corresponding calculation comes into conflict with the confidence in the statement, are being supplied with a short description of the general scheme of the calculation and with auxiliary constructions.

In the second part, we discuss the requirement of repeatability itself with respect to its relation to reality. This is necessary in order to define boundaries of the applications of the Method. The main tendency here will be to define these boundaries from *inside* the Method as it is performed by means of further analyzing its basic concepts.

Part One. How and Why?

> And for mean life number was existing:
> Like domestic harnessed cattle served,
> Since the slightest shadows of meaning
> Clever number readily exposed.
>
> N. S. Gumilev, *The Word*

Chapter 1. Taking one step back

> I do not define time, space, place, and motion, as being well-known to all.
>
> I. Newton, *Mathematical Principles of Natural Philosophy*

"One of the basic concepts of mechanics is the concept of *material point*. Under this name we conceive the body, the size of which might be neglected while describing its motion. "The position of the material point in space is defined by its radius-vector $\boldsymbol{r}$, the components of which coincide with its Cartesian coordinates x, y, z." (L. D. Landau and E. M. Lifshitz, *Mechanics*.)

This or about this is the way to present the primary positions in any textbook in physics. It is implied that the reader, upon receiving a standard education and upbringing, asks no more questions in this respect. More cautious mathematician begins differently: "A number of experimental facts are a basis of classical mechanics... Our space is three-dimensional and Euclidean, and time is one-dimensional...". (V. I. Arnold, *Mathematical Methods of Classical Mechanics*.)

Newton proposed a scheme to solve some practical problems called *mechanics*, based on a generic system (devised some decades before the method of Descartes) worked out to unify algebra and geometry and on using coordinates in order to relate points to numbers. This Newtonian approach survived until now, though with an important improvement due to Einstein. Let us describe the main ideas of the scheme in general. In so doing, we intentionally scrutinize the elementary logic of the scheme, keeping in mind the development of its logical alternative in the sequel.

One has to choose a three-dimensional reference system, comprised of solid rulers or some other devices to be used for a coordinate network. The concept of *material point* is introduced as a *body* that moves along a one-dimensional smooth structure — the *path*, each point of which is specified with three numbers — coordinates — and marked with one more number — a time moment. Time flows uniformly, ensuring the absence of self-intersections in the full picture, even if the coordinates of the points of the structure are repeated.

Such a picture arose due to the observations of small or distant objects, so that their details are not important for the possible user of the scheme. This elementary description of natural events is selected for its simplicity and for the possibility of making predictions for a future position of the body. The body might change its shape, something might occur inside it, for example, a chemical or life transformation; all these are of no importance. We are interested only in this that we are, in a limited sense, able to give prediction. As S. Lem noticed in his "*The Sum of Technology*": "If everything that you want to know about the hanged is the period of his swinging on the rope, then you are a physicist".

For an actual use of the scheme, the body must be "seen", i.e. its initial coordinates must be known as well as some rules for finding its later position in the same coordinates. In Newton's time, no evidence of a top velocity would come from practice, otherwise his mechanics might have looked differently. Quite oppositely, it seemed then that for each motion a faster motion could exist. So, the body must be "seen" immediately wherever it was. Then it would be possible to follow it. Otherwise, provided the signal was retarded, the body might overtake the signal upon its acceleration to be lost from sight, and then another (similar if not marked) body might be confused with it. However, the very importance of the solution here is just in the possibility to influence the situation intentionally, which would never happen under confusion.

Further in Newton's mechanics, among all possible trajectories a particular subset is selected comprising all *uniform* and *rectilinear* ones, that is, straight lines in the four-dimensional space-time. Of these, each one is being determined by any pair of its points. One such point would be irrelevant for mechanics. If the reference frame had been chosen so poorly that any motion from an initial point uniquely determined the final point, it would then be impossible to influence this transition, and one would just unite these points. In this scheme, no explanation for this particular choice was presented. Indeed, there are many classes of lines, each one being specified by any pair of its points. However in Cartesian coordinates, a straight line corresponds to the simplest — linear — equation, having good properties with respect to linear, in particular vector-like operations.

It is assumed in Newton's scheme that these trajectories correspond to "free" motion, i.e. without external influence. Existence of such trajectories (though they never existed in practice, but rather belonged to some limiting case) is known as "the first law of Newton". "The second law of Newton" consists in representing all sufficiently smooth trajectories by means of broken lines comprised of straight line segments, infinitely small in the limit, so that transitions between adjacent segments — acceleration — depend on an external influence — force, and on an individual parameter of the body — its mass.

The necessity of dividing the influence into external force and mass is not evident from the scheme itself. However, it is necessary for it, within its self-definition, not only to extend the variety of relevant situations, but also to predict future positions of the body according to the very statement of the problem. Indeed, in the general scheme the force must be specified at all points up to the end, and what is left to predict then? Therefore the scheme should be completed with a notion of inertia: whatever force, there exists the last segment, for which this force could be ignored so as to regard the motion as free; and this must be true for any intermediate step as well.

In practice, various particular cases are considered in mechanics, in which forces are known in advance over the whole possible trajectory, however in the full theory there must be a guaranty of the meaningful problem statement with any forces whatsoever. Forces arise from their sources, typically coming from some other bodies to weaken over a distance from them. Different forces bring about different accelerations, hence besides its mass the body to be accelerated must be provided with an additional parameter — "charge", requiring that acceleration due to this force be proportional to this charge disappearing in the limit of zero charge.

But then, what is the way to find a force in general, while knowing nothing of its source? The answer of the scheme is: this is achieved using the same second Newtonian law though inverted to determine a force by the acceleration that it provides. This looks like a vicious circle, but the point is that to determine the force along the trajectory of the body in question, the force is being measured according to acceleration of different — test — bodies, to be afterwards used in the problem. But then one must be sure that all the test bodies observe a common measurement standard. This is by no means a simple task, and a further restriction of the permitted class of forces is required. This topic will be extensively discussed in Ch. 6.

The scheme allows for extension on extended bodies, however only at expense of additional restriction on the class of permitted forces. If the body changes its shape or size, then sometimes it can be considered as consisting of smaller parts, each one moving along its own trajectory unchanged, while all these together describe the behavior of the total object. Then one more law — "the third Newtonian law" — is required to introduce, in the notions of the scheme, motions of finite length bodies (e.g., solid ones) as a whole by virtue of internal forces analogous to the external ones, thereby preventing decay of the body. Since these forces must not influence the motion of the body as a whole, they must compensate reciprocally. In terms of the Newtonian second law, this sounds as follows: "Action is equal and directed oppositely to its anti-action". Newton himself noticed that these internal forces (for solid bodies) must be very strong as compared to the external force, so that the latter only moves the body rather than deforms it.

If the source of an external influence is explicitly given in the problem, people tend to speak about interaction, and then the Newton's third law calls for the intensity of the source to be represented by the same charge. In this context the charge is coined the *constant of motion*. So, if, for example, the force comes only due to interaction of the bodies, all these together might be considered as a whole ("closed system"), that is, the law allows for only some definite class of forces for this condition to be fulfilled.

The primary concept of material point as a body of "zero" size, that is, such that its state is completely specified by its three coordinates, does not depend on a general concept of size, but it might serve as a preliminary for the latter. If a solid extended body is considered as consisting of so small pieces that each one is practically a material point, then its position is specified by means of its coordinates in the *same* reference system. Further, when approximating each acceptable path with rectilinear segments, as well as ascribing to each segment its *length* as specified by positions of its ends again in the same coordinates (since there are no other numbers in the scheme), then in a path defining limiting process this length must tend to zero independently of the orientation of the body by its own definition. This might be achieved with the definition of squared length via, e.g., the sum of their three differences squared. Now we can introduce a concept of size also for extended bodies as a maximum length of segments specified by any pair of its points, again and again in the same coordinate system that was first introduced solely for paths. We are in a position now to redefine a zero-size body as one not containing finite length segments.

Over a few centuries of its use, the Newtonian scheme became so customary that it was conceived as something belonging to Nature as her very own — her own internal "harmony" — amounting to the statement that Newton "discovered" his laws, being up to then ready though unknown, firmly hidden in Nature. A significant alternative approach (Kant, Bergson and others) denies the existence of any laws of Nature, regarding the scheme as merely a choice of objects, to which attention should be paid according to some convenient rules in order to be useful in applications. Thus, one should regard the Newtonian laws an "invention" rather than a "discovery". The user (applying the scheme) just looks around obliviously grasping only situations in which a useful action is possible. The Newtonian scheme provides the user with instructions for paying attention to particular occurrences, namely, to pick rare cases, which allow for warranted predictions. We'll examine below this question systematically, but for the time being let us look at the mentioned features of the scheme from the viewpoint of their necessity.

The final product of the scheme — three number functions: the dependence of coordinates on time. But why are these needed? How and when to use this information? A possible answer: if these functions for one body at some moment of time coincide with those for another body at the same time, the bodies might collide, that is, come into contact. So, these functions get a practical meaning only if some other bodies are present, otherwise the trajectory is found hanging, as to say, in nothing. Why then not to consider the full problem, including explicitly all the participating bodies? How reasonable is the division of the problem into separated parts, while the question is universal: whether or not the bodies collide?

Furthermore, the canonical (Newtonian) scheme is redundant in this respect that many reference systems for the solution of the same problem might be introduced on an equal footing, and some additional rules are necessary for transitions between them upon describing the same motion. The trajectories are specified with number functions, which are different as for different trajectories in one reference system, so also for one trajectory as described in different systems. Disentanglement of this ambiguity requires some special rules — "relativity principles" — to find "covariant" combinations of coordinates, such that the "form" of resulting equations will not depend on a particular reference system (in the theory of relativity these combinations inherently include also time). In this respect two types of coordinate frame transformations are introduced: "passive" transformations to change the coordinate values of a given point and "active" when the point shifts itself in a given coordinate frame (still one has to ascribe any sense whatever to the notion of motion from one point to another in empty space: what is the difference between these two?).

Moreover, reference systems themselves require a gauge to be relevant for representing actual motions of bodies. The gauge is carried out using some *standard* trajectories. For example, the rectilinearity of rods is gauged using light rays or free fall of bodies, while clocks are gauged with some stable processes. Finally, all motions are thus compared to some others, while rods and clocks are a mere intermediary for comparing motions. However, any intermediate device might either introduce something of its own to the procedure, or lose or hide something. Usually, this is harmless — still sometimes it might be important. In particular, as we will find later on, some experimental facts turn out to be unexplainable in the framework of the scheme just because a part of information is actually lost in the intermediary. For example, the "eternal" question about the dimension of the space: why only three, not seven or two (fewer still)? In the sequel we will find also some other examples.

However successful the canonical version proves to be, still a question is there concerning its possible logical alternatives. Now, what if some different schemes might exist, and those should better meet some of our needs, whereas we have just got used to this very approach upon being taught to think solely in its framework? In the second part of the 20th century, many authors strived (though generally with limited success) to get rid of clocks and rods, replacing them with the propagation of light and free fall of bodies. However, the very idea of independently existing space-time has always been considered "intrinsic to our intuition" (in the sense of Kant's judgments a priori).

It is desirable therefore to begin with something more "primary", for example, with that which makes itself evident even for the "naked eye" like the possibility of describing in a similar way such seemingly quite different events as motions of stars and flights of birds. However, a many-century-long tradition is so mighty that even the discourse on the prime position without a preliminary ripe feeling of its necessity brings about, as experience shows, a depressing effect. Therefore, we begin with the discussion of ways to reach repeatability, though a bit prior to the cited textbook (as well as others), while postponing the most primary ideas until the last chapter.

It is customarily said that bodies move along their trajectories — one-dimensional continua. It is this that we want to consider in more detail from the viewpoint of the user, all this science being ultimately destined for. In distinction to the curious researcher with his traditional "why?", the question of the user is more prosaic — "what for?". He expects recommendations for action, and it is these recommendations that only give a value to knowledge, hence the concepts of a scheme must be coordinated with its expected predictions.

The concept of motion itself depends on the statement of the problem. For instance, the orbit of a satellite might be considered as a change of its position, but sometimes (in atomic processes, say) it is more to the point to regard as motion only changes in the orbit itself. In the canonical version, it is the initial state that is highlighted as a state that later on specifies the whole trajectory along with the law of motion. Just this approach makes it indispensible to accept in advance a particular construction of space-time. Otherwise there is no reason to choose something definite for a proposed change of the state. Indeed, what is a state then the initial state has to transform at?

Quite oppositely, the final state is something known to the user already prior to addressing the Method. This is something the user wants to reach. Therefore the final state possesses its *external* description as known to the user independently of the Method, which is then committed in order to find a way (if possible) so as to reach the desirable. If the user is not able to formulate as to what is wanted, the Method cannot teach him. And only afterwards — already in terms of the Method — the problem arises concerning a relevant construction, so that both the final and initial states are now encoded accordingly to the problem statement. Thus, with respect to the relationship of initial and final states, it is just final states that are to be specified as leading ones, leaving only auxiliary roles for initial states.

So seemingly unimportant deviation from symmetrical, as it looks, relationship in a ready scheme is important for an initial formulation of the problem. Likewise, the cause-effect relationship is asymmetrical for the user. The effect is important for him in its own right, whereas the cause is important only insofar as it leads to the known-in-advance effect. Only starting with this statement does it become possible to substantiate geometrical constructions as an instrument for solving practical problems.

As for the final state, a criterion of whether or not it is reached must be formulated by the user in advance. Otherwise the problem does not exist, since upon reaching the final state it is still unknown whether or not just this was implied. Once this state is defined, we stay in need of finding a way to reach it. The required construction must somehow encode this final state now with its own *internal* for the Method description, i.e. in its internal terms serving as a tool for the solution. In this procedure, the initial state must be encoded as well, since it isn't the desired one. If these two codes are sufficient, that is, given the initial state, the final is surely achieved, then no problem at all is there, as well as if the required transition is not known as yet. It might happen, however, that in the accepted encoding scheme there is an *intermediate* state such that a way to reach this state from the initial is known and also from this state to the final. For example, it might happen that in the ripening of a plant its color in an intermediate phase defines its properties at the end. Then the farmer (biotechnician) is interested in reaching just this color.

Further development of the scheme comprises a sequence of intermediate states with transitions in between. When ascribing the index 0 to the initial state and 1 — to the final, then let us ascribe 1/2 to the intermediate state. Analogously, the intermediate state between states 0 and 1/2 receives index 1/4, while that between 1/2 and 1 — 3/4 and so on. Proceeding along this way, we obtain a structure ordered by the very statement of the problem, still not, however, acceptable as a trajectory. Indeed, the structure cannot include the last state other than the final (marked as 1). Were it that such state does exist, the transition from it to the final would be necessary, and then this state would actually render itself superfluous, and it must be identified with the final. The same is true for each intermediate state. Therefore the whole set of states must be infinite. However, in this structure sequences might exist, that have no final states further progressions to begin with. In the order-defined topology, these sequences are everywhere dense (they correspond to irrational indices). But this numbering expresses only the order in the set of states, being arbitrary in other respects. It is possible to change the indices, so that a formerly irrational index becomes rational and vice versa (this cannot be done, however, for all the indices at once). It is natural to consider every such sequence a definite state, since the sequence of its indices has an upper boundary by definition, dividing the whole construction in "before" and "after" (Dedekind). It is this very construction that will be called a trajectory.

Up to now our indices look like time moments only due to their linear order. In what follows this likeness will acquire a definite physical sense, however, this will not be in accord with the readings of some clocks. No clocks whatsoever will appear in this book; rather surprisingly, it turns out that these are not at all needed in physics (as well as rods).

In various fields of knowledge states are fixed differently. In particular, physicists suggest their own approach, which is effective, however, only within a very limited scope of real situations, while subsequently letting predictions be universally repeatable. They notice that a final state is always encoded according to the "yes-no" principle by the very problem statement. Now, it is proposed in physics to encode all other states in the same way. States encoded with this rule will be called *contacts*. The contact is either existent or not, that is, it is a point, and this definition has nothing to do with such notions as size or distance. (If a duelist missed having just one cartridge, he doesn't care how far he missed.) Contact as a state corresponds to the pictorial image of touching, and in this respect the involved entities are called bodies, but we stress that the concept of body has here but a pure informational meaning independent of an illustrating picture referring to something used in connection with contacts. This image helps the user pay attention to similar situations, in that he tries to select bodies out of the world and to reduce his problem to their touching. In general, this is a mere mental construction introduced in an ivory tower independently of any reality. But then, it allows for effective construction of transitions between relevantly encoded states. It is only afterwards, while leaving the tower armed with the scheme and using his senses, one has the opportunity to search in the surrounding world something looking like the elaborate mathematical scheme in order to make predictions in actual situations. Thus, the astronomer Galileo, who used to observe the motions of celestial objects (demanded by the practice of navigation), began to throw for some reason stones from the leaning Pisa tower, thereby founding experimental physics, in distinction from the purely observational. How funny he must have looked to the others! People used to plough, fight, bargain, whereas this eccentric man was throwing stones.

After this digression let us return to the correspondence between the scheme and the usual concepts. What is of interest in a trajectory? It is only this that, if it intersects with another trajectory, then the related bodies might come into contact. What happens in the contact is a separate aspect unrelated to the given problem. The essence of the concept of the trajectory is in this, namely that this cannot happen, provided these trajectories do not intersect, and then knowing the trajectories we are in a position to predict the occurrence of the contact. If a hare comes into contact with a wolf, it is not necessary that it will be eaten: perhaps the wolf is not hungry at the moment. But the hare-physicist, being familiar with the basics of geometry, knows for sure that he will be safe upon avoiding any contact with a wolf. This little one would get *guaranty*. So, for him the contact possesses a meaning that is *external* to his problem, which is "to be or not to be eaten", but in order to exclusively solve a *Contact Problem* (to be abbreviated throughout the text as simply "CP", by the use of which we generally also imply the sense and instance of "CP set-up"), the user is advised to develop for this purpose some artificial *internal* mental map with respect to the Method's construction.

Therefore, the fact of the presence or absence of a contact might be taken as the starting point for a special science, namely, *physics*. Indeed, something common for an apple and stars that Newton noticed, according to the legend, belongs just to their mechanical motions — trajectories with their contacts with light entering the observer's eye, say, rather than with some changes in general, for instance, with the evolution of the star and ripening of the apple. The problem is being stated about the prediction of contacts on account of some relevant initial data.

Upon developing the Method from scratch, we should not accept all the traditional geometry as fallen from heaven. Rather, we shall first put the question about the relevance of just this structure, though perhaps just this one will spring up in some form in the course of our development. We have defined the scheme as CP. But in any CP, at least two bodies are present. Hence, it is not necessary to construct an external reference system with its coordinates fixing "positions" of a body, dropping the presence of other bodies from the outset. Now, what if we were to formulate CP directly in their relations? Perhaps then we should be able to dispense with coordinates? It turns out that this is the case, and we shall forever forget coordinates, their transformations, quantities that transform in some accord to these, relativity principles, etc.

Solutions to CP must be unambiguous and universally repeatable. These demands are so categorical and restrictive that the situations they are being fulfilled at are sufficiently rare in real life. But then, they are permanently being searched for, especially in technologies, due to efficacy of their predictions, hence looking quite widespread. The oversimplified CP statement has its consequence in the fact that for infinitely rich Nature, it is always easy to give an answer to it too, so that for all possible hardly restricted constructions of the Method, Nature will surely find applications. If the Method predicts, e.g., a particle corresponding to its scheme, it will necessarily be found in experiments, otherwise upon perceiving the particle solely in terms of the Method, we would never notice it, i.e. extract from the world as a whole. Somewhat loosely, it can be said that using the rules of the Method we "create" this particle, as well as being constructed according to the same rules by which a TV-set does exist in the world. In the development of the Method within the framework of a mental scheme, we will frequently illustrate introduced constructions by means of familiar examples. It is necessary, however, to follow the internal logic of the constructions.

Since various trajectories with their mutual relations like intersections are present in CP, we are in need of a structure for their common description. Such structure suited exclusively for CP solving we will call the *contact space* (analogous to the space-time of the canonical version). Its points are contacts as occurring in the intersections of various trajectories. The condition of universality, that is, of the possibility to formulate any CP within this structure, defines the requirements for the *geometry* of the contact space.

Trajectories of their own are already provided with their internal geometry. According to their definition as the sets of states, they are the segments of the number axis, i.e. of a simple arc. Considering their intermediate states as points, and the arcs as the trajectories of moving bodies, we should consider solely situations when the contact of two bodies A and B, with the CP being stated, takes place only if their trajectories intersect. In the same terms, we can introduce contacts of these bodies with some other bodies. In particular, the latter might be useful if they comprise a prepared-in-advance auxiliary set of *measuring* bodies specially introduced in order to predict the contact in CP. Thus, in each particular CP there might appear many (sometimes infinitely many) trajectories of bodies with or without mutual contacts.

Since the contact space as a structure has been introduced solely to solve (a combination of) CP's, the bodies that intersect the trajectory of A (for instance, at its state 1 in its own order) are considered having the contact with A at this point, i.e. the combinations of only such trajectories are being accepted in the scheme. We want to predict the contact between A and B to be denoted as (A, B), while knowing, at some pieces of their trajectories, their prior contacts with measuring bodies. In other words, we will follow A and B using their contacts with measuring bodies. To this end, we have to be sure first of all that on every piece they are the same A and B. Indeed, what for did we select the motion of a body from its one position to another among more general situations when at one place the body disappears, while in another appears an "exactly identical" one? The answer lies in that we imply a possible influence on the contacts of just this body. One could imagine bodies as marked somehow, e.g., carrying something written on them. This method might be useful sometimes, but a specific feature of the Method is the inclusion also of the impossibility of such a marking, say, if the bodies are small enough. Therefore in the Method, which is actually nothing else than a set of various combinations of CP's, we use in the following just contacts of A and B themselves and with measuring bodies (because there is nothing else in the scheme).

Let the trajectories A and B be such that (A, B) occurs. Somewhere before (A, B) we emit a bundle of measuring bodies from A, so having their common contact with A and among themselves (here and further on up to Ch. 4, it is implied that contacts have no effect on the trajectories of bodies, i.e. on the existence of their other contacts, in our terms — on both A and B, as well as between the measuring bodies).

We try to choose, if possible, such measuring bodies out of the bundle that they further come into contact with B, of course, before (A, B). Each such body has a contact with B at a point, having its own index in the trajectory of B. The construction of the contact space is just an arrangement of relevant kits of measuring bodies.*

Among these, we find the body, the contact of which with B occurs before all others with respect to the order in B. Recall that no separate "clock" is required to reveal this "before": Let a contact put a "mark" on B, now any other contact will occur later if it "sees" B already marked. Not always might this be the case. For instance, how exactly to mark electrons? However, sometimes an indirect marking is still possible using auxiliary bodies. It would be reasonable to regard this first body the fastest, were it not possible that bodies might go over different paths. However, our condition "first in the order of B" means *total extremum*: The limit is being reached upon testing both paths and velocities.

If CP has a solution, hence a possibility to follow B while "sitting" on A, then such bodies must be present in a relevant measurement kit. If we were to claim the possibility of solving any CP in the framework of a single scheme, these peculiar bodies might serve as universal signals (they will be conditionally called *photons*, while their definition doesn't imply just electromagnetic implementation). Photons must exist at every point of both trajectories. Otherwise, the contact (A, B) could not be predicted, since B, say, might happen to be "faster" than bodies of the kit, thus evading the following; this kit would be irrelevant for CP. The Method is impotent in the absence of top speed. If it is not possible to distinguish two identical bodies from one that "instantly" moves from one position to another, then the user cannot control the situation by means of acting on the motion of a particular body. It is then said that this is not physics, meaning that the situation cannot be reasonably simplified in order to employ the Method with the use of the concept of body, as being defined by something allowing for CP statement. So, CP itself chooses situations, in which it is efficacious. However seldom these occur, it is recommended each time to look for the reduction of a problem to CP, because then predictions are very reliable. In practice, photons are not always necessary. For instance, in dealing with slow enough motions it is sometimes possible to use even a usual post as the top signal, using, in principle, the same theoretical scheme. The scheme of mutual contacts of bodies can further be used in a broader context. So, for instance, the steady flux of a river cannot be recognized, since its parts are being replaced by completely identical ones. In order to discern the flux and to measure its speed one has to break its uniformity placing a buoyant body there.

In the basic scheme of Newton with an infinite speed of signals, it was necessary to place clocks, synchronized in advance, in the knots of the space lattice. Just for this reason he had to ponder so laboriously on the nature of time, distinguishing the notion of "mathematical" or genuine time from the not strictly definite time, copying some, mainly astronomical, periodic process.

After this digression, let us return to CP. Let after the contact with B of a photon emitted from A another photon be instantly emitted from B back to A, then again from A to B and so on. It is convenient to say that it is one photon that oscillates between A and B up to (A, B), if this exists (Fig. 1.1). This photon realizes the following of B from A. This following is discrete, and it seems to be more reliable to emit from A more photons one after another, so that the reflected photons provide a more detailed information. However, there is a risk of confusion the returning photons. It is not obligatory that one photon emitted earlier than another will also return earlier: both their paths and velocities might differ, since our definition of the photon as a body that overtakes all others having their common contact with A is local.

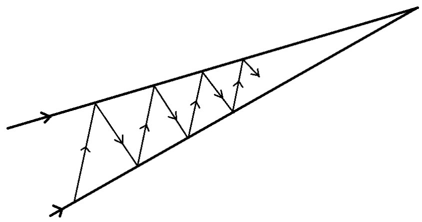

Fig. 1.1: Thin lines are the trajectories of the oscillating photon.

Wherever the counting of the oscillation numbers begins, this number as counted up to contact (A, B) is necessarily infinite. Otherwise, a last oscillation must be there, so that the next occurs after (A, B), in contradiction with the definition of the photon as the top-speed body that overtakes all others, including A and B. Such a sequence of contacts is called a *Zeno sequence* recalling his paradox about Achilles and the tortoise.

Let us now reverse the criterion for it to be relevant for CP-solving, considering the occurrence of (A, B) unknown (since we want to predict just this) and counting the photon oscillations. Starting from any point, it would be desirable to conclude that (A, B) will occur, provided the number of oscillations increases infinitely. However, this number will tend to infinity also if the contact does not occur. This will take infinite time, of course, but we don't have any definition of time in terms of contacts. The situation might be cured by means of introducing some multiple contacts. Suppose we

*One might keep an image of them as comprised (though not always) of bodies emitted from each point of the Euclidean space-time with all possible velocity vectors. We use the notions of velocity, acceleration, mass, charge etc. though we still have to define all these solely in terms of existence and order of contacts.

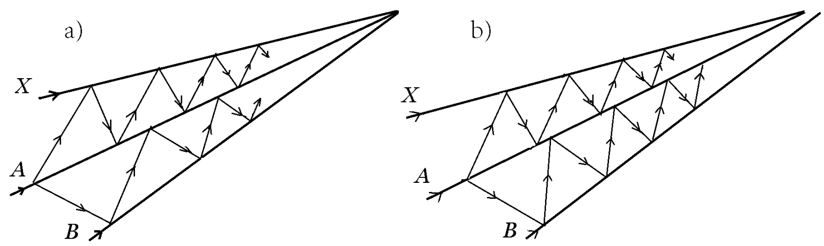

Fig. 1.2: a) (A, B, X) exists. b) (A, B, X) does not exist.

have, besides A and B, yet another body — X, that does have a contact with A, say (later on, we will include such bodies in our measurement kit). Since X is just an auxiliary body, that is, it is not one, the CP is stated about, we may specify its contacts whenever needed. And then we will change the very statement of CP, i.e. we will ask not about a contact "in general" but rather about a triple contact (A, B, X).

Now we are in a position to formulate our CP as follows. Let two photons be emitted from A at once (Fig. 1.2): one — toward B, another — toward X, and we will count the numbers of these photons' contacts only with A.

If (A, B, X) is absent, then the *ratio* of the oscillation numbers between A and B to the oscillation numbers between A and X tends to zero upon approaching the fixed (A, X), and it is this that will be the criterion of the absence of (A, B). If this ratio tends to some non-zero limit, then (A, B) does exist. Since both numbers tend to infinity, this limit depends neither on the point the counting begins from, nor on the reciprocal positions of the contacts with A of the photons reflected from B and X within neighboring oscillations. In the canonical version, this ratio can be expressed with a simple formula via local values of the velocities of A, B, and X at (A, B, X). It is important, however, that the measuring of oscillation numbers is an actual physical procedure in its own right, and it should not be regarded as something tacitly involving the "genuine" concept of velocity as a ratio of centimeters to seconds. We shall see further on that basic procedures of the Method can very naturally be expressed solely via oscillation numbers whenever they are finite and via their ratios whenever infinite.

It is just here — in the necessity of an auxiliary contact of A with a body from a measurement kit — that the concept of time, so far having appeared only in the form of order relations (basic already in the two books of A. A. Robb, written at the dawn of XX century), begins to acquire a particular meaning in measurements. We stress that the definition of a photon as top-speed body-signal implies neither its numerical value, nor even its identity in different points of the contact space, because for each pair of trajectories the photon oscillating between them are to be specified independently of all other trajectories. In this approach a numerical value of the top velocity itself is completely unessential, whereas its changes from point to point makes it possible, as will be explained in Ch. 5, to include, in the general contact scheme, also gravitation with its curved (in terms of the canonical version) trajectories of photons.

Upon corresponding photon oscillations to motions we receive an ideal realization of the Method, viz, "measuring motion with motion" devoid of any intermediary like clocks and/or rulers. By this means, we introduce a particular meaning of the very concept of motion in physics (of course, at the expense of further restriction of the field of experience). It is now not an uncertain "changing in general" but only something expressible in terms of contacts. So, considering motions of macroscopic bodies in an electromagnetic field, we ignore their internal structure, in which similar fields participate as well. But then, the so restricted approach gives us a hope that everything describable in the framework of the Method will sometime find its application in practice.

Ratios of the oscillation numbers in multiple contacts will be one of the main tools in the following. However, it might happen that in the situation in Fig. 1.2 this ratio is zero even in the triple contact due to an "unsuccessful" choice of X as a tangent (in terms of the canonical version) to the trajectory of B in the contact point. We have therefore to complete the above-given definition by an additional requirement to the measurement kit: It must include such X's ("in general position"), that the said ratio becomes non-zero. Moreover, it is possible, with an appropriate choice of X, to obtain non-zero ratios for "different orders of tangency". As will be shown in the next chapter, with an appropriate choice of the own intersection scheme in the measurement kit, it becomes possible to obtain the needed tangents in a regular way rather than just trying out various bodies from the kit.

Two arbitrary chosen trajectories might intersect many times, even infinitely many. In particular, they might be tangent at a point or even to have a common interval. The prediction of a contact using oscillation numbers counting on the trajectories implies these to contain some intervals (each one according to its own ordering indices) before the expected contact that are free of other contacts. Exactly in these very intervals the measuring photon oscillations occur. Were there so "densely" positioned contacts, the oscillations counting would begin before some (A, B), that is before (A, B, X), thus erroneously showing the absence of the expected contact.

The next task is the formulation of the properties of the measurement kit that are relevant to CP solutions, with respect to its own mutual contacts. The finiteness of the top speed implies that not every pair of contacts might belong to a single trajectory. In order for CP to possess a solution, the trajectory of any single body must involve "sufficiently long" intervals around the possible contact, containing points reachable by photons emitted from other bodies in the problem (Fig. 1.3). Otherwise, some bodies would be "invisible" to others, and hence CP could not be stated.

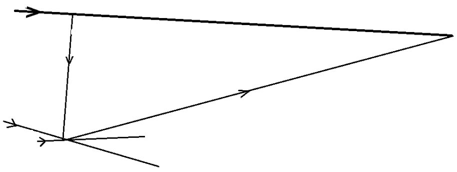

Fig. 1.3: The bodies in CP must "see" one another.

The knowledge of the full trajectory seems to provide the required prediction of the state in question to be reached. However, this trajectory, if being known up to the end state, leaves no room for an action to influence the occurrence of this state. It is then desirable to select in the set of all possible trajectories a subset of such that can be completely specified with only some of their states. Evidently, such a trajectory cannot be uniquely determined by just one of its states, since then the scheme should merely be reformulated to mark this state as the initial, so again representing a trivial no-action situation. The next possibility includes two states. If this solution is unique, i.e. all the infinity of its states can be determined in the scheme with some of its two states, and no other trajectory can include these three states (initial, final and auxiliary third) together, then the third could be chosen arbitrarily on the trajectory. Indeed, suppose that, starting from the initial state and following the trajectory up to a specified third state, we might — in this particular problem — to connect this state to the final along a set of states not belonging to the same trajectory, then this trajectory would not be unique, and the solution becomes ambiguous, bounding the user to choose among various solutions. Since this third state is sufficient to enable some choice for action, any fourth state would be superfluous. The final state being given in advance, we thus look for a broadest class of trajectories ending at this state, each one being specified with any pair of its other states. A whole possible scheme is anticipated to be defined in terms of these particular trajectories.*

The relationship of the bodies in the measurement kit defines the "geometry" in the contact space. Let us start with the simplest structure — the topology. We will define the *neighborhood* of a point of this space as a set of contacts such that any trajectory outside this set ending at this point necessarily has contacts with some other points in the neighborhood. Moreover, we require that the set of points that is common with the points in this neighborhood in each such trajectory includes some open (i.e. without its end points) interval according to its own order. Thus, nearness springs up in the neighborhood as induced by the arrangement of all possible trajectories tending to this point from outside of its neighborhoods (Fig. 1.4).

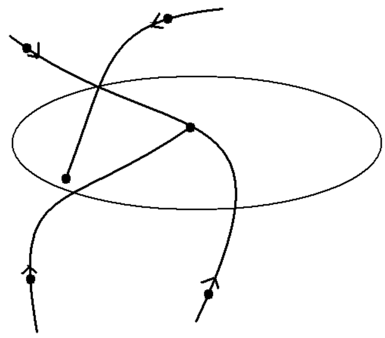

Fig. 1.4: Definition of neighborhood by means of trajectories (the boundary of the neighborhood is shown with a thin line).

This definition is in agreement with the intuitive notion of places close to the given as those not to be missed upon nearing this place from far away. The importance of this notion for practice is in this, that in order to predict the final contact it is not always necessary to know a trajectory. Sometimes, it is sufficient to know only the tendency to near the state. In the trajectory itself closeness is naturally defined by its own order as arising in the primary CP statement. Though it by no means follows from the definition that any two points of a neighborhood can be connected with a trajectory, but if, for a point in it, we take only those trajectories that pass this point, then a neighborhood of this point exists there, generated by these trajectories and completely contained in the initial neighborhood. Though a neighborhood of a point in the contact space is not necessarily a neighborhood of any of its points, as is the case, e.g., in the Euclidean space, however, it still contains a neighborhood of this point.

A particular interest for CP present so-called *spacelike hypersurfaces* to be defined as comprising points, any two of which cannot be connected with a trajectory, whereas any other point of any trajectory crossing this hypersurface at one of its points can be connected to some other of its points with a trajectory.† This condition helps to introduce some own nearness in this hypersurface as induced by the trajectories that cross it, while not belonging to it. Indeed, let us take a trajectory crossing the hypersurface at some point and an interval on the trajectory containing this point. We define the

*In the canonical version, these — initial — conditions give rise to particular "principles". Starting with the requirement of the unique trajectory to be obtained in a solution, one could invent a means to specify this trajectory with the extreme value of something like the minimal length in a metric for geodesics or, equivalently, the least action principle in dynamics.

†In this context, the trajectories themselves are also called "timelike" lines; however, we will use only the term "trajectories", thereby accentuating their primary role with respect to the space.

related neighborhood in the hypersurface as all its points that can be connected with trajectories to the points of this interval (Fig. 1.5).

The boundary of this neighborhood, formed by photons, is to be excluded from it, so that the neighborhood will be an open set, each point of which having its own neighborhood completely contained there. The boundary forming a photon set is called a light cone. In contradistinction to usual surfaces in geometry, the specification of a light cone automatically defines also its decomposition into lines — the trajectories of photons, since no other "line" here is the trajectory of a body.

Let us consider so small an interval on a trajectory containing one (then only this) point of a spacelike hypersurface, such that the neighborhood induced by this interval is completely inside this hypersurface. In accord with the order of the trajectory in this interval, there is a sequence of neighborhoods, each one including the next, thus letting us introduce continuous mappings of this interval into the hypersurface using trajectories that actually do pass the points of this interval (Fig. 1.6). Such constructed sets of points in the hypersurface we will call a *path*. Hence, strictly speaking, paths are not trajectories! They are not a subject for operations with photon oscillation numbers. In particular, they are not bound to be simple arcs, and they can have various self-intersections. However, they are lines that are continuous with respect to the structure of neighborhoods on this spacelike hypersurface.

The role of a spacelike hypersurface as an envelope of all possible configurations of paths to be relevant in CP, consists in giving them the freedom to intersect. If the paths intersect, the related bodies might either or not have a contact, but if the paths do not intersect, the contact is impossible. What is then the minimal geometry, still observing the freedom of intersections? The answer is: a three-dimensional topologically Euclidean (i.e. including, for instance, also Riemannian) space. This space allows for various combinations of one-dimensional continua — lines, since it is always possible to round one line by another, while in only two dimensions some restrictions for CP exist not due to the features of acting forces but rather on their own: A line cannot leave the region inside another closed line without intersecting it. On the other hand, four dimensions would be redundant, since for an adequate description of paths with their intersections, its three-dimensional subspace would be sufficient.*

However, this answer implies ready notions like dimension and therefore might become ambiguous in finer problems, still leaving existent effective methods of CP. It might turn out that not all paths are relevant or we will need some complex arrangements of infinite sets of paths. There are, yet, extended bodies to be considered in the Newton's scheme as if "made up" of material points, and this concept involves geometrical ideas *a priori* not to be relevant, e.g., on micro-

*"Traffic interchanges" ensure the absence of collisions, while crossings require "traffic lights".

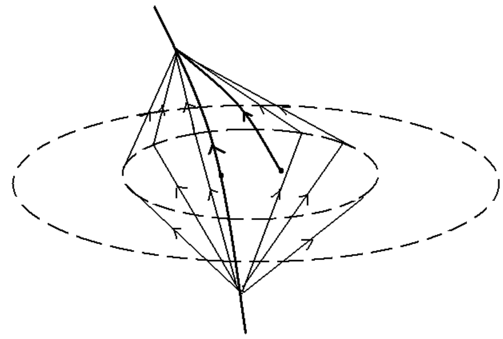

Fig. 1.5: Definition of neighborhoods on a spacelike hypersurface.

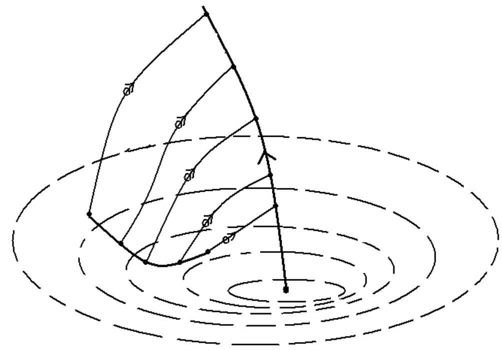

Fig. 1.6: The trajectory A is mapped (projected) into a path using a family of trajectories (thin lines) on the spacelike hypersurface, using a fixed trajectory Y. Paths are not oriented of their own. For this reason, they are shown without arrows.

scopic levels. We thus need the analysis of the commonly used concepts from the point of view readily accepted in CP.

Time and again, we start with the analysis of the canonical version, in which points of the space are considered as ready and specified with their coordinates. What is the way to measure coordinates? Using a ruler. The ruler is something made up of atoms, it is solid and straight, and measurements with it imply touching, i.e. contact. What is "solid and straight" will be discussed a bit later. Let us first consider the principal design of coordinate frames, i.e. what its essence and importance actually are. Indeed, what is the relevant space and how are numbers coordinated with its points?

In the related scope of mathematics, namely topology, these questions are united under the title "dimension theory". Let us briefly recall some results of this theory as applied to CP. Each point of an n-dimensional Euclidean space is being encoded with n numbers in order to distinguish one point from another, in other words, points and numbers are to be in one-to-one correspondence. However, already in the XIX century, Kantor realized that only one number is sufficient to this end. For visual simplicity, we confine the case to two dimensions ($n = 2$). Let us perform correspondence to the points of a unit square by means of the coordinates

$(0.a_1a_2\ldots, 0.b_1b_2\ldots)$, the point of a unit segment by means of the coordinate $0.a_1b_1a_2b_2\ldots$ This is a one-to-one correspondence, hence, the "quantity" of different points on one side of the square is the same (the same infinity!) as in the whole square. Why then are two coordinate sets needed? The reason is that this one-to-one correspondence is not continuous: It is not necessary that close points of the segment correspond to close points of the square. For example, two points of the segment 0.500… and 0.499… are infinitely close, while the "image" formed out of them — according to the said rule two points of the square (0.500…, 0.000…) and (0.499…, 0.999…) — will be on the opposite sides of the square. Now, it is impossible to find a correspondence between these that is both one-to-one and continuous in both directions (Brower).

But why do we require continuity? It might then happen that something else would be needed as well. Isn't it enough to find some needed numbers, upon calculating something somewhere, and so to subsequently make the prediction of the contact? And what is the meaning of "close" in CP? The answer is in this that an unlimited increase of the oscillation numbers in a contact implies the continuity (and even some smoothness, see below) of the trajectory. Discontinuity might result in the lost of the following, i.e. identity, and so a possible confusion renders CP meaningless. Frequently given examples make it possible to appreciate the danger.* Let us take a point in the square, its center, say, and define the distance between any two points as the sum of the usual distances for each of them from the center (the so-called uncountable "hedgehog"). If we encode the points of a square, as usual, by couples of coordinates, then points with adjacent coordinates though positioned on different rays aren't said to be "close" in the metrics of the "hedgehog" (Fig. 1.7).† Is this "hedgehog" two-dimensional as well?

In 1912, Poincare suggested an inductive definition of dimension allowing for the specification of a definite integer even to unusual geometrical constructions, while being equal to its dimension for a usual Euclidean space. According to his idea, "…for to partition space, one needs sets called surfaces; for to partition surfaces, one needs sets called lines; for to partition lines, one needs sets called points; we cannot step further, and a point cannot be partitioned…" (Partitioning means that the remainder is disconnected.)‡

Some other definitions of dimension have been suggested later on for various applications, and it has become popu-

*Close phone numbers don't necessary belong to neighbors.

†By analogy, in an environment with mountains and abysses, it might be easier to go around them.

‡This approach has been familiar to people, however, somewhat earlier. "The body, according to Apollodor in *Physics*, is something having three dimensions: length, width, and depth, this body is called volumetric. Surface is a visible limit of a body, it has a length and width, but has no depth. Line is a visible limit of surface, it has no width but only a length. Point is a limit of line, that is, the simplest sign." (Diogenes Laertius, *Lives and Opinions of Eminent Philosophers*.)

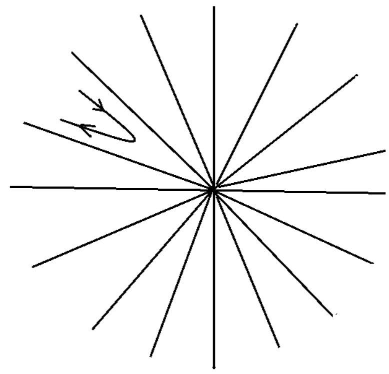

Fig. 1.7: The only way to get from one ray to another in the "hedgehog", is to pass its center.

lar to look for the types of spaces these definitions coincide. So, Lebesgue's notion of dimension relevant to integration problems is based on how many intersections of the topology defining ("open" or "closed") sets are there, which provide a covering of the space in their totality. So, if we cover an open (sides removed) square with small open squares, then some points of the large square fall in three small squares, and Lebesgue's dimension is defined as the integer smaller by 1 than this number, i.e. it equals 2.

All these concepts are based on closeness relationships, as being stated in advance in a point set, in order to give it the status of a "topological space". For a definite class of spaces, the Noebeling-Pontryagin theorem states that these might be topologically embedded in the Euclidean space of the dimension $2n + 1$, that is, so that the original closeness relationship will be intact. Intersections of neighborhoods of this Euclidean space with the embedded space form in the latter the same system of neighborhoods that it had of its own, and all neighborhoods of the original n-dimensional space will be so recovered. In particular, for the common representation of all finite and some infinite but not too complexly arranged sets of one-dimensional paths, the appropriate Euclidean space is three-dimensional. On the other hand, the "hedgehog" from Fig. 1.7, while also one-dimensional everywhere but its center, cannot be embedded into an Euclidean space, because its rays are too densely "glued" together. Although its neighborhoods can be obtained as intersections with it of open three-dimensional balls, the "hedgehog" has more neighborhoods. We have herein focused on the "hedgehog" geometry, because similar configurations will be met with in the sequel, and so we have had to outline their affordable limits.

As it turns out, this example demonstrates that topological restrictions are not very heavy for CP. Combinations comprising an infinite set of paths as well as a complexity of paths to be met with there will turn out to be even less sophisticated, so that the three-dimensional Euclidean space will always be sufficient. Most complicated situations are mainly met with in theories of propagation of various fields, in which expansions in the sets of regular functions are used. However, actual schemes based on photon oscillations require in essence still less restrictions with respect to closeness (adjacency). Various singularities, appearing mostly in the vicinity of contacts, where the numbers of oscillations increase infinitely, are potentially smoothed out automatically in the course of the measurement procedure itself, therefore *softening the needed continuity down to differentiability*. Ultimately, just the existence of a top speed is the cause of the smoothness of the Method's construction.

An important arrangement of trajectories is shown in Fig. 1.8. In the first step, for each trajectory their neighbors are found as those for which the oscillation numbers are the largest, and then the whole distribution of trajectories is so rearranged as to make the smallest of these largest numbers as small as possible. If in addition for each trajectory the ratio of the oscillation numbers between it and a pair of its neighbors equals unity, we receive a uniform distribution of trajectories over a *sphere* of constant absolute value of velocity (in terms of the canonical version). In terms of the same version, the sphere in Fig. 1.8 is pictured in the rest frame of its center. The ratios of oscillation numbers don't depend, of course, on a reference system, but the rest system is symmetric visually, hence allowing the use of a picturesque image, i.e., to introduce a fictitious central body and to count oscillations numbers between it and the bodies belonging to the sphere. Then a sphere might be defined by the unit ratio of the so-counted numbers for all pairs of its bodies. In the sequel we will use this image without additional explanations. In the same notations, it is possible to define a *ball* as a set of spheres with a common center, while having different oscillation numbers between the central body and the bodies belonging to different spheres.

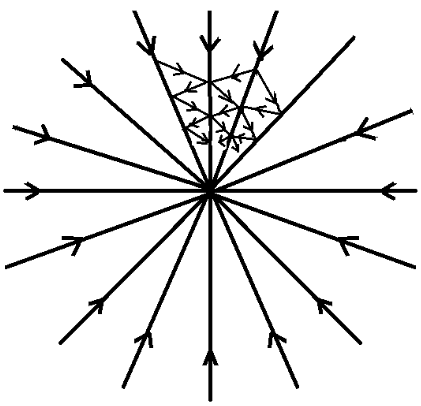

Fig. 1.8: Definition of the sphere via photon oscillations.

In two dimensions, the number of the bodies taking part in the sphere might be any. In three dimensions, however, only five strictly uniform distributions exist, since the third dimension introduces additional interrelations. These five relate the so-called "Platonic solids" or Plato bodies. Namely, four trajectories comprise the tetrahedron; six — the octahedron; eight — the cube; twelve — the icosahedron; twenty-the dodecahedron. These *stars* of trajectories have important applications in the Method to be discussed in connection with the elementary particles theory in Ch. 6. For other numbers of the bodies, a strict uniformity is impossible, but if this number is large, the deviation from uniformity is relatively small, and the distribution tends to uniformity upon increasing the number of the bodies to be accounted for in the limiting construction. In this "hedgehog" type arrangement of trajectories, their number remains only countable, and this is enough for it to be topologically embedded in the three-dimensional Euclidean space. However, in the limit of infinitely increasing the number of trajectories in the sphere, a subtle problem springs up due to the accompanying increase of the oscillation numbers.

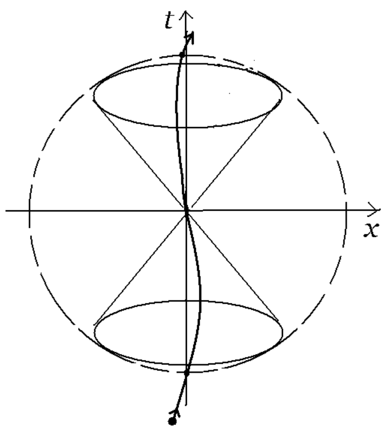

Fig. 1.9: Space-time diagram of the neighborhood; x represents the three space axes.

In terms of the canonical version, the ball consists of concentric spheres with various absolute values of their velocities. The totality of balls at all points of the spacelike hypersurface is the basic concept for further constructions of CP. An induced-by-trajectories neighborhood in the full contact space is topologically equivalent to the *space-time* of the canonical version. It is convenient to imagine this neighborhood with the diagram in Fig. 1.9 as the intersection of the interior of the light cone with Euclidean balls. The vertices of the cones fill the three-dimensional Euclidean space. This topology is uniform over the space and it is natural in CP, while it doesn't look like the familiar Euclidean topology. It is impossible to define the usual metric as a distance between any two points, the closeness of which would be specified by the smallness of its value. In particular, both mentioned definitions of dimension are equal to unity, and the spacelike hypersurfaces are zero-dimensional (discrete) for any number of coordinates, if we regard them as subspaces of the full contact space in this usual meaning that the neighborhoods on a subspace are the intersections with it of neighborhoods of the encompassing space (Fig. 1.10). It is worthwhile to mention in this context that the notion of closeness on a spacelike hypersurface as defined above by means of trajectories is needed solely for the adequate representation of the paths, while this definition does not turn by itself the very hypersurface in the subspace of the full contact space. We recall that the only motive to introduce closeness, i.e. a topology in the hypersurface is to remove non-existing contacts as the intersections of trajectories independently of their full combinations. The three-dimensional Euclidean structure is sufficient to ensure this.

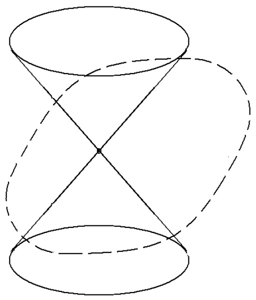

Fig. 1.10: Intersections of the light cones with the spacelike hypersurface induce only a discrete topology on it.

Further constructions of the Method will appear in this book whenever required in relevant applications. Each time it will mean an additional reduction of the scope of situations accessible within the framework of the Method. But then, each new construction provides a new possibility of effective prediction. Every time we will accurately formulate the conditions of the applicability in terms of the relevant contact schemes. The compromise between the meagerness of the initial information and the broad scope (range) of applications shall always be our main concern. We conclude finally that the actual content of the Method is just a "library" of particular cases collected according to a general approach rather than a "theory-of-everything" sometimes being dreamed about. The only requirement to a proposed construction is its realization within a relevant contact scheme. Outside this scope, one has to turn to some other science — not to physics. So certain hard restrictions on the language of the Method allow us to expect that everything compatible with its rules would necessarily be implemented in Nature's infinite self-diversification. One needs only to give a close observation to pick out in the real world, looking with a certain expectation at the surroundings, being armed with the Method in advance. Thus we have found the necessity and sufficiency of the three-dimensional Euclidean space to perform imaging of paths universally. This approach might seem as resulting from the very confined imaging of the World. Indeed, there exist, e.g., extended bodies, as it seems, besides any reference to paths. But the extension of a body reveals itself just as a restriction on possible paths. The three-dimensionality of a building is nothing but an obstacle to pass through its walls: A door is needed. A transparent glass wall for photons will not provide the impression of its extension unless you actually strike it on your very *path*.

Chapter 2. Forces in terms of contacts: prediction of the link

> The weakness of the principle of inertia lies in this, that it involves an argument in a circle: a mass moves without acceleration if it is sufficiently far from other bodies; we know that it is sufficiently far from other bodies only by the fact that it moves without acceleration.
>
> A. Einstein, *The Meaning of Relativity*

Such constructions as described in the previous chapter define only the general framework of CP, specifying the kit of tools that is sufficient for its statement, while being free of unnecessary items. However, as it was said, the prediction of the final contact (A, B) only when the whole trajectory is known makes no sense, since the result would then become known only at the (A, B) occurrence, when nothing could be changed. *Dynamic laws*, letting sometimes find a trajectory upon knowing only some its parts are of particular concern, providing actual predictions. So, even if it is found that in a given situation CP is applicable, an efficient solution to CP requires further restriction of its field.

In the idealized scheme with a material point only the exact intersection of trajectories is implied: It is not important how far they miss if they do. Then topology is enough, because any general scheme of a theory claiming universality cannot use some fixed scale of precision, hence, it is bound to confine to strict limiting sequences. It is implied that in a practical CP such a scale is conditioned by the application itself, and predictions are to be made already according to a (small) part of the trajectory. A possible approach consists in approximation of all the diversity of trajectories by means of some combinations of a special kit of *standard* trajectories, the mutual contacts in which are specified in advance, already before dealing with a particular CP, just as it is convenient to build a house using bricks or various functions using sinusoids.

In the canonical version, the role of standard trajectories is entrusted to those free of external influences. In flat space-time free trajectories are considered uniform and rectilinear. We shall frequently refer to this image for its visual familiarity, still keeping in mind that the only issue is the scheme of the mutual contacts of bodies. The kit of standard trajectories must be capable to represent any trajectory belonging to a class of interest as a sequence of standard ones, so that in the relevant construction of the limit these sequences tend to the contact of interest in CP, if actually existing. In the canonical version this sequence is a broken line, i.e. a chain of straight segments tangent to the given trajectory (Fig. 2.1). We anticipate to use the bodies from the measurement kit as the standard tangent bodies, and therefore we will use for these the same letters $X, Y \ldots$. Actually, of course, the problem of chains construction just shifts the prediction of the final contact to no less difficult problem of finding appropriate tangents and joining them to obtain the whole chain.

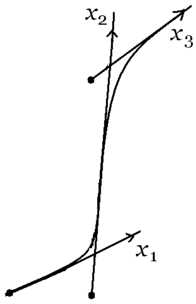

Fig. 2.1: Approximation of the trajectory with a chain of its tangents.

If a contact (A, B, X) exists, then the tangents Y to A and Z to B represent the last (inertial) links of a chain. This means that now it is (X, Y, Z) that is in question in CP, while (X, Y) is specified. The solution exists under the condition that in some neighborhood of (X, Y, Z) only this contact exists, otherwise some additional information would be needed to distinguish them. Since this information must be presented in terms of contacts as well, we would merely return to initial problem. Therefore even in general (within any particular CP) the first (1) requirement to the choice of measuring trajectories, which is at our disposal, consists in that any two of them either do not intersect or have a single contact. It follows that if any two points can be connected with a measuring trajectory, then only this one can be in the kit, since if one more existed, these two would have two mutual contacts. Besides this requirement, also the evident (2) requirement of completeness must be hold, i.e. the existence of contact at least with one measurement trajectory at arbitrary point of any trajectory. And the last (3) requirement to the measurement kit consists in this that any two contacts, which can belong to a trajectory were also belong to a measuring one (and then to only one, in view of (1)). The requirement (3) expresses the absence of a universal scale of distance a priory, in other words, a principal possibility for any interval to be the final in some PC.

The totality of uniform and rectilinear trajectories of the canonical version fulfills these requirements, of course. However, an idea might spring up as to the existence of some other properties of these in comparison to arbitrary trajectories, which idea is just one that Einstein discussed as cited in the epigraph to this chapter. In terms of contacts only these requirements are important, and they arise from the very statement of CP, unrelated to being "sufficiently far from other bodies". Simply, the solutions to CP provide predictions given initial conditions, including not only direct sources of influence on the contacts in question, but also a possible "surrounding". If this surrounding is such that it is impossible to find measuring trajectories with the required properties, CP cannot be solved. For example, one could state CP for bodies moving in an electric field in the presence of a gravitational field. Trajectories of measuring bodies as well as of photons are then no longer uniform and rectilinear, though CP still can be solvable unchanged by means of counting the oscillations numbers, provided the above requirements are still satisfied. However, outside the range of the particular CP the measuring trajectories are free to intersect many times, of course.

Only the trajectories belonging to the measurement kit are bound to intersect no more than once. Their intersections with other trajectories might be multiple, and just these are the base for dynamics. These contacts cannot be too dense as yet in order to leave the opportunity for (also infinite) photon oscillations. Consequently, the ratio of the number of these contacts to the number of photon oscillations must tend to zero in the converging sequence of the approximating chains. This corresponds to the concept of differentiability in analytical geometry.

Let us return to the prediction of (X, Y, Z). Of course, this contact might be predicted upon observing, as before, the tending to infinity of the number of oscillations with their finite ratios. However, now it is the contact of bodies from the measurement kit that is in question. Isn't possible basing on the particular properties of this kit to receive the prediction earlier? We describe first a possible procedure in canonical terms, that is, regarding the trajectories to be uniform and rectilinear and, moreover, provided with some definition of parallelism (to be discussed shortly), defining parallelism as the identity of velocity vectors rather than only of directions.

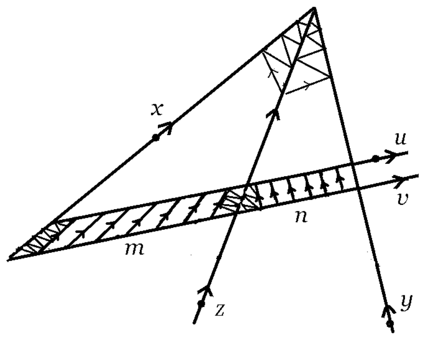

Fig. 2.2: Effective prediction of a contact.

Fixing (Y, Z), we look for a construction to predict (X, Y, Z) at a finite range, according to the order on any of the trajectories, to obtain a criterion for (X, Y, Z) to exist (Fig. 2.2). To this end, we draw an auxiliary trajectory U between X and Y and a parallel to this U', having also a contact with Y. The triangle of U, X and Y defines a plane, containing all the trajectories to be considered (If U' doesn't intersect X, the CP immediately is being solved in the negative, because then U', X and Y don't lie in the same plane). Next, we take a point on U and draw between X, Y and U' two sets of trajectories that are parallel: one set to X, another — to Y, so that in both sets (each one starting at its side from the mentioned point) the numbers of oscillations between neighboring trajectories (the "elements") are everywhere equal. Let it be n elements between (U, Y) and (U, Z) and m elements between (U, Y) and (U, X). Upon varying m given n, we are able to achieve (X, Y, Z), letting m and n tend to infinity while keeping given m/n. So, a relevant definition of parallelism would be enough to solve CP in this case. We propose the following scheme.

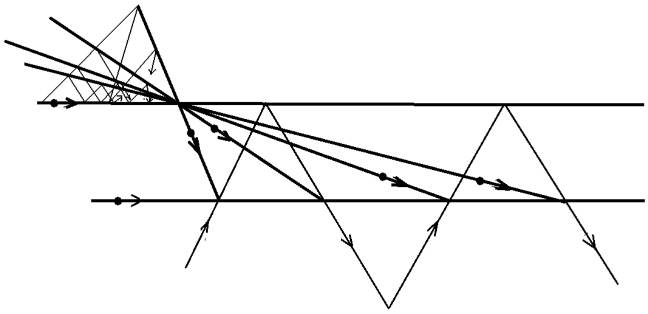

Fig. 2.3: Construction in a plane of a trajectory parallel to given, using solely the ratios of the (infinite) oscillation numbers.

In Fig. 2.3, a photon is received from infinity and emitted at a point of a first straight trajectory a parallel trajectory to be drawn to. The emitted photon is reflected somewhere to come back and to be emitted again toward infinity. In the plane, crossing all the arising light cones, a second straight trajectory is drawn, crossing all these four basic photon trajectories. We have to find the condition for the first and second trajectory to be parallel. To this end, at a point positioned before all these contacts we draw four straight auxiliary trajectories to connect this point with the contacts of the second trajectory with the basic photons. At the same point we specify the ratios of any three (infinite) oscillation numbers between the first trajectory and auxiliaries to that with the fourth auxiliary. Using these ratios, we determine from the system of three linear equations the moments of emission and returning of the two middle basic photons and also the points of contacts of the second trajectory with all four basic photons. If the second trajectory is parallel to the first, i.e. all four distances between them are the same, then these equations are homogeneous, and the equality of the determinant of the system to zero yields the dependence of its coefficients uniquely defined with the oscillation numbers ratios. Importantly, these ratios provide *the construction as a whole* rather than just to provide a condition of the trajectories to be parallel; otherwise it would be necessary to specify in advance also the contacts of emitting and receiving the photons on the first trajectory.

These schemes, solely in terms of contacts, unite for a plane space-time the concept of parallelism with the uniformity and rectilinearity of trajectories in one condition. Essentially, there is no separate definition for each of these properties. Any contact scheme regards their complex as an indivisible whole. Upon being included in the scheme of Fig. 2.2, the scheme in Fig. 2.3 directly specifies as the trajectories U and U', so also a pair of sets required for the prediction of the final contact.

Various ratios of the oscillations numbers define the set of trajectories parallel to the given, provided their combination satisfies equality to zero of the parallelism defining determinant. A simple way to select a particular trajectory out of this set is shown in Fig. 2.4. This can be done upon counting oscillation numbers between the parallel trajectories over the interval limited by the middle basic photons in Fig. 2.3, and it might be useful in constructing sequences of mutually parallel trajectories.

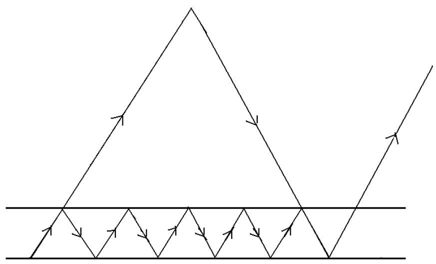

Fig. 2.4: A way to select a particular trajectory in the set of all parallel to the given.

Let us proceed in the approximation of a general trajectory by means of a chain comprised of the standard trajectories. The same measurement kit, as specified by its particular intersection scheme, might be used instead of standard trajectories in the approximations of general trajectories. According to the formulated above condition of CP applicability, for each point of a trajectory A there is a point on this trajectory, prior in the own order in A, to the first point and such that these two points are the intersections of A with one (then, only one) measuring trajectory (X_1 in Fig. 2.5), and there are no other their intersections in between. If it coincides with a measuring trajectory in this interval on A, then approximation is trivial. Otherwise, a point must be in this interval such that the trajectory between it and the final differs from a measuring one. Let us connect this point with a measuring trajectory to the final and so on. As pointed out in Ch. 1, the ratio of oscillation numbers between X_i and a measuring trajectory in general position Y to the similar ratio between X_i and A tends to zero upon nearing the final point. This will be the definition of the measuring trajectory tangent to A in this point in terms of contacts.

However, tangents in different points of a trajectory are not bound in general to have mutual contacts. So, their se-

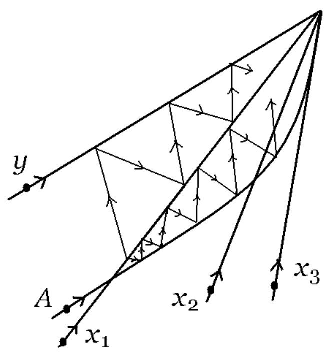

Fig. 2.5: The tangent to A is the standard trajectory that is the limit (if exists) for the sequence $X_1, X_2 \ldots$.

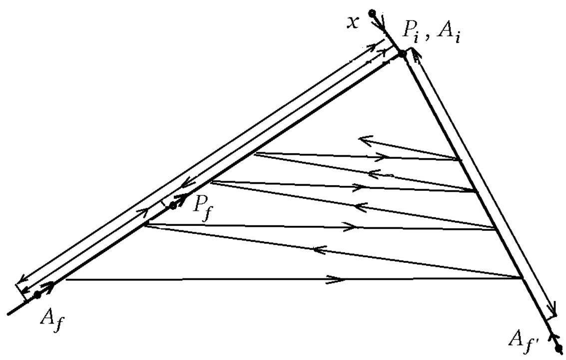

Fig. 2.6: The oscillation numbers are being counted between: 1) P_i and P_f; 2) P_i and $A_{f'}$; 3) P_f and $A_{f'}$.

quence fails to be a required chain. However, the opposite operation — the construction of a trajectory as the limit of approximating chains is possible, since in the relevant arrangement each link of each approximating chain defines the approximating tangent on its own. In other words, the sequence of approximating chains forms the sequence of the approximating tangents.

Having in hand the measurement kit, everything still needed to construct a chain is a relevant rule to define transitions between links at their contacts. The related transition is to be determined by some external influence on the motion of a body, considering the measuring bodies as not experiencing this influence. Otherwise, we cannot be sure that our conditions for the kit still holds (see, however, Ch. 5). The possibility of this separation is the next restriction on the applicability of the Method. In the canonical version, a force causes acceleration of the body, inversely proportional to its mass. But what is the way to measure force itself? As it was explained above, force is being measured according to acceleration of the bodies from a special test kit as specially constructed for this particular force. These are different from bodies in CP as stated above. The trajectories of this kit don't require a special means for encoding, because their acceleration might be measured with the same measurement kit. Indeed, we needn't construct chains for them, their use being only local to determine link transition at points of trajectories in CP, which are being determined link by link by these trajectories themselves.

A trivial solution would prescribe at each break of the broken line-chain to have a test body identical to that in CP. It is clear, however, that no prediction would then be possible, and one is left with pure observation of the motion of the body in question. Therefore, we let test bodies differ from this body, however, inasmuch as still to be expressible with a contact scheme. We denote a test trajectory as P. Then A_i and P_i will relate to the initial link and A_f and P_f to the final (Fig. 2.6).

We choose P_i to coincide with A_i to be detected by the equal zero ratio of the oscillations numbers between any of them and a trajectory in general position X to the oscillation number between them. In the common rest reference system of A_i and P_i the trajectories A_f and P_f are, generally speaking, diverging, still remaining collinear (to the first order). To determine A_f, known P_f, we should specify the ratio r oscillation numbers between P_f and A_f. However, the value of r alone doesn't determine A_f, since any A_f' belonging to the sphere with its center at the common contact (A_i, P_i, P_f, $A_{f'}$) has the same value of r. In order to find A_f, we have then to measure also the ratio of oscillations numbers between P_i and P_f to that between P_f and $A_{f'}$. The lowest value of this ratio, fixed r, specifies A_f collinear to P_f. The number r, expressing the difference between A and P, depends as on the external force, so also on the properties of A itself.*

Not sacrificing generality, it is now possible to reduce the full test kit, with any values of r whatever, to a kit, which in the canonical version corresponds to the kit comprising trajectories with various velocity vectors, because its intersection scheme is the same as that of the measurement kit. For this to be possible, we have to give to r in this kit the status of the universal standard for all CP's. The definition of this standard in terms of oscillation numbers ratios will be our main concern in Ch. 6. Moreover, practical applications of the scheme in Fig. 2.6 imply some restrictions on the smoothness of the distribution of a force in the contact space. If the force includes discontinuities on the scale of link, one should use here smaller links. In singular points, for instance, on the obstacles for the motion, CP cannot be used on its own, and then it will be a motion with ties, and these might even reduce the dimension of the motion area. A correct limiting process requires a coordination of the involved procedures solely in terms of contacts, and the necessary range of links with respect to a force should be estimated in accord with the deviation from zero of the ratio of oscillation numbers between P_i and a trajectory in general position to that between P_i and P_f. For the integration over the chain, the largest of these ratios should tend to zero. The obligatory condition to have free

*In terms of the canonical version, it would be its charge to mass ratio.

segments for the photon oscillations makes it possible to find the correct coordination of limiting sequences on many occasions, while in the canonical version this needs additional, often artificial, hypotheses.

Is it possible to set the test kit in an ordered arrangement, e.g., to provide it with coordinates? In Ch. 1 we defined a sphere comprised of trajectories with the common contact and all possible directions, though having the same absolute values of velocities. Alternatively, spheres can be defined with contact schemes (Fig. 1.8). This definition can be used to construct the whole test kit based on a finite (desirably small) number of trajectories, all others being defined using their oscillations numbers with the basics. It will then be possible to define the transitions between links requiring (again at the expense of further restriction on the class of permitted forces) these transitions to be specified only for the basis, while all other transitions are to be defined by means of counting the oscillation numbers between arbitrary trajectory and the basic trajectories.

Let us choose a non-degraded three of trajectories in the sphere, viz, such that the two ratios of the oscillations numbers between these bodies to that between them and the center don't define the third. Any such three with the common contact define a sphere, and there is the single reference system, in which they can be visualized as in Fig. 1.8. Then any other trajectory of the sphere possesses some definite ratios of the oscillation numbers between this body and each one of the basis to that between any of them and the basis center. These ratios will be the coordinates of the given trajectory. As it must be on a two-dimensional sphere, suffices it to fix just two coordinates. This definition can be extended on the whole ball, provided the basic sphere is specified. However, for each trajectory there exists its twin with the same ratios. It is easy to see this in the rest reference system of any of the basic bodies (Fig. 2.7).

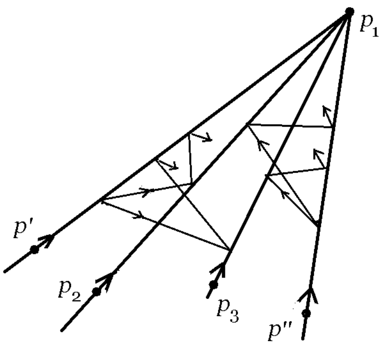

Fig. 2.7: In the reference frame, in which P_1 rests, the mirror-like positions of P' and P'' respective to the plane formed by P_2, P_3 are obvious.

For arbitrary trajectory, its "mirror" trajectory respective the plane (in general, surface) formed by two other basic trajectories will have the same ratios. Since these ratios, as any contact scheme, don't depend on a reference system, this representation is double-degenerated. The same degeneration exists, of course, in the measurement kit too.*

Let us now define the class of external forces with a naturally arising in CP uniform "conservation law" as the conservation of the oscillation numbers ratios under transition in initial-to-final links for arbitrary spheres in the test kit (Fig. 2.8). In view of the mentioned degeneration, this law should be completed with an auxiliary contact scheme to forbid spontaneous leaps to the mirror trajectory in the transitions, if it is important in a particular CP.

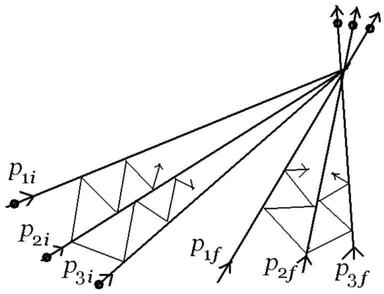

Fig. 2.8: As in Fig. 2.6, the final link is the continuation of the shown trajectories beyond their common contact.

In particular, it follows from this law that the oscillations numbers ratios between all pairs of initial and final links are equal 1. Since any trajectory can be represented via this basis, the transition for any test trajectory can be determined knowing only one of them. If the test bodies could be made identical, it remains to specify their charge and mass by some standard values (see below in Ch. 6).

Endeavoring to express via contact schemes everything in sight, we have introduced a condition on a possible force. It is interesting to look at what are the forces in the canonical version that satisfy this condition. It turns out that, for example, the Lorentz force does. In the canonical version, the three-dimensional forces are represented with the two real-valued three-component algebraic objects — the electric and magnetic field vectors. Upon considering fundamental issues, it is convenient to combine them in a complex-valued 16-component object (tensor). Algebraically, this object is represented with a four-to-four matrix, which accordingly must have only six independent components: three for electric and three for magnetic fields. This is reached with the requirement for it to be antisymmetrical: the four diagonal components equal zero, while off-diagonal components are the components of the field, and each one enters twice — with opposite signs. So happens, it is just antisymmetry that causes the conservation of the ratios of oscillation numbers under electromagnetic field influence according to the canonical version. In CP this argument should be reversed: just the only possible uniform over the whole contact space condition of

*This degeneration will further be important in the context of spin.

the oscillations numbers ratios conservation restricts the relevant forces by the requirement of their antisymmetry. As will be found in Ch. 6, antisymmetry is characteristic not only for electromagnetic, but also for the carriers of the weak and strong interactions (for bosons — integer spin particles) — gluons and heavy intermediate vector bosons, since they all are naturally being expressed with their contact schemes.

Chapter 3. Fields and their propagation: prediction of the chain

> But the properties of bodies are capable of quantitative measurement. We therefore obtain the numerical value of some property of the medium, such as the velocity with which a disturbance is propagated through it. . .
>
> J. C. Maxwell, *A Treatise on Electricity and Magnetism*

In order to restore the trajectory, according to only local data, suffices it to specify the force solely at the points of the trajectory itself, namely, at the next points in its progression. An alternative approach consists in the extension of the test kit, carrying information about forces, from the outset, so as to measure a force not only at the points of the trajectory but everywhere it might go. In so doing, we need not care already on the first step whatever the trajectory actually is. Being known from independent measurements also at all possible points, it would be known for the trajectory wherever it goes. If the force of its own doesn't depend on the trajectory (Such dependence might exist, e.g., due to the influence of the body in CP on the source of the force), then CP will naturally be divided in two independent steps: the determination of the distribution of the force and the construction of the trajectory under this force. Actually, no extension of the test kit is needed, provided an algorithm to determine the force is known in advance. The determination of the distribution of a "pre-force", i.e. the *field* is to be carried out by means of a universal rule independently of the charge of the body in CP itself. In this context, charge is only a factor to determine the effect of the field on the trajectory, and it does not define as yet the back influence of the body on the field, being its source. The very possibility to represent a force as a product of field and charge is being achieved in CP at expense of the introduction of the test kit in addition to the measurement kit.

Our task in this chapter will be to look for situations allowing for the prediction of field distributions in a region of the contact space according to its distribution somewhere else. In accord with the general approach, any method to make prediction might be regarded relevant as soon as it yields an unambiguous result basing solely on an initially specified distribution of contacts. Time and again: Nature scarcely refuses to answer so primitive questions.

Since everything is considered to be encoded with trajectories from the test kit as specified in some regions of the contact space, we shall have to deal with infinite sets of trajectories, and their compatibility with the constructed space geometry must be examined. The role of photons is particularly important in this respect, since the constructions they take a part in might be uniquely defined. In order to make clear the constructions themselves, we shall consider only one-component, that is, scalar fields. Later on, this variable should be defined with a contact scheme as well. However in preliminary geometrical constructions aiming to obtain the values of a field at a place via its values somewhere else, only some algebraic operations are needed, such as addition of the partial field values times real numbers. Later on these operations will be defined as contact schemes, but by now let us accept that they do exist.

First of all, we have to find the regions in the contact space, the values of the field at which uniquely determine its value at a given observation point. These regions can comprise only points that might be connected to the observation point with any trajectory whatever, in particular, with photons (Fig. 3.1). Photons form the boundary of the zone of influence for the given point, its "light cone". As mentioned, a light cone is not a usual surface but one that is defined along with its decomposition into lines — photon trajectories, containing no other trajectories.

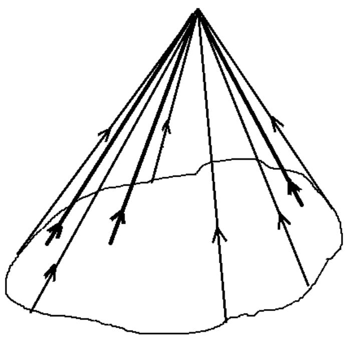

Fig. 3.1: Boundary photon trajectories form a light cone.

We begin with a partial problem, in which the value of the field at the observation point is being determined only with its arbitrary values as specified at some part of the zone of influence rather than with their differences caused by its deformations. The observation point itself cannot belong to this zone, of course, otherwise the field would be specified at this point, and nothing would be to look for there. Among all possible trajectories, coming to the observation point from its zone of influence, consider first their limiting subset, i.e. photons. Their contributions to the field value are independent of each other, since there are no trajectories that cross two photon trajectories having a contact while not joining this contact (Fig. 3.2).*

*Recall that all standard (i.e. measuring) trajectories, including photons, may have at most one contact within the kit.

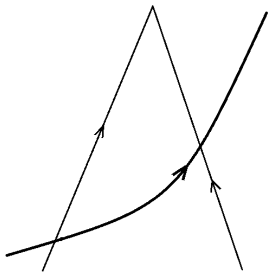

Fig. 3.2: Such trajectories never exist, otherwise the photons wouldn't be the fastest bodies, contrary to their definition.

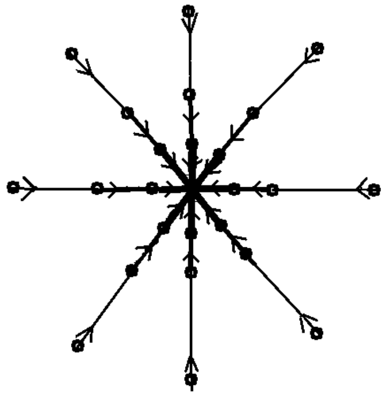

Fig. 3.3: Thicker lines show slower bodies; thin dashed lines show top-speed ones — photons.

Further, we can specify a field value only at a single point on each photon trajectory. Were there two such points, then the value at the point, which is closer over the photon ray to the observation point, would depend on the value at the second point. Indeed, if it were possible to change the field value at the observation point changing arbitrarily the value at the farther point and leaving all the others unchanged, then the field in the closer point would alter too, since taking it as an observation point of its own, while changing nothing at other points, we would get a different value at this point, although according to our condition this value is to be specified arbitrarily. For the same reason, it is forbidden to arbitrarily specify the field values on non-photon trajectories, since these have points that might be connected to other trajectories, hence again one value will depend on others. So, initial values could be specified independently of each other only on the past light cone and necessarily on every its trajectory (i.e. ray), for not to leave uncertainties, otherwise coming as the contribution from any ray that was not accounted for initially. But then, the required law of the field propagation must yield its value at the observation point given the whole (uncountable) set of independent of each other values at every ray on the light cone of the past.

An important particular case is a photon sphere formed as the limit of a sequence of massive spheres of a ball. Using the above mentioned artificial device to count oscillations with respect to the body at the ball center, we can visualize this limit as resulting from the tending to zero the ratio of oscillation numbers as counted between the center and a sphere of this ball to that for an arbitrarily chosen sphere from the ball (Fig. 3.3).

All the specified values on the rays contribute to the result with equal weights. Were the set of the rays finite, the natural solution would be to define the field value at the observation point (the center) as the mean arithmetical of its values over the limiting photon sphere. The extension of this definition on the infinite set of values implies a limiting process upon unlimited increasing the quantity of rays. In so doing, some universal measure is needed on the photon sphere. It must introduce some kind of uniformity ("democracy") in the distribution of the density of rays over the photon sphere, otherwise contributions to the value at the center would depend not only on the specified values over the cone but also on the number of rays contributing a particular value.

If it were not a photon sphere, it would be possible to introduce a uniform distribution of the initially specified values in terms of contacts like in Fig. 1.8. For the photon sphere this definition cannot be applied directly. A complex limit must then be in order, including the simultaneous tending to infinity the quantity of rays, keeping their symmetry on each step, and tending the sequence of the spheres to the photon sphere (Fig. 3.4).

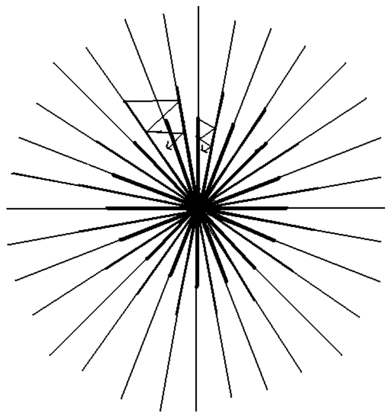

Fig. 3.4: Quantity of bodies in the spheres increases together with their symmetrization and the increase of their velocities.

An image of the construction is shown in Fig. 3.5. For the transition to the limit the moment of the contact of the photons is fictively shown as being before that of massive bodies. In the construction of the limit this outstripping, tending to zero in the limit, makes it possible to induce the uniform distribution of photons over their sphere with their imaginary contacts with the massive bodies of the ball interior.

The successive increase of the massive bodies in their spheres might be performed in accord with their "angular"

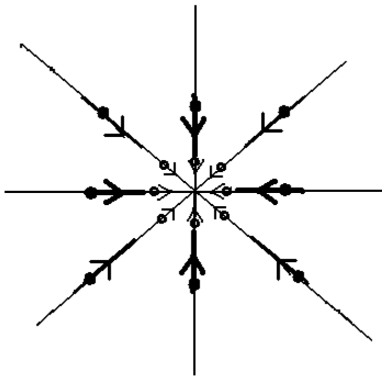

Fig. 3.5: The distribution of photons successively copies distributions on a sequence of the spheres along with the increase in their quantity and velocity.

distribution: once occupied, the angles in the closest to the center spheres are being kept in the farther ones, where the half-angle trajectories are being added in each next sphere. All this is being, of course, controlled by the photon oscillation ratios: they are being preserved in the successive (faster) spheres, while new trajectories enter to fill the angles. Since on each sphere the angles are equal, it is always possible to arrange the construction in such a way, that the oscillations, beginning in a sphere cover those in the slower ones.

This is the final construction, provided initial data are only the values of the field. However, it doesn't exhaust the abilities of contact schemes. It turns out that it is also possible to specify independently some differences of the field values, though the related procedure involves a definite coordination of algebraic operations in close points. It is impossible, as we know, to arbitrarily specify field value differences along a ray, since it would be equivalent to independently specifying these in two its points. There remain two options: either the differences between the values at the according points of the adjacent rays on the same light cone, or outside the cone (if a relevant contact scheme could be found to specify the closeness of points). We'll examine these variants separately.

In order to find the contribution to the value in the observation point from the differences of field values on different rays, we have to average these differences around the cone, i.e., first of all, to add them up. But this sum equals zero, because over rounding the cone we return to the initial point. Indeed, only one point can be taken on a ray, and then all the values will come in the sum in pairs with opposite senses (Fig. 3.6).

We are thus left with the differences between points outside the cone, i.e. the external differences (Fig. 3.7). These are to be averaged over the rays as well, but first we have to find the difference on a single ray to be then averaged. In the limit the difference will become the differential of the field, thus prior to the limit it must be non-zero and finite, otherwise nothing but zero or infinity will be obtained. In contradistinction to values of the field itself, their external differences might be specified in different points of the ray independently of each other. Even at the observation point this difference might be specified a priory, since it is the value of the field but not its differences that is the question in CP. It is therefore possible to define on each ray a depending on the differences finite value by means of adding up the external differences along the ray, so that in the limiting integral sequence with these differences tending to zero the number of the points on the ray, in which these differences are being taken, was increasing in accord.

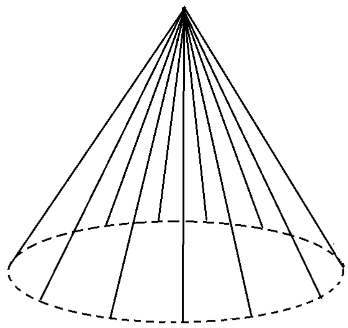

Fig. 3.6: Contributions from differences along a closed contour reciprocally compensate to zero.

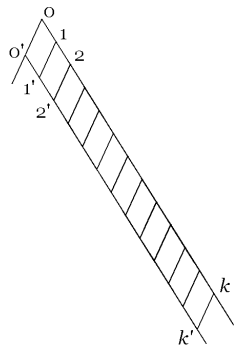

Fig. 3.7: External differences at the points on a ray as taken along the conjugated (opposite) rays.

Consider first the simplest problem, in which the difference is specified only at one point on each ray, namely, where earlier the field value has been specified itself, so it is the difference between this value and its value at the "close" point outside the cone. In order to obtain a finite quantity upon unlimited nearing these points, it is necessary to multiply this difference with a number that tends to infinity in accord with the tending of the difference to zero. On the other hand, this number must tend to zero upon nearing the observation point by the point, in which the value is specified. Indeed, then the field value here must become equal to the specified one upon any construction whatsoever, and no additional contribution able to change this value is tolerable. Therefore, the required number must reflect also the closeness of the points along the ray and, moreover, it must be defined similarly on all rays to receive a definite result in the course of further averaging.

If we find a united contact scheme to realize also the subdivision of the ray in segments which are identical (in the same sense) as with the segments of the conjugated ray the differences are being taken over, so also with the similar segments on other rays of the cone, then just the number of the subdivision points might be this very number.

Remember in this context, that the light cone itself is nothing more than an auxiliary construction, making sense exclusively for CP solving. Dividing CP in steps, we are at risk to fall into a non-necessary abstraction, so that auxiliary at the outset concepts start "living their own life, pretending to be valuable of their own". Such are, in particular, the concepts of space, time, reference and coordinate systems, various invariance "principles", seeking their substantiation in experiment, the self-evidence of which as a basing language of the Method is declared in the canonical version. In order to be protected against non-necessary abstractions, it is useful to return time and again to the primary concepts. We recall therefore that light cone is nothing else as a tool to find field values; field is a tool to find transitions between links in chains. Hence, the initial link of this transition is always present, however non-explicitly, in all our constructions. It is its turn now to take a highly important part in the general scheme. The dependence of the field determining scheme on a particular choice of a measuring trajectory brings no questions as soon as the algorithm of the solution doesn't depend on this choice, suggesting universally definite operations, though explicitly based on a particular choice of the initial link of a transition.

So, let us take arbitrary measurement trajectory going to the observation point — the vertex of its light cone of the past. Next, take on this trajectory a point before the observation point with its own light cone (Fig. 3.8). Draw a series of trajectories parallel to this one — $00'$ — so that the last goes to the point the field initial value is specified at. Make a subdivision of the ray into k segments under the condition that all (finite) oscillation numbers as counted from one cone to another were equal each other.

One more trajectory k_ek' parallel to kk' goes between past and future light cones. The number of oscillations between k_ek' and kk' is taken the same as for all k trajectories of the subdivision. The position of the initial point k being kept fixed, the number of oscillations depends on both k and the relative shift of the light cones. Tend k to infinity and the relative positions of the light cones so that the number of oscillations between the segments is infinitely increasing. Upon multiplying by k at each step of the limiting process the difference of the field values between the segments, we obtain in the limit the contribution of this ray to the value of the field in the observation point. The full contribution of the external differentials will then be obtained by averaging over the

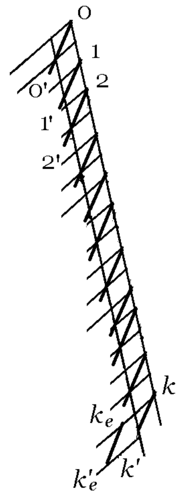

Fig. 3.8: Parallel trajectories for the construction of external differences.

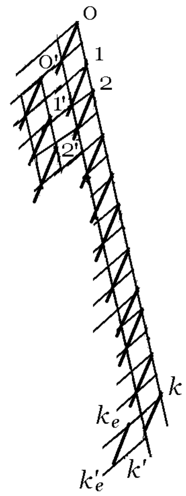

Fig. 3.9: Instead of being multiplied by k, the external differences should be added up from 0 through k.

rays, just as it was done before for the specified values of the field itself.

This particular case is interesting by itself exhausting, as will be elucidated further on, all geometrically permitted contributions for "free" field propagation. However, the developed in this case device of uniform subdivision of rays is also applicable in a broader context, when the external differences are specified not only at one point on each ray, but rather on the whole light cone. In this general situation, it is also possible to get finite quantities to be averaged over the rays, adding up external differences at all the subdivision points of the ray to use its own conjugated cone at each such point (Fig. 3.9).

In the limit, these differences become infinitely small, while their number accordingly increases. The result will be finite, provided the field falls out rapidly enough from the observation point along the rays (This condition is the next restriction on the fields acceptable in the Method.). The integral sum along a ray might also be presented in a somewhat different and more usable way. Replace the first order external differences with second order differences, that is, with differences of the first order differences taken between the adjacent points on the ray. However, if we directly add these differences up on the ray, we would get zero due to their reciprocal cancelling, as it was for the values at the points taken on different rays. In order to receive a non-zero quantity, let us first multiply the second order difference at each point by the number of the subdivision points up to this point from the observation point, and only then add up the results over the whole ray. The so obtained sum is the same as the direct sum of the first order differences, although it might be useful, e.g., provided the external differentials are being initially specified only in some isolated point on each ray: the differences should simply be set zero at all other points. It is not, however, possible to use the same device for the differences between points on the neighboring rays, since there is no initial point here similar to the observation point for a separate ray.

So exhausted is the variety of initial data as allowed for by the geometry of the contact space on light cones. All others either add up to zero, or are expressed via these. We turn now to the possibility to specify additional data *inside* the light cone. As we saw, it is forbidden to arbitrarily specify field values there, but differences could be specified in the same way as on the cone. However, in flat contact space the sum of these differences as taken over the whole interior of the cone is zero — again due their reciprocal cancellation: Whatever pair of adjacent points the difference is taken at, it is repeated with the opposite sense at another pair (Fig. 3.10).* Only over the boundary, the light cone, there is no compensation from outside (the Stocks' theorem). It seems that this compensation could be cured with the same device as was used on the cone itself, that is, to multiply each difference by the related subdivision points. As it is seen in Fig. 3.10, there is a point to start counting from: the primary light cone along the rays of its conjugated cone. Indeed, the sum will not be zero now, but then, in the limit it becomes infinite. Such a leap from zero to infinity comes from the change of dimension: inside the cone it is more by one than on it, so a finite sum of the differences on the ray is to be multiplied by the number of the subdivision points that is infinite in the limit. This is the reason for the Huygens' principle to be valid in flat (and only in flat) space, allowing to specify initial data only on the light cone.

So, the geometry of the contact space, coming into existence due to the requirement of maximum variety of the allowed trajectories, heavily restricts, in turn, the variety of allowed fields. It turns out that the constructed above solution is nothing else as the solution to the *wave* equation of

*What the term "flat" means, see in Ch. 5.

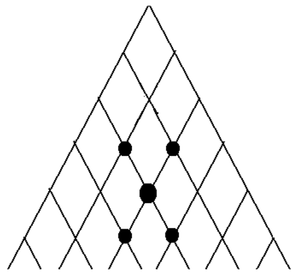

Fig. 3.10: A network inside the cone might be arranged solely with photon trajectories matching an already completed distribution of the cone in Fig. 3.9. However, the differences between the values in the network knots are being reciprocally compensated.

the canonical version. In the usual form of this version, the initial values of the function and its differentials are specific for the second order wave equation. The construction with only the values of the function specified at one point on each ray is known as the Kirchhoff solution to the Cauchy problem for the homogeneous wave equation describing a free field, whereas the construction with the specified also differentials on each ray corresponds to the solution of the nonhomogeneous wave equation, describing the field with specified sources.

In view of the asymmetry of the order relation on trajectories, contact schemes automatically select only retarded solution to the wave equation, while another one is considered in CP as "parasitic". It is possible, of course, to formally construct this second solution according to the same procedure, reverting order relations on the defining trajectories. However, the very meaning of CP would be ruined, since by the same reason one could change the order for only some trajectories or even on some segments of one of them. Such constructions (the so-called "Feynman paths") are used in the quantum field theory. However, this not CP but rather a probabilistic scheme as built on its base. In this scheme, the particle is present, as it were, at different points at once, and the particles are created and annihilated, although being registered individually by means of non-annihilating (as the experimenter always hopes) classical measuring devices. It is just these that are constructed according to CP schemes.

So, in the own statement of CP half of the solution are fictive. This is not a flaw of CP, as it would be were its predictions ambiguous. Similarly, a circle is described with a square equation, the second solution of which yields a negative radius "circle", and the parasitic solution is being excluded with a separate rule. But then, our construction comprises naturally solutions when insufficient smoothness of the initial field values makes the wave equation non-existing, since no needed derivatives are there. The well known construction of solutions in terms of generalized functions realizes integration using auxiliary sets of sufficiently smooth "basic" functions to imitate differentiation. However, this construction implies the wave equation itself as "fallen from heaven", whereas the above presented schemes immediately arise in the very CP statement.

Remember now that the field value itself must have its own contact scheme. Force is revealed in the breaks of chains (Fig. 2.6), and for the body in CP it comes via fields. Hence, the specified initial data for a field are to be expressed with inter-link transitions, though now applied to the test bodies. In order to find the field value at the observation point, where the force for CP will afterwards be determined, we have to transport all the transitions for test bodies to this point to be averaged there. In so doing, we have to realize everything we regarded insofar as known, namely, addition of the values and their products with real numbers.

We can use for this purpose the scheme of parallel trajectories (Fig. 2.3) to construct an oriented parallelogram using two such pairs (Fig. 3.11). The number of oscillations between the trajectories of one pair counted from one to another trajectory of another pair we compare to the analogous number if we exchange their roles. If, in particular, these pairs are such that the oscillation numbers are equal each other, then we'll refer the diagonals as *sums* of the trajectories.* The pairs are orthogonal, if the ratio of the oscillations numbers between the sum and the trajectories in the points of triple contacts equal 1.

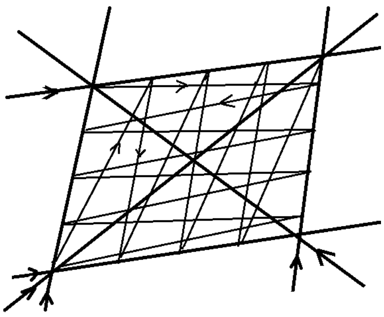

Fig. 3.11: The oriented parallelogram defines the operation of adding trajectories up.

Now we are in a position to define the sum of contributions from different rays in the observation point, so obtaining here the field value acting in CP in the limit of infinitesimal subdivisions. Initial data are no longer abstract quantities, serving earlier as a model to define the very procedure of the solution, but rather objects as defined with a contact scheme, viz., the transition between the links of a test trajectory. In order to find this in the observation point, we have to take the initial data to this point with a parallel transport. Averaging is being performed according to the scheme, once used to determine the transition in the CP trajectory on account of this transition for the test one (Fig. 2.6). In order to find the oscillations numbers defining the averaged trajectory, we have to divide the number of oscillations between the found sum and the initial link of the CP transition trajectory on the number of subdivision points. The transport of both links of the transition along the ray is being performed according to the prescription in Fig. 2.3. The external differentials are defined as the limits of differences after the parallel transport of the test bodies' links along the corresponding cones (Fig. 3.12). As shown in this figure, we have to add the third light cone to the construction in Fig. 3.8 to form the required difference. This difference is to be constructed in four steps. On the first step, the final link of the transition is transported along the conjugated ray. On the second step, the external difference is formed according to the "parallelogram rule". Then this difference is transported to the point the initial difference is to be specified at in two steps — along the conjugated and then along the basic light cones.

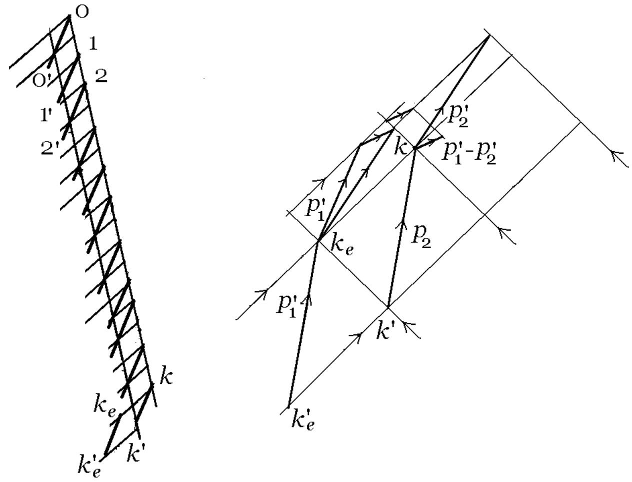

Fig. 3.12: Construction of the external difference on the ray with the parallel transport of the final link is shown in the right diagram. This difference is to be inserted as the initially specified datum in the corresponding place in the left diagram.

With all necessary procedures and quantities at hand, it is possible now to actually construct solutions for a free field. However, in a more general situation of a field with its sources, i.e. when the differentials are specified over the whole ray, the solution remains a phantom, still requiring measurements up to the final contact. A satisfactory solution is possible only if the needed differentials are known in advance, being represented with some separate contact scheme. It might happen, in particular, that the differences defining sources are the trajectories of external for CP bodies. In these cases, a self-consistent CP might include interactions, sometimes retarded, of two or more bodies. The electromagnetic Lorentz force gives the most important example of interaction admitting such problem statement. On the one hand, this force is being expressed with a uniform over the contact space scheme as preserving oscillations numbers ratios

*Otherwise, these will be weighted sums.

to provide its own description in these terms. As pointed out above, this force might therefore be represented as the antisymmetrical combination of the derivatives of potentials. On the other hand, its propagation with top velocity is expressible with the shown above schemes, hence, it is equivalent to the wave equation of the canonic version. In this version just the antisymmetry of the Lorentz force causes its spacetime derivatives (corresponding to the differentials of the field in the contact schemes) to be not arbitrary, but satisfying an additional continuity equation. However, the same equation expresses the condition of the field generating charged bodies to be non-disappearing upon comprising, e.g., some flux. Such fluxes might therefore play the role of sources in the wave equation, since in the scheme with second differences these are presented with antisymmetric combinations of the derivatives of the flow of bodies-sources. In the canonical version, it is just antisymmetry that causes the system of the second order wave equations for the field components to split into the first order system — the Maxwell equations. These are elegantly presented as in the antisymmetric tensor equations, so also by means of the alternating differential forms.

We have now to find a contact scheme suitable to present the differences in Fig. 3.12 in the own terms of the field sources rather than via the test bodies representing known in advance external fields. In this scheme, the source must be given directly with the trajectories of the bodies the source is comprised of. Then in the limiting process upon increasing the number of rays (Fig. 3.4), these trajectories are to contact the rays that are involved on each step. Otherwise, some sources might be lost. Whereas the test bodies we could put by will in the places needed in the solution scheme itself, the sources belong to the CP statement in their own right. Indeed, on each step of the limiting process to find the integration sum, the points, in which the initial data are specified, are being fixed with the very procedures of uniform subdivisions as along the rays, so also between them. These points are distributed discretely. Hence, the trajectories of the bodies-sources that miss the subdivision points will not be accounted for. We thus need a special contact scheme to smoothen the distributions of sources, realizing the idea of an averaged trajectory in the vicinity of a subdivision point. To this end, we have to parallel transport to a subdivision point the trajectories of the "closest" to it trajectories out of the source flux, and we stay in need for a definition of closeness for this case.

In the basic scheme in Fig. 1.2, the related oscillations numbers ratio turns zero if the contact is absent (Fig. 1.2b). Let us add a third body to this scheme (Fig. 3.13) and define the ratio of the oscillations numbers for these two "missing" bodies upon measuring the oscillation numbers — one between A and B, another between A and C — up to the supporting (A, X), which fixes a point of the implied subdivision.

It is now possible to specify the sources unambiguously in the full scheme of integration, parallel transporting the trajectory of the body-source to the closest point of the subdivision. This procedure completes the contact scheme equivalent to the concept of flux density in the canonical version. It isn't necessary, however, to know the trajectories of bodies-sources at full. Frequently, it is only the total flux of these bodies (especially, if these are numerous) that is important, so that, for example, the exchange of identical bodies doesn't alter their total field, even if it doesn't result from their actual motions. In essence, it is only the flux of their active factor, i.e. of their charge that is of importance. This issue is tightly connected with the procedure of gauging the charge, that is, of establishing its universal standard at all points of the contact space in the course of a special contact scheme to be presented in Ch. 6.

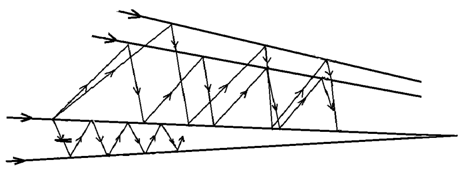

Fig. 3.13: Definition of the related closeness of the trajectories to a given point.

Thus, electrodynamics as well as mechanics might be deduced from a single condition: "Everything moving" must be an implementation of a scheme in CP. What remains doesn't belong to the Method, merely because then we would not distinguish and look for such things as space, bodies, forces, fields etc. Concepts a priori that we use to approach Nature with, must correspond to the purpose of our approach in order that its response will not be regarded as a meaningless "noise". This language is by no means arbitrary, basing instead on the main condition of the universality of predictions, on their unrestricted repeatability.

Chapter 4. Quantum theory: repeatability of the non-repeatable

> . . . we have to assume that there is a limit to the fineness of our powers of observation and the smallness of the accompanying disturbance — a limit which is inherent in the nature of things and can never be surpassed by improved technique or increased skill on the part of the observer.
>
> P. A. M. Dirac, *The Principles of Quantum Mechanics*

An important condition of applicability of the above described contact schemes to clearly isolated bodies is the ignoring of the effect of measuring contacts on their trajectories as those in CP or auxiliary. For the development of the Method from scratch, this strategy looks natural, since it merely suggests a reliable way to make predictions in a limited scope of problem considered meaningful for the implied user. In other words, the inventors of the Method begin with the analysis of practice endeavoring to elucidate what is actually desirable. However already in the course of discussing the basic constructions, the question about the limits of applicability of the Method is important. It is purposeful to analyze these limits from inside the Method, since it appears so successful, that even upon embarking on new problems the user is reluctant to reject it totally. Then the more, if these spring up within the Method itself and look as its natural continuation and refinement.

The schemes for CP solutions, as describing motions under external influence, lead on their own to the question, as to what will happen with their predictions, if the influences become weaker. Indeed, the measuring contact is an interaction as well, and it may happen that it is impossible to weaken it at will, while preserving the reliability of the registration of the very fact of contact. If CP is being stated about very light bodies or about very fine details of motions of even heavy bodies, it might happen that the effect of measuring contacts on the predictions of future contacts is no longer ignorable. But then, measuring contacts are unavoidably present in the very statement of CP, and even the concept of space and its properties were established solely as a tool for CP solutions using these contacts.

It seems that the Method fails as soon as the perturbation of motions by even most delicate measuring contacts becomes comparable with the external influence. It is just the measure of such delicacy that we have to determine, again with the contact schemes, that is, to select the cases, in which the Method could still be applied, perhaps not in its complete form.

Practice provides examples of possible extensions of the framework the Method could be applied in, while partially sacrificing the uniqueness of predictions to comply with only statistical description of actually pure mechanical situations, although in these cases it is not a measurement perturbation that is being met with but rather the complexity of the trajectories themselves, which in principle could be described as CP. These might be processes, in which along with a regular external force the body experiences multiple collisions, each one influencing the trajectories but weakly although adding up to yield an important effect. The most familiar example is the Brownian motion — the averaged effect of molecule collisions on the motion of a macroscopic body. The possibility of the description in terms of a diffusion random process is conditioned in this case by the sufficiently smooth averaged parameters of the medium allowing for taking into account the momenta only up to the variance of the random (Markov) process. Averaging methods are also useful in the description of the motion of a body in a bounded area under a force that is quite regular and simply specified with a contact scheme for the test bodies, but the collecting of deviations due to high order resonances, however small individually, leaves only probabilistic predictions to be reliable. In this case, a statistical description is relevant for sufficiently smooth initial distributions, and the particular features of the force provide the ergodicity and exponential local divergence of the trajectories.

All such cases are peculiar in this that CP in its original statement becomes no more than an auxiliary means, since the details of the force are but of minute importance, while the statistical, average features come to the first place. This means quite a new problem statement, disregarding individual predictions and implying multiple repetition of the situation with different outcomes given the precision of repeatability of the initial state.

Quantum mechanics implies the statistical approach too. However, this time the uncertainty comes from the measuring contacts themselves. In so doing, the probabilistic approach becomes intimately in touch with the basic concepts of the Method. Indeed, the very concept of trajectory has been realized in the Method with contact schemes of bodies (called particles in quantum mechanics, usually being applied to problems in micro) with some arrangements of special measuring bodies — as photons and massive bodies. It is expected that quantum mechanics might be applicable, provided the registration of measuring contacts is organized in such a way, that perturbation of the particle trajectory will be minimal, though already comparable with the external influence as found in measurements with macroscopic test bodies.

As distinct from the two above cited examples, in which a particular feature of the medium or a space distribution of the acting force immediately entered the problem conditions, now the very measuring device is to be so designed as to support the repeatability of at least probabilistic predictions with a relevant measuring procedure. This implies quite different output of experiments: we no longer predict the final contact at every case, limiting ourselves down to predicting only the probability of its occurrence in multiple measurements with "identical" initial data.

Apart from creation and annihilation of particles, we suppose the final contact of the particle to be registered unambiguously — "yes or no", since the next events are implied to occur beyond the problem limits. So, here the perturbation by measurements is no longer important according to CP statement, in which the same particle is being considered over the whole evolution. The evolution itself as well as its former realization as a trajectory is needed solely as an instrument to predict the final contact. Whenever the intermediate contacts don't influence this prediction, we can speak about a trajectory, but if the prediction of only the probability of the final contact is supposed, it is no longer obligatory to reduce the evolution down to a trajectory.

Carrying out all the discussion exclusively in terms of contacts, we have to modify the measurements in accord. So, instead of a somewhat uncertain notion of "macroscopic device", which is ultimately being reduced to the contact with a measuring body either directly or via a relevant gauge procedure, we try to extend this notion in still acceptable in mechanics way. To this end, let us analyze the structure of CP in more details. Actually, upon constructing solutions it was suggested that measuring bodies, implicitly forming vacuum, fill the contact space so densely that the body, CP is being stated about, meets a body from the measurement kit at every point of its trajectory. This introduces no problems if the measuring contact doesn't perturb the trajectory.* We have already seen, however, that in order to construct the trajectory we don't need for it to have measuring contacts everywhere. On the contrary, these contacts should not be distributed too densely, leaving room for photon oscillations. This kind of measurements defines the differentiability of the trajectory, letting it to be approximated with a chain of separate links. For the prediction of the final contact by means of trajectories, it is then necessary for the measurement kit to keep some regular structure as defined with photon oscillations between its bodies. However, this kit must be sufficiently dense, so that still affording differentiability, it does not let the trajectories be lost, that is, we demand that the absence of the contact with one measuring body implies its occurrence with some other. But in a process similar to Brownian motion the impacts of molecules are distributed at random. Actually, just two separate random processes are here: the random position of the molecule at the impact moment and the random momentum impart in its scattering. We could reduce the randomness of our prediction removing at least one of these factors. To this end, instead of the measuring device consisting of a single measuring body, we propose a new measuring device. Namely, we will employ particle contacts with the same measuring kit, while registering now measuring contacts not with a single measuring body, but with a group of them somewhat ordered — the *order*. In this registration, *we don't determine the particular measuring body of the order this contact took place with*. A sequence of such measurements doesn't give a trajectory in the former sense, but with a relevant arrangement of the orders it is still possible to make sometimes predictions about the final contact occurrence, although now it will be only its probability. The proposed extension of the concept of trajectory consists in this that afterwards upon constructing the evolution under external force effect, it will be possible to correspond the orders to links and chains, borrowed from macroscopic contact schemes for trajectories, so as to make it possible to define the orders themselves with some contact schemes.

Considering former trajectories from this new viewpoint, we might say that there the contact with a measuring body occurs with the probability equal one. Since the measuring kit fills the whole contact space, a non-one probability of the particle contact with definite measuring bodies means its contact with some others at the same moment.

A minimal departure from the former schemes consists in this that now only the contact of the particle with an order, not with some of its bodies, has a finite probability. If according to CP statement the particle doesn't disappear, while the scheme of mutual contacts in the measurement kit is left unchanged, any intermediate state might be considered as the final, accordingly reformulating CP. Therefore beyond the limit of sensitivity it is also possible to register the fact of a contact between the particle and a particular measuring body, but now this registration will become the final for CP.

In so doing, we try to keep the construction of space intact at the expense of making the particle trajectory, as it were, "spread", allowing for the simultaneous (in terms of the canonical version) contact with more than one measuring body without their common contact. Strictly speaking we have to accordingly change the very geometry of the contact space as a minimal structure encompassing all possible trajectories. This geometry will still be valid for the averaged trajectories multiply repeated, allowing for only probabilistic CP solutions, that is, fluctuating around these average.

Avoiding for the time being complications already on the initial step of presentation, we shall suggest the external influences on the particle trajectory to be specified with the trajectories of test bodies in fields as determined with the same contact schemes as before. Then we are in a position to divide the full influence on the particle in the parts, one of which is defined by the field independent of the particle evolution, and another depending only on its measuring contacts.†

In this description of motions, we have to replace standard trajectories-links in chains, which approximated actual trajectories upon neglecting measurement interactions, with links comprised of measuring orders. The latter are specially organized contrary to chaotically distributed molecules in the Brownian motion, acting on the motion of the macroscopic particle. This process might be called "semi-random". Accordingly the statement of CP is to be altered. In a macroscopic measurement one asks: "What is the value of the variable to be measured?" In quantum theory, for each individual measurement the question is being formulated differently: "Has the variable a specified in advance value?" Interaction with orders results in a random diffusion-type process in the scattering of the particle on macroscopic measuring bodies. Unlike the Brownian motion, this will be the scattering of a light particle on heavy bodies. In this approach, no hypotheses concerning Nature are there. We just try to ask familiar questions on the verge of their applicability, and the theory is simply restricting the scope of deserving our attention cases to those, where it is still able to make predictions.‡

In a sufficiently dense flux of the measuring bodies, the scattering of the particle on them might dominate the external interaction in its influence on the final position of the particle

*Otherwise, the body could not move at all pushing through measuring bodies.

†Further on, the external field values will be corrected in accord with the probabilistic schemes.

‡If some other interesting situations would be found, in which the description is not reduced to the registration of contacts, the theory might be different.

in the contact space. It is this boundary situation that is the issue of quantum mechanics in the canonical version, in which the measurement orders copy those determining the trajectory in cases when the measurement perturbation is inessential. Let us first consider the measurement process in terms of the canonical version, insofar as they express a CP statement and correspond to their own contact schemes, i.e. we shall use such quantities as velocity, acceleration, angular momentum etc. It is desirable to keep these concepts as long as possible in the extension of the scope of applicability of the Method, while matching them to the statistical description. In the canonical version these quantities are defined as operators acting on state amplitudes. These operators copy the forms, borrowed from the macroscopic CP, and such that their mean values fulfill classical relations. It is just the keeping of the CP statement, perhaps in a probabilistic form, as directly expressing the user's concern that explains the well-known paradox: "Why quantum theory with a different, statistical, type of predictions failed to elaborate its own forms for dynamical variables?"

The measurement order of measuring bodies with parallel trajectories and the particle inside is shown in Fig. 4.1. It is a measuring device completely constructed as a CP contact scheme. It is convenient to conceive vertical rows in Fig. 4.1 and similar in the transverse direction, which move together and without distortions of the order in the direction perpendicular to these rows. This scheme is in agree with the structure in Fig. 3.11 for the case of mutually orthogonal trajectories. The positions of the bodies in the order with respect to their neighbors are defined with the oscillations numbers, which are counted in such a way that the initial and final contacts in the neighboring intervals coincide within their longest periods. The total number of such periods must be sufficiently big to avoid the collection of the error coming from the difference in the position of end contacts within one period. The motion of the particle inside the order is in itself a purely measuring procedure, depending only on its collisions with the order bodies and not depending on the external force. Since it is only a contact with the order as a whole that is being registered, this procedure should not be regarded as existing in the same "time" as the motion of the particle in external fields. To simplify the presentation we'll consider the process of registration in the rest reference system of the order as a whole.

All the measuring bodies being taken identical, the fact of registration doesn't depend on the position of the body it happened with. In particular, the probabilities of this contact are the same for all the rows. If the order is uniform, that is, all the oscillation numbers are the same, and consists of infinitely many rows, then the probability of registration doesn't depend on the position of the row the contact occurred with within the order, hence the fact of registration provides no information about the place of the particle inside it. If also the velocity of the order is exactly the same as that of the particle, then the particle once positioned at a free place inside the order, would never be registered. Reversing the argument, it would be tempting to conclude from the absence of measuring contact of the particle with the order that their velocities are exactly equal. But the same would be observed if no particles were there. Therefore some residual interaction must still be kept to register the measuring contact. In the canonical version this interaction is naturally characterized by the lowest ("boundary") momentum value of the particle to be transferred to an order body in the act of registration, i.e. its boundary velocity relative the order.

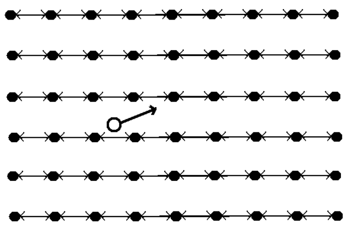

Fig. 4.1: A particle within the order of measuring bodies. Thin lines with arrows draw oscillating photons.

A single scattering contact doesn't necessarily result in the registration of the measurement contact and only multiple independent of one another collisions of the particle with the bodies of the order might at last produce the registration. In the elastic scattering of a light particle on infinitely heavy measuring body the absolute value of the momentum doesn't change. Then the existence of some fixed lowest value of the particle momentum means that the event of registration for the particle having only this absolute value might occur only in its scattering in the direction opposite to its motion. But on average the particle scatters over a small angle, and the probability of back scattering is low. Therefore, the particle having this value typically transfers but insufficient for registration momentum in a collision and only once after many collisions in the diffusion process the back scattering occurs. If only one non-disappearing particle is meant in CP, the measurement contact must occur only in inelastic scattering. Otherwise, second and more such contacts might occur, and the measurement would not be able to determine the number of involved particles. The inelastic scattering could always be interpreted as the transfer of the energy from the particle to an intermediate carrier-photon and from this photon to the body-detector. If we consider the photon as a harmonic entity, then some frequency might be ascribed to this minimum momentum, so being related to a wavelength of the photon, in turn defined by the minimum inter-row distance, in order to let photon oscillation process remain meaningful. So, we can regard the largest number of these oscillations as an equivalent in CP of the boundary particle velocity in the canonical version.

In the utmost precise measurement with the infinite number of tests the particle has only this boundary velocity. Of course, the particle with a different velocity will come into contact with this order as well, but it is possible then to choose a different velocity for the measuring order, for which the relative velocity of the particle turns boundary. Actually, this is the same as what is met with in macroscopic measurements (Fig. 2.5), where the tangent trajectory from the measurement kit is being matched to that of the body in CP.

Measurement contacts consist in the transfer of momentum from the particle to the order. If the particle has only the boundary velocity in the reference system of the order, then — loosing this value in the measurement interaction, it becomes at rest, i.e. not discernible. This causes no difficulty for an infinite order, since the particle has already been discerned. Infinite order detects the particle with the probability 1, however this order is not relevant for dynamics requiring localization of the particle in the contact space. To this end, we could use orders with a finite quantity of rows, again with the equal inter-row oscillations numbers. But in this order the measurement contact for a particle, having the relative velocity more than the boundary, though scattering over but a small angle to transfer the boundary momentum, might be more probable than the back scattering of the particle having only its boundary value. However, we are no longer able to use the criterion for the precise matching the velocities, hence, an uncertainty in the measurement of velocity springs up in the use of orders as the only measurement devices. Actually, localization is still uncertain too, because even for a fixed quantity of rows it is still possible to vary the number of inter-row oscillations numbers left free so far. So, once the measurement contact has been registered, it is still indefinite, in which row of the order this contact occurred as well as what the relative velocities was.

The uncertainty of measurements might be reduced, so not eliminated, if we construct the measurement device-order as a non-uniform sequence of rows. This order could also be completely defined with numbers of inter-row oscillations, which start and finish at once. Only now these numbers will not be equal each other. For instance, in some part of the order these numbers might be the biggest, while so decreasing according to some law in both directions that on its ends there is only one oscillation.* Thus, we tie the measurement up to the top velocity. Now we can introduce an averaged over the order oscillation number Q as the ratio of all the oscillation numbers in the order S to the number of its rows K. Next, we can define some law of the oscillation numbers decreasing q as a function of the row number k, as counted, e.g., from the row having maximal value of $q = q_{max}$ relative to its neighbors. In both directions this numbers could be defined independently of each other. These utmost dense rows are the most important ones for the localization of the particle, while the relative oscillation numbers in different its parts are to be normalized with Q.†

It is convenient to compare this way of localization to the measurement of the position of a particle in the canonical version, upon considering the quantity of rows, for which $q > Q$ and specifying q_{max} in terms of the boundary velocity as it was done above for the uniform order. As a model, let us consider an order with a single dense part and a simple law of the density of rows decreasing in the form of the geometric progression.‡ This order could be conveniently represented with the function of the kind $q(k) = q_{max} \exp(-a|k|)$ with $q(0) = q_{max}$ possibly with different values of a for its left and right branches as along the order velocity, so also in transverse directions. Suffices it to address only one right, say, branch ($k > 0$). Here $K = a^{-1} \ln q_{max}$ (since $q(K) = 1$). This immediately defines S and Q. The value of a defines the localization of rows in the order: if a tends to zero, the order becomes uniform and accordingly K goes to infinity. Let us subdivide the order into a dense part $q > Q$ and a rarefied part — $q < Q$ with the corresponding numbers of rows to give K in the sum. It is natural to normalize the probability of the measuring contact registration to the average oscillation number Q. For a Markov random process, becoming equivalent to diffusion when the quantity of rows is so big that a discrete process might be approximated with a continuous one, the numbers of rows are replaced with their density with respect to the now continuous variable k. The probability density will be relatively high in the dense part, so that the higher probability will be here, provided the velocity of the particle (in terms of the canonical version) is close to the boundary value. However, in a regular order only the angular scattering remains, hence the probability of the contact depends only on the quantity of rows the particle is able to cross. So, if the quantity of rows in the rarefied part is much more than that in the dense, the particle with the velocity value far from the boundary might have a high probability of the contact as well.

In this case, the velocity (so also the momentum) of the particle will be inversely proportional to the relative oscillation number, so that for Q oscillations it could cross the necessary for the contact registration quantity of even rarefied rows.

In our model, the ratio of the quantities of the dense rows to that of the rarefied ones $w = \ln(f \ln q_{max}) / \ln q_{max}$, where $f = [1 - \exp(-a)]/a$. Upon varying a from zero to infinity f decreases monotonously from unity to zero. Large values of a correspond to the small total quantity of rows, and anyway it must be $f \ln q_{max} > 1$, for the quantity of the rows to be a real number. Taking q_{max} so big that even $\ln q_{max} \gg 1$, while a not too big, we may regard $f \sim 1$ for the argument of the

*Since the velocity of the particle cannot exceed the top velocity, the total quantity of rows will be finite.

†In terms of the canonical version, on the parts with comparatively small oscillations numbers the distances between the rows are longer, and a slow particle cannot pass a required quantity of rows for Q oscillations to be registered with high probability.

‡We don't address here the quantum field theory with its more complex orders.

logarithm to get $w \sim \ln(\ln q_{max}) / \ln q_{max}$, so that even the repeated logarithm representing the quantity of the dense rows, must be much more than 1. Then the value of w practically depends only on that of q_{max}, completely defined by the least detectible measurement contact. So, in CP w is the analogue of the universal constant $\hbar$ of the canonical version, since the *ratio* of the quantity of the dense rows to that of the rarefied rows in the order is analogous to the *product* of the distances and momenta in the canonical uncertainty (or indeterminacy) principle.

An important modification of the non-uniform order, completely defined with oscillations numbers ratios, is presented in Fig. 4.2. It represents the own angular momentum of the particle, i.e. its spin, and might be understood as a combination of the non-uniform order and the two-dimensional sphere. In the direction perpendicular to the plane of the Fig. 4.2, we leave inter-row oscillation numbers to be uniform, while in the radial (and the related angular intervals) prescribing the same law: $q(k) = q_{max} \exp(-ak)$ with $q(0) = q_{max}$, k being the radial number of the measuring body. The largest "radius" corresponds to one oscillation independently of the angular quantity of rows: Upon increasing this quantity this radius increases as well as the initial with $q(0) = q_{max}$.

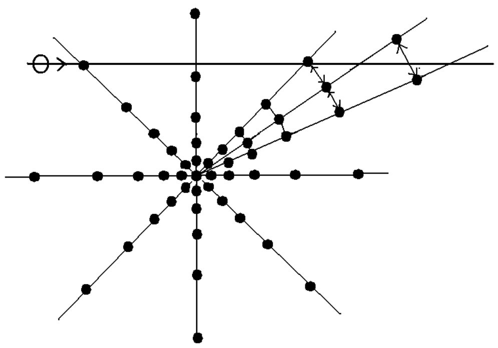

Fig. 4.2: The particle inside the order of the centered rows. Thin lines with arrows are the photon oscillations between the bodies from adjacent rows.

The analogue of the angular momentum in this contact scheme is again the ratio of the dense and rarefied rows, while now it will be interpreted as the realization with a contact scheme of the particle's spin, the existence of which has been mentioned in Ch. 2, but only as a necessary condition in the basis representations of trajectories, not supported as yet with a contact scheme. For the comparison with the canonical version we consider, as usually, the construction of spin in terms of distances and momenta. Given the initial radius r_i, the total quantity of rows K is specified by the value q_{max}, in turn, specified with the proportional to r_i distance $d(q_{max})$ between the rows for their quantity π/K. On its passing the order, the particle crosses one-by-one rows with the oscillation numbers $q(k)$. With the increase of r_i, given $d(q_{max})$ the K accordingly increases to decrease all $dq(k)$. The angular diffusion of the particle is a function of only the number of crossed rows necessary for its scattering with the average probability in a collision, corresponding to the transfer of the boundary momentum, given the absolute value of its velocity. In the vicinity of any k, the required quantity of crossed rows for the measurement contact to occur, increases with K, in turn, corresponding to a smaller velocity. Then the product of r_i and the averaged over the order velocity doesn't depend on r_i, so representing the own angular momentum of the particle, i.e. its spin. Being so defined, spin is completely specified by q_{max}, in contradistinction to the orbital momentum with its independent values of radius and velocity.

The discussed in Ch. 2 presence of twin trajectories in the sphere as represented with their decomposition in a basis, is innocuous if the diffusion accompanying measurements is neglected, since in any CP this uncertainty might be eliminated by means of a definite choice of the basic trajectories. Continuity of trajectories allows for the preservation of orientation along the chain, ascribing to the next link the orientation of the previous. However, in quantum theory indispensible measurement scattering introduces uncertainty in orientation, Spin makes it possible to remove this uncertainty, providing a "mark" on the particle.

One more example, illustrating registration schemes, is a screen with a slit (Fig. 4.3). The notion "screen" corresponds as its definition to a particular order of measuring bodies, belonging to "vacuum" in CP. Indeed, how to recognize the existence of a slit in the screen? It is "seen". This can be found upon passing bodies through it (in particular, light). In so doing, it would be incorrect to check everything on and then to turn the flux of measuring bodies off: what if the slit then gets obstructed? So, the screen itself as occupying a place in space should be considered in CP as a contact scheme, which defines limitations on the mutual contacts of moving bodies. So, the screen in Fig. 4.3 lets some trajectories pass, while blocking all others.

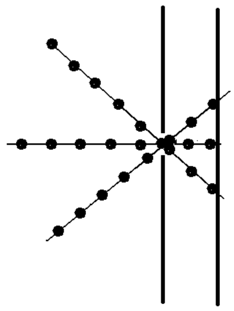

Fig. 4.3: The screen with a slit is specified by its effect on measuring trajectories.

Let us consider in this context the effect of interference in passing by the particle the screen with two slits (Fig. 4.4).

We have to consider the passing of particles through the slits on the background of the measurement order for just this

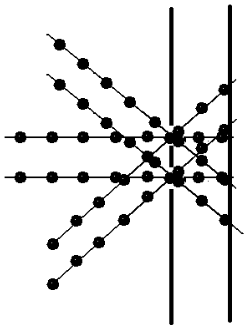

Fig. 4.4: The interference experiment with a double-slit screen.

screen and just this experiment statement: The order must have nearly the same velocity as the particles. If also this order is about uniform on the experiment scale, the scattering of the particles on its bodies will form an interference pattern in the distribution of the particles over the detector plane. Considering scattering on the measuring bodies, it is purposeful to correspond to the periodic structure of the uniform order a harmonic function with its period as defined by the numbers of the inter-row oscillations. Since the slits cut out a part of the full flux of particles, the total order to represent the screen includes also skew fluxes as shown in Fig. 4.4. Ignoring the sickness of the screen* the oscillations numbers are about the same for all the components of the total flux and equal to the velocity of the particles divided by the distance between the slits. A joint order for the two slits is characterized by the same values of these numbers for its two parts.

The trajectory of a particle as registered with its contacts with the measuring kit remains a continuous line as soon as the particle doesn't disappear, so might be detected in every neighborhood of a point it has been detected earlier. However, this trajectory is no longer a differentiable curve in the contact space. Indeed, a sequence of measuring contacts as corresponded to a trajectory cannot be locally approximated with a segment of the trajectory of a measuring body, because in diffusive collisions with measuring bodies the displacements are proportional not to time intervals but to square root of them, hence the velocity as defined with the ratio of distance to time becomes infinite as time interval tends to zero. We highlight that it would be entirely wrong to regard the "genuine" trajectory as smooth though seeming "rugged" due to an imperfect measurement procedure. The only available information about trajectories is the sequences of measuring contacts and only this. In this respect it might be possible to consider quantum mechanics as a structure *on* the basic geometry as specified with the classical scheme of mutual contacts. Then even in a free motion, i.e. in the absence of external influences, the particle moves over non-smooth diffusion trajectory due to its collisions with measuring trajectories, since were these absent, no information concerning this trajectory could exist. However, the measurement procedure is peculiar. Just this semi-random measuring process with the scattering on regular orders enables such phenomenon as interference, not to be met with in the Brownian motion or alike.

Multiply repeated measurements using orders identical in their distribution of the oscillations numbers create the statistical representation of the motion of a particle. It is then possible to describe the measuring interaction of the particle with an order in terms of a function defining the probability distribution of its trajectory as being measured with an order. Namely, each order as a measuring device, corresponding to some classical observable, appears as selecting from this function one of its own eigenvalues depending on whether or not this order had registered its contact with the particle. In terms of the canonical version, e.g., the fact of registration of the particle's contact with a non-uniform order, having a definite velocity vector and a value of a, defines the related variables within the precision limited by the uncertainty relation. Mean values as determined in the course of numerous measurements will coincide with the motion of the order in view of the symmetry of the scattering in the collisions. The particle being suggested non-disappearing and the kit of the orders full, the probability for it to be registered with at least one of them that is to be equal to the sum of the probabilities for all orders under independent measurements must be one.

Starting the description, in terms of contacts, of quantum processes under external influences, we will limit ourselves to the classically specified external fields as being measured with macroscopic test bodies ignoring their scattering. In so doing, the inter-link transitions in chains are defined as having the same ratios of their oscillations numbers as the related orders: Orders as the measurement devices move in the same way as measuring bodies were in the absence of measuring perturbations. On average, the particle in CP follows the chain transitions of the orders in accord with the trajectories of the test bodies.

However, because of uncertainty of the momentum of the particle inside the order its particular momentum in a probability distribution in the initial link in a transition depends on the place in the order the measurement contact took place at. So, in the part of an order with relatively small oscillations numbers the particle with an insufficient velocity will not be registered over the average oscillations number for this order, being unable to cross the required for the measurement contact quantity of rows. Therefore, a peculiar quantum dependence arises in the momentum transition upon averaging over the quantum ensemble, which doesn't depend on the external influence but rather being determined in the each transition by the probability distribution of the particle velocities respective the order.

In terms of the canonical version, the average velocity vector might be determined by means of decomposition of

*Screen is not a collimator!

the distribution into pieces, the distribution being then averaged over these pieces. If a piece is sufficiently small, the registered velocity is nearly constant over it, and in the total averaging each piece is to be accounted for with the weight equal to its part of the whole probability (Fig. 4.5). Just this is the velocity, the related order must move with.

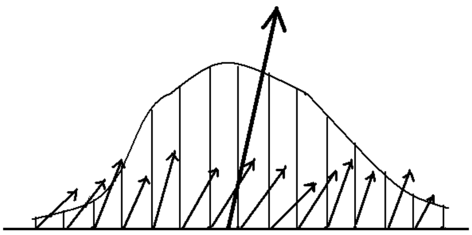

Fig. 4.5: The operation of velocity averaging.

In order to find the transition in a chain comprised of links-orders, adequate to the local change of the probability distribution for the particle (Fig. 4.6), it is necessary first to add up velocity vectors with their probability weights distributed over x_1 at the moment t_1 in the intermediate moment t_2 at the point x_2, so obtaining the average velocity on the initial link.

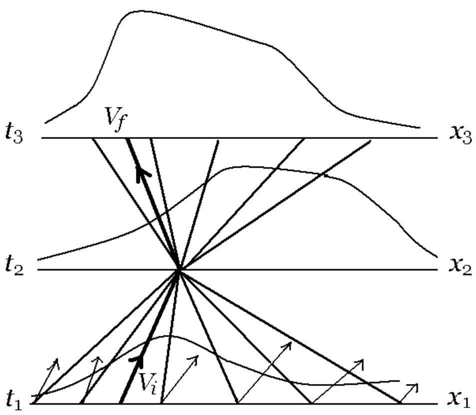

Fig. 4.6: Particle positions probability distribution functions in three close time moments. The x axis represents all three coordinates.

On the initial link, the particle is scattered by the measurement order having the velocity V_i. On the final link, the average velocity differs from V_i under the external acceleration on the interval between t_1 and t_2, and the contribution from each point on the axis x_2 on the part between t_2 and t_3 in the distribution along x_3 depends on the scattering by the order with the velocity V_f.

So the diffusive scattering by the orders on the initial and final links of the transition is important even on the infinitesimal intervals. Because of this the average velocities and variances are no longer some prescribed functions as is the case of Brownian-type motions, but now depending on the distribution itself. Moreover, even apart from external forces, upon virtually dividing the trajectory into small parts, we would obtain its effective perturbation as if due to an external force that alters its momentum over a given time interval.*

A developing quantum process could be conveniently described with the formalism of the "Madelung fluid", in which the substitution of the wave function in its exponential form in the Schrödinger equation provides the representation of this process with a classical Hamilton-Jacobi equation, though including in addition to the external potential the so-called "quantum potential" that depends on the wave function itself. In our construction of the order, this potential is directly connected with the uncertainty principle, because the averaged over the order addition to its velocity for a specified time interval, depending on the probability distribution, is an equivalent to altering the external force to be defined as a cause of changing the momentum for this time interval. A complex-valued and possibly multi-component ("wave") function of a point in the contact space is sufficient for probabilistic predictions in CP, provided the sum of their amplitude absolute values squared is interpreted as the probability for the particle to be found at a point.

The constructions of orders solely by means of the photon oscillations counting would correspond in canonical version to the relativistic quantum mechanics, in which the Schrödinger equation is to be replaced with the Dirac equation. The dependence of the full potential on the amplitude of the wave function in the Madelung formalism is still relevant, but now the diffusive addition to the probability of the inter-link transition is proportional not just to the second derivative of this amplitude absolute value as it is in the Schrödinger equation, but to a more complicated combination of this amplitude with the external field including also their derivatives. In our representation with orders this contribution results not only from the distribution of velocities over the order but also from the distribution of the external force there. Therefore, the scheme becomes nonlocal. Depending on a particular CP statement, this nonlocal behavior might appear also in a macroscopic measurement as soon as it might be represented with a relevant order.

The solutions to quantum equations define possible distributions of the particle states. In particular, if two or more identical particles are confined by an external field (as the field of the nucleus in an atom) in a phase space region of the order of quantum uncertainty, then they can contact with the same order at once, and therefore this order cannot be regarded as belonging to a definite distribution of a single particle. The measurement scattering thus masks their state inside the region. Once registering a contact with the order, it would be impossible even to say how many particles are there, and a separate "Pauli principle" is needed to for-

*Such is, e.g., the spreading of a wave packet in its free motion.

bid such a situation.* Even placing the particles in separate though partially interlacing states, it is not possible to exclude their exchange. This transposition could be considered as an additional "exchange" interaction, since it might select stationary states similarly to an external potential out of those defined by the external potential alone.

Chapter 5. Gravity: a forceless force

> Proposition 7, part III.
> That there is a power of gravity pertaining to all bodies, proportional to the several quantities of matter which they contain.
>
> I. Newton, *Mathematical Principles of Natural Philosophy*

The necessary component for CP solution — an external force must be presented with trajectories of the test kit bodies to be expressed, in turn, in terms of contacts with trajectories from the measurement kit. In this context, a question arises as to the existence of the utmost general scheme of free contacts for a single link, not using a separate kit of test bodies, though dispensing with chains with their inter-link transitions.

If no test kit is there, then no coupling constant like charge is needed any longer to define trajectories using forces. Consequently, this force must be directly expressed with photon oscillation numbers. Keeping the idea of inertia to predict contacts with CP solutions, we have to keep also the related concept of mass, and then the only possibility to eliminate coupling constants consists in this that to make the charge of a body to be equal to its mass. Then their ratio becomes a universal constant, and the motion will not depend on the individual properties of bodies, so generalizing the concept of motion that is free of external influences.

In the constructions of the last two chapters we systematically used the concept of the trajectories' parallelism. In flat space-time of the canonical version this concept is realized with rectilinear trajectories having equal velocity vectors. Sets of straight lines possess also a remarkable feature that any pair of them either don't intersect or have only one point in common. However, not all features of straight lines are so exhausted. Suffices it to draw straight lines on a sheet, which will then be arbitrarily deformed, but neither cut nor (its parts) glued together. Straight lines become curved but the scheme of their intersections remains the same: If initially the lines either intersected only once or not intersected, their images feature the same. However, a particular way to construct parallel trajectories presented in Ch. 2 doesn't guarantee all the properties of their sequences. Let a sequence consisting of parallel standard trajectories is such that for each of its trajectories the next is closer to it than the previous. In terms of contact schemes like that shown in Fig. 5.1, this means that the oscillations number in a scheme between this trajectory and the next is bigger than that between it and the previous.

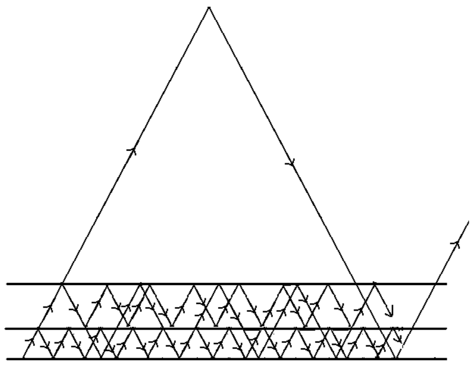

Fig. 5.1: The converging sequence of parallel trajectories.

The limiting for this sequence trajectory is determined upon tending these numbers to infinity. In flat space-time simple transitivity exists: If we specify the numbers of oscillations between the first and the second and the same between the second and the third trajectories as shown in Fig. 5.1, then a linear combination of these determines the number of oscillations between the first and the third trajectories. In a curved space-time this relation will be non-linear. So, it is possible to characterize this deviation from linearity as violating the transitivity of parallelism, which might be different in different parts of the contact space.

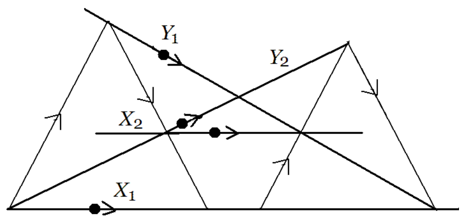

Fig. 5.2: In this scheme the parallelism of X_1 and X_2 depends on the existence of (Y_1, Y_2).

A different from shown in Fig. 2.3 construction of a trajectory that is parallel to a given was proposed by Marzke and Wheeler (1964). Their contact scheme is shown in Fig. 5.2. The parallelism of X_1 and X_2 follows from the similarity of the triangles formed by the contact of Y_1 and Y_2. In a curved space-time these two could, generally speaking, fail to come into contact, so the proof fails. This scheme cannot be generalized on a curved space-time, because it no longer provides a definite trajectory, continuously tending to a parallel to the given trajectory upon the decrease of curvature. Therefore, the authors were bound to construct a chain as being comprised of piece-wise straight links. But in an acceptable contact scheme, a trajectory that is not influenced by an external force must be a single link devoid of inter-link transitions.

*It is still possible to distinguish two particles with their spins orientations.

The scheme in Fig. 2.3 is satisfactory in this respect.

But what is bad, if the trajectories in the sequence shown in Fig. 5.1 were not parallel? Since the convergence of the trajectories is specified with the infinite increase of the numbers of the oscillations between them, the limiting trajectory would not be uniquely determined, provided these numbers could tend to infinity due to a different cause. In particular, a false sequence might occur if some its adjacent members come into contact somewhere, so that the oscillations number becomes infinite already here. Just to eliminate this possibility the parallelism is needed.

So far the concept of test bodies as a source of information was basic to determine the force that accelerates a body in CP, that is, the transitions between the tangents to its trajectory. Of course, the violation of transitivity of parallelism is able to simulate an external force on its own. It seems that it is always possible to distinguish these situations in the same way as it was done in Ch. 2, that is, to choose for the test bodies neutral or heavy ones, the motion of which is not affected by an external force. In so doing, it is implied that oscillating photons don't feel this force. But if the main ingredient of contact schemes, i.e. the trajectories of top velocity bodies (photons) depend on curvature as well, then a curved contact space itself as a contact scheme for free trajectories might be applied unchanged. It is possible logically, hence must exist in Nature, because CP is that primitive.

This peculiar interaction requiring no test bodies is known as gravitation. Its source is the presence of bodies, which influence in the canonical version as the motions of bodies themselves, so also the propagation of fields. In particular, the propagation of light possesses an interesting property (the so-called Huygens' tail): The contact space curvature lets the inside of the light cone contribute to the solution.* In Ch. 3, the inside of the light cone was deprived of the initial data specification, because this contributes to the solution with the relevant contact scheme nothing but either zero or infinity. It might easily be found, however, that a finite contribution, impossible in the degenerate plane case, can exist, provided that instead of multiplying initial values by discrete natural numbers (although tending in the limit to the dense subset of the compact) to use a continuous function of points $V(x, y)$. Indeed, the differences of this function values are also approaching zero, when the points near each other upon increasing their quantity in the compact area inside the cone. In general, this possibility cannot be ignored, if it is possible to find a contact scheme to realize the required function. The initial value to construct this function might be (see Fig. 5.1) the ratio of the oscillation numbers between X_i and X_{i+2} to that between X_{i+1} and X_i for the symmetric positions of X_i and X_{i+2} respective X_{i+1} if (X_i, X_{i+1}, X_{i+2}) exists. In particular, these trajectories might be parallel, i.e. with their triple contact at infinity. In the limit, all these numbers go to infinity, while their ratio might remain finite presenting the local contact space curvature. It is 1/2 for plane contact space, and the deviation from 1/2 will be taken as the measure of the space curvature $K(x)$.† The construction goes in steps. On the first step, an auxiliary function $U(x, y)$ for a pair of points of a ray depending on the space curvature is defined (Fig. 5.3). To this end, on the trajectory X_x a point x' with its light cone is taken close to x. As above (in Ch. 3), k trajectories are so taken between x and y that each of them is parallel to its preceding. The distribution of these trajectories along the ray is specified with some fixed number of oscillations n between the neighboring trajectories "from cone to cone". Then the own cone of the point y' positioned on the intersection of X_y with the cone of x' is taken. On both cones at x and y' we construct uniformly distributed sets, consisting of sufficiently big (not necessary equal) quantities of photon trajectories. We chose out of these a bunch of trajectories close to that from x to y on the cone of x and the reciprocal bunch from the light cone of the future of y just covering the first one. The ratio of the quantities of the trajectories in each bunch to their total quantity in the uniform distribution over the cone is analogous to the ratio of the area occupied by the bunch to the total area of the two-dimensional sphere of photons. In flat contact space, their solid angles, hence the relative quantities would differ by k^2 factor. Therefore the basic function U should be the ratio of the portions of the bunches in both spheres times k^2. Then the deviation of U from 1/2 will determine $K(x)$ via the transitivity violation in the parallelism of measuring trajectories as expressed with the ratios of photon oscillations numbers.

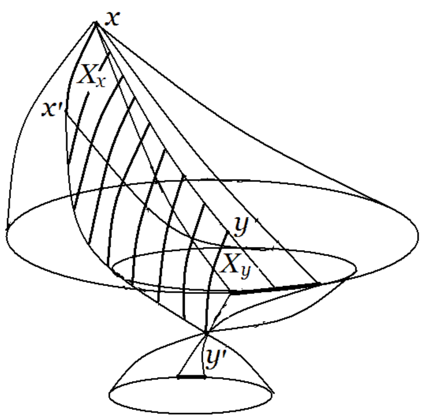

Fig. 5.3: The auxiliary function on a photon trajectory.

So far, all the construction involved only light cones, since just the limiting status of photons provided the uniqueness to the constructions. In the structure of the solution to the equations of fields' propagation, this part corresponds to the sin-

*We proceed addressing the cone as "light", since already in the next chapter just usual electromagnetic photons will play the decisive role in the contact schemes for the weak and strong interactions, though in principle one could also use the fronts of gravity field itself for the oscillations.

†We drop here rather tedious details of constructing $V(x, y)$ basing on $K(x)$, limiting ourselves to a general description of the derivation.

gular component, corresponding to initial values specified on the light cone itself. For the given definition of $U(x, y)$, suffice it to multiply by U the specified initial data at all the points y to find the solution at x. But U could also be used to construct the function $V(x, y)$, which is needed to account for the contribution from the inside of the light cone. It turns out that $V(x, y)$ might be constructed with a contact scheme by means of iterations the schemes already developed for the singular component of the full solution. Using in turn the cones of the past and future, it is possible to reach all the points inside the cone just as was done above (Fig. 3.10). Using the introduced there operations of differentiation with coherent subdivisions as of the photon trajectories themselves (null geodesics), so also the constructions of their uniform distributions on light cones, $V(x, y)$ is being determined as the limit of the convergent sequence of the functions determined by the iteration on going to consequently denser sets of points inside the cone. Two first points and the related light cones are shown in Fig. 5.4. The function $V(x, y)$ is being constructed as an "inverted tree" model. In order to determine its value at x, which depends on the values of the same function inside the light cone of x, we need to find first its values at all points of this cone (conveniently, in the intersections of an initial uniform lattice). Let this lattice already formed on the light cone of the past of x and that of the future for y. To list the operations on the first of these cones, we choose a point of the lattice y_1 and take a similar pair of cones between y_1 and y, and form their own lattice on these. For the next iteration step, we take y_2 and so on. In order to find their own $V(y_1, y)$ on each pair of cones, we need its values in their insides. So, the functions V on the smaller cones are the initial values for the larger ones, in which also the singular components of the each step's light cone take a part. All these infinitely getting smaller and smaller, cone-pairs and lattices provide $V(x, y)$ at all points, where the initial data are specified.

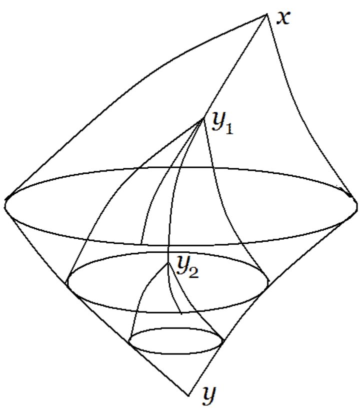

Fig. 5.4: First two initial points with their light cones pairs.

In the canonical version, the presented procedure corresponds to the solution of the wave equation in a curved space-time for the values of $V(x, y)$ at x with the initial data at the light cone of the future of y (the so-called problem with characteristic initial values). These are the values of $V(x, y)$ itself, where x's as being taken now at this cone, are to be determined with the integration of $U(x, y)$ and its derivatives. We stress that in all contact schemes the trajectories of photons are their actual trajectories, and it is only in the canonical version they look curved and non-uniform. However, in contact schemes such pictures are redundant, and they might even be deceitful, corrupting the real problem with extra decorations.

The presence of the "tail" in the propagation of the top velocity signal, violating the Huygens' principle, is characteristic for a curved space-time. This tail owes its existence to the contribution from inside the light cone. The cause of this well-known fact is evident in Fig. 5.3: The propagating wave is being "scattered on the curvature" of the space partially and multiply, so that the scattered fraction is retarded with respect to its front upon going the longer ways. In the canonical version this tail constitutes the non-singular part of the Green's function.

All this discussion belongs to the classical, that is, not quantum contact space. This space has been constructed as a tool for CP predictions, as a minimal structure enveloping all possible trajectories of bodies. However, if the space curvature is so strong that scattering on the curvature becomes comparable with the scattering on the measurement orders, then $K(x)$ becomes probabilistic itself. So, also the presentation of contacts via trajectories becomes uncertain, and the question arises as up to what degree of curvature it is still possible to regard the contact space as the same geometrical structure that only fluctuates about some average. In particular, whether or not quantum effects might violate even the topology of the space, enabling stochastic transitions across the singular light cone?

Chapter 6. What interactions are permitted by the Method?

> To earth, then, let us assign the cubical form; ... the pyramid [tetrahedron] is the solid which is the original element and seed of fire; and let us assign the element which was next in the order of generation [octahedron] to air, and the third [icosahedron] to water.
>
> Plato, *Timaeus*

Everything expressible in terms of contacts is within the Method and must exist in Nature. This is the principle the classification of interactions compatible with the required for CP geometry must follow from. It is thus natural to inquire their accepted variety. In the framework of the Method, our purpose is not in reducing this variety to a single interaction, but rather to reveal the universal construction of all interactions in terms of contacts. Actually, for the representation of forces with contact schemes it is only the possibility to uniquely correspond at any point the trajectory of the body in CP to that of a test body is important. Being already capable to determine a field structure, we still stay in need to define everywhere the universal standard of the charge for any interaction. In other words, this standard, once specified at a point, must then be unambiguously transported to each point that is reachable with a trajectory starting at the initial point. We have to devise a relevant contact scheme.

It is tempting to use for the transport the above defined uniform distribution of trajectories in a sphere. In the constructions of integration, we used almost uniform distributions of a big (infinite in the limit) quantity of trajectories. It was not required therefore to keep the uniformity precisely, since small deviations from this might be ignored in the limiting distributions of oscillations numbers ratios.

Quite a different situation is met with if only a few trajectories are involved, while the required uniformity is precise. In the three-dimensional flat space, as mentioned in Ch. 1, there are only five such exactly uniform distributions of trajectories over a sphere. Recall that these correspond to the vertices of the regular polyhedrons known as the Plato bodies, namely, tetrahedron (4 vertices), octahedron (6), cube (8), icosahedron (12), dodecahedron (20). The cube might be presented as the two interlaced tetrahedrons, and the dodecahedron as consisting of a cube and a group of six "dipoles". Although the latter is not a regular polyhedron, it might be of interest as a complementation of the cube up to dodecahedron, the richest with respect to regular substructures sphere. Neither octahedron, nor icosahedron possesses regular substructures.

Let us correspond to each polyhedron its sphere-star comprised of the trajectories of test bodies passing the star vertices. It follows from the symmetry of a polyhedron that these bodies have equal unity ratios of the maximum (that is, between the neighboring pairs) oscillation numbers. If the charges and masses of all these bodies are the same, still due to the symmetry these ratios will remain unity in the presence of electromagnetic, say, interaction of the bodies.

Let the star comprising bodies go exactly through its center to depart from the star afterwards. Though in the classical theory with the singularity at the center this is impossible, it is possible for quantum wave packets. For the oscillations numbers counting, only the motion of the wave packet center is important, while its spreading (in addition, being smoothened for relativistic velocities) is usually of no importance, since the packet center moves classically. However, quantum effects are important for radiation upon accelerating or decelerating the bodies.

It is possible to transport the standard of charge in sequences to other points of the contact space (Fig. 6.1), so constructing a lattice to specify the charge value in CP. The exact copying of the prime symmetry in the descendent star would ensure the correct charge transport — its equality to the prime value in all the descendent star generations.

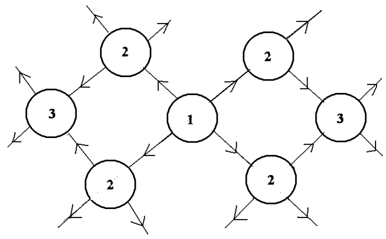

Fig. 6.1: The sequences of the stars in a regular lattice.

Inside each star, the identity of the charges (and masses) of its bodies is guarantied by the observation of the symmetry in their motions toward the center as measured with the ratios of their oscillations numbers. The copying of the charge in generations is realized with the use as a seed for the next star some bodies that leave the decaying previous stars. The correctness of the copying might be checked on, provided that in every star several bodies coming here along different paths take a part. Then the observation of its own symmetry means that the charge has been correctly transported along the sequence. The lattices possessing this property will be called *regular*, and their constructions will be our main concern throughout this chapter. In so doing, suffice it to take just three bodies out of the preceding stars as a seed, since these can form a basis.*

For visual convenience, we again shall carry the analysis out in terms of the canonical version, though actually all the constructions might be presented solely with contact schemes. The potential of the interaction of the star comprising bodies must satisfy the general for all relevant forces condition to preserve the ratios of the oscillations numbers, while to have a sufficiently long range to ensure the detection of symmetry breaking with photon oscillations counting for any size of the star — the cell of the lattice.

Among the Plato solids the cube alone possesses this property that in the motion of comprising it bodies under their interaction the trajectories keep straight and have the contact at the center not only if their charges and masses are equal but also if these are equal only in each of its two tetrahedrons separately (Fig. 6.3). If in addition these tetrahedrons differ only in the sense of their charges, then the bodies are being equally accelerated by their interaction, and the symmetry as detected with the oscillations counting is observed.

The neutrality of the star as a whole results in the common contact at its center also in the classical picture. All eight bodies are being accelerated toward the center along straight lines, and the symmetry remains intact under any radial dependence of the interaction potential. However, this dependence is not arbitrary: The potential must decrease with radius. Otherwise, even observed symmetry in stars would not allow for the regular lattice with these stars, since the star

*Remember the existence of the degeneration, however!

will not decay into separate trajectories after their contact at the center to take a part in descendent stars. The most important example of the relevant potential, enabling the detection of symmetry break in the cube by means of counting the oscillations numbers for any star size, is the electromagnetic interaction as the only available for being directly measured with detectors in experiments. In this implementation, the charges of bodies are the usual electric charges, as presented in Fig. 6.2, and the oscillating "photons" are the usual photons. (Recall that in their definition in Ch. 1, it was only important for them to move with top speed.) Note that due to the cube symmetry magnetic field is zero on the trajectories, and it is only electric field that effects on the motion. We call attention to the fact that contrary to the gauging charge in an external field, where only the charge-to-mass ratio is being measured, the star symmetry detection requires the identity both the masses and the absolute values of charges.

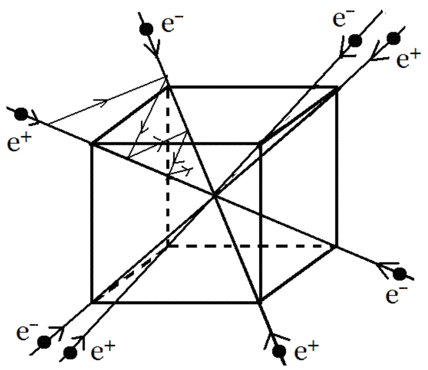

Fig. 6.2: The cube symmetry of trajectories consisting of the two oppositely charged tetrahedrons.

This contact scheme allows for the ideal gauge of charge upon gauging "motion-to-motion" without intermediate rods and/or clocks, which are prone either to add something of its own or to hide something. In order to detect asymmetry, suffice it to detect the difference in the oscillations numbers by just one oscillation. However, the infinite number of oscillations brings a problem about as to how to be sure that the symmetry is observed. Indeed, whatever number had been counted, it might happen that upon going the process on we would still detect asymmetry. In macroscopic measurements no serious problems will be met, since the desired precision is being determined in a practical CP by its application. However, if we address the issue of the minimum possible size of the star as a cell in the regular lattice, there is no a priory precision now, since everything is to be determined by the limiting process itself.

In this limiting case the particles must be the lightest, to maximize their acceleration in the interaction, so increasing the gauge sensitivity for the smallest charge. In this gauge procedure the mass and charge (its absolute value) must be discrete. Indeed, if the charge, say, were to vary continuously, then however big number of oscillations had been counted showing the symmetry as observed, a small deviation of the charge value is still possible, such that asymmetry could be detected, provided the counting was continued. Therefore, some particles with the smallest charge value must exist. These are electrons and positrons presented in Fig. 6.2.

We proceed in terms of the canonical version to keep correspondence with the familiar values. In order to find the smallest radius of the star, we consider asymmetry detection in the star, comprised of particles with the same mass, while the charges are the same within each of the tetrahedrons but the charges of one of them twice as large then those of the other. In this case, the interaction leaves the trajectories rectilinear. The double charged particles will be accelerated less than the single charged ones because of their larger repulsion. The smallest star size corresponds to the case when, given initial radius and velocity, the single-valued tetrahedron nears the center down to the distance corresponding to two oscillations, while the double-charged tetrahedron reaches only one oscillation distance. In so doing, we start counting oscillations from the initial radius which is to be minimized.

The process proceeds as follows. On the large radii the acceleration is small. In spite of the increase of the force at smallest radii, the difference in the velocities of the tetrahedrons is small here because of the already large relativistic factor. The main contribution to the inter-tetrahedron distance is being thus collected in the vicinity of the initial radius. Ignoring radiation reaction under acceleration, the estimation yields the initial radius of the order some tenths of the classical electron radius (3×10^{-13} cm), and initial relativistic factor $\gamma \sim 3$. The smallest radius the oscillation counting stops at is of the order of 10^{-16} cm.

The account of the radiation reaction, relatively low for the longitudinal acceleration, yields an additional equalizing of the tetrahedrons' velocities, so increasing the initial radius of the star. It is well-known that this radiation consists of photons with the energies up to the full energy of the particle and the directions of emission are within the angle $\sim\gamma^{-1}$, so it is only on average over many tests the particle can reach the center. In the limit of radius much larger than the classical electron radius, radiation consists mainly of multiplicity of "soft" (low energy) photons, emitted independently of each other. These might be described with a single Feynman diagram with many lines, infinite in the limit of low energy, where it amounts to the classical formula of radiation power. The relatively low probability of the emission of high energy photons makes their average radiation reaction much lower than that of soft photons. Therefore, to estimate the upper limit of radiation reaction we can account for only classical radiation reaction even on the small distances, where, strictly speaking, the classical field theory fails.

Were radiation absent, we could construct the whole regular lattice out of symmetric stars-cells, using for the descendent cells the particles slowed down to the initial velocity by the output potential barrier of the star. Three such particles are enough for the basis to determine the other five in the cube, if the twin degeneration were absent (Fig. 2.7). The orientation of spin — along or opposite the particle velocity — makes it possible to select the needed orientation in the cube. However, even low in each individual cell radiation, not precluding symmetry detection inside it but steadily decreasing the kinetic energy of the particles, might ruin the regular lattice upon collecting the error in the initial velocity for the descendent cells, since even on the atomic range the quantity of minimal cells exceeds 10^5.

In order to overcome this difficulty, we have to improve the gauge procedure. As it was found, it ends up at the radius of the order of 10^{-16} cm. Over smaller radii we are free to introduce any new interaction, not precluding the gauge. In particular, this interaction might alter the charge of the particle. If this charge becomes zero, then the electromagnetic radiation would disappear just in the vicinity of the center, where it is the strongest, and its small remnant in the cell would not prevent the gauge even over the whole lattice range. Returning the charge to its initial state for the next cell, we anticipate the construction of the lattice to become possible though not practically but at least in principle.

The question of practical realization isn't that important as soon as it is only a limiting situation like the minimum size of the cell that is under consideration. We deal here just with the language reflecting CP statement. On a macroscopic and even on atomic scales the motion-to-motion gauge is quite practical, since radiation is ignorable there. In macroscopic measurements there is no need in the charge altering since the required quantity of cells is not that big, and it is thus possible to use the bodies passing the star center as a seed for next stars. In atomic scale gauge the charge might be altered in the processes of charge exchange and stripping (ionization).

However, in the limiting situation a separate particle with zero charge (*neutrino*) is needed to connect the stars. Since in the descendent star we detect the charged particles' symmetry anew, we need a process of recovering the charge. To this end, "blind" stars are introduced, consisting of neutrino and antineutrino, in which their annihilation creates electron/positron pairs to participate in the next charged star (Fig. 6.3). In the blind star, the neutral particles cannot be gauged with usual photons, but this is not necessary because the detection of the observed symmetry in the next charged star is sufficient to claim that in the intermediate blind star it was observed as well.

Minimum three trajectories are to be received from the ancestor stars to construct a basis of a descendent star. In so doing, we have yet to choose an appropriate trajectory out of the twins, otherwise no cubic star would arise at all. For this choice the spin contact scheme developed in Ch. 4 is in order. Indeed, any trajectory in the cube together with the three its neighbors define the full cube star. Even two of these three would be enough, provided the order of rounding them

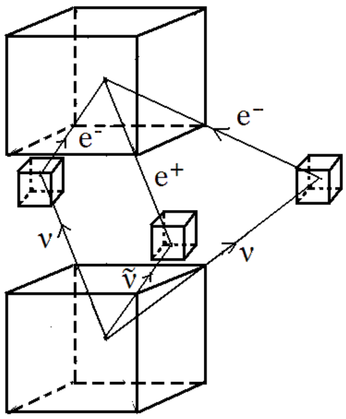

Fig. 6.3: The fragment of the lattice of cubic stars.

in turn is specified in addition to distinguish the third trajectory from its mirror in the basis decomposition. This order is just equivalent to selecting one of two spin projections on the direction of the particle motion toward the star center. However, for the definite arrangement of the descendant star out of its predecessor we have to translate the correct spin orientation through all the steps of this transition. For this to be possible the particles of the predecessor must already have a definite ("left" as it used to be said) orientation of its spin projection, i.e. to be left-polarized, and also their neutrinos must have the same spin to be kept unchanged in all transitions. Besides, the dynamical correspondence of the stars is required as well: The final velocity of the particle in the gauge process in the predecessor must turn in the initial velocity at the entrance of the descendant charged star.

To realize all these constructions, a new *weak* interaction turns the electron/positron in the neutrino/antineutrino and vice versa, so introducing a *doublet* of the weak interaction, since its role in the gauge needs just two charge states. This interaction must be short-ranged — of the order 10^{-16} cm for not to spoil the gauge in the star by altering its charge value. On the other hand, it acts within the same cubic symmetry, sharing this zone with the electromagnetic interaction, so giving rise to the united "electroweak" interaction. It is therefore natural to use for its formulation the same for all interactions structure of the wave equation, as substantiated above with the condition of preserving oscillations numbers ratios, although now with an additional "mass" member (Yukawa potential), providing a short range to the weak interaction. However, this potential, though being exponentionally small at a large distance as compared to electromagnetic interaction, still penetrates into the gauge region. For not to deteriorate the charge gauge, we must bound the upper limit of the coupling constant (its effective "charge") of the weak interaction as compared to the electric charge. On the one hand, the switching of charge and the dynamical effect of the weak interaction cannot be allowed to deform the gauge so heavily as to produce an effect at the gauge minimal radius of the order of one oscillation. On the other hand, intensity of the weak interaction must be sufficiently high for the charge to be switched on a short distance. To meet all these conditions, the weak charge must be of the same order as the electron charge.*

Down to the radius in the weak interaction zone, at which the switch of the charge occurs, the charged particle (the electron, say) moves under both weak and electric forces. After the switch event only the weak force is active on the newborn neutrino, while the electric force becomes active again on the newborn electron after the opposite switch, now in the blind star. For the electrical Coulomb potential, the total dynamic effect of acceleration/deceleration is determined with the difference of the reciprocal values of the radii of direct and opposite switches. It seems that the required dynamics for matching the final velocity in the charged star to the initial velocity in the next charged star could be entrusted to the electrical potential alone. However, apart from the unnaturally specified difference of the average values of switching in both charged and blind stars, we would also have to neglect the much more probable process of the annihilation of the electron/positron pair into two photons. The ratio of the probabilities for annihilation and charge switch scales as γ^{-4}, since the cross-section for annihilation scales as γ^{-2}, whereas that for charge switching scales as γ^{2} according to the general features of the wave-like equations. The involvement of the weak interaction not only in the charge switching but also in dynamics helps to solve both problems — to appropriately match the velocities of the electron and to suppress annihilation. For this to be possible, the weak interaction itself must be able to accelerate the electron in the charged star and accordingly decelerate the newborn electron in the blind star to obtain the necessary for the descendent star initial velocity.

However, given the initial and final points for the series of these switches and matches, the net dynamical effect of the weak Coulomb potential would be zero, and to actually involve the weak interaction, it is needed to turn it on and off somewhere, just like it was for the electrical potential. Turning a force on and off is equivalent to the appearance of an intermediate particle connecting these events. This particle appears when the weak potential turns off and disappears (decays) when it turns then on. For the small radius of the weak interaction, this particle will be heavy its mass being proportional to the argument of the exponent in the Yukawa potential. For the typical energies in the stars — γ less than 10^2 — this particle might be only a virtual one, and the correct translation of neutrino polarization requires it to have an integer spin. The minimal spin of this boson must be 1, since spin 0 cannot transport polarization. We are still free to choose the radius of the charge switch. This might be chosen under the condition for the electron to reach a maximum velocity at the switch still compatible with the required velocities matching to suppress the effect of its annihilation adverse for the gauge.

Different behavior of the left- and right-handed particles in the weak interaction is called its parity violation. Their dynamics remains similar in the weak interaction, provided the reverse of polarization is combined with that of the charge sense. Indeed, the opposite positions of electrons and positrons on the diagonals of the cube star correspond to their opposite polarizations, since it is the same interaction that turns the electron into its neutrino and the positron into its antineutrino.

For the short range of the weak interaction, the charge switch cross section is small and great many left-handed electrons fail to turn into neutrinos. They pass the center of the charged star, and loosing a part of their energy in radiation, however low, are not able to pass the exit potential barrier. They return to the star center changing polarization, so not being able to become neutrinos. Being reflected once again they now become able to turn into neutrinos. However, for this to be possible the opposite positrons must move quite similarly, and the probability of this event, equal to the product of their probabilities, is low: Typically their radiation losses differ, and they will not reach the weak zone at once. Even if this happens, their neutrinos will be belated with respect to those experienced normal transitions.

We have also to consider the destiny of right-polarized electrons (if these are present in the star). These produce no neutrinos, but being reflected by the exit barrier, come back to the center as left-polarized and together with analogous positrons might admixture false neutrinos to normal anti-neutrinos that have been created by positrons. We can essentially suppress this adverse process providing the weak interaction with an additional dynamical property to slow the right-polarized electrons down, so favoring their annihilation even with normal right-polarized primary positrons.

We are now in the position to complete the analysis estimating the weak interaction coupling constant in terms of the electron charge. Currently this value is specified with the "weak interaction angle" θ_w. The above considered transition conditions yield $\sin\theta_w \sim 0.5$, in agreement with the measured value.

The symmetrical cube star provides the ideal gauge of the electric charge standard by means of transporting its value along the regular lattice. However, in an individual star-cell it might be possible to "simulate" the symmetry, substituting some of the particles with "false" ones in such a way that photon oscillations counting would not "notice" the substitution. We could try to change, for instance, the mass of two particles positioned on the same diagonal of the cube. If these particles are sufficiently heavy, while their charges are the same as those of other particles, then the remaining electrons and

*Of course, all these conditions are to be understood in the probabilistic meaning of quantum mechanics.

positrons will influence their motion but weakly, and the false particles might reach the weak interaction zone at once with the electrons. The back influence of the false particles on the electrons might be small far from the center where the main part of the difference in the photon oscillations numbers between the tetrahedrons is being collected, were the symmetry broken.

For so heavy particles their acceleration, so also radiation, might be small, and contrary to the electron they might move from one star to the next not needing to cancel their charges. Perhaps, some such arrangements are able to support the symmetry test in the individual cell with the photon oscillations counting at some particular initial data. And provided this is possible, is it also possible to develop the whole regular lattice comprised of such cells or, at least, a considerable fragment of it?

To address this issue, we have to solve a rather complicated full system of the nonlinear equations of motion accounting also for radiation. We will limit ourselves to estimations with the following assumptions. First, we'll search for the false particles' trajectories disregarding their radiation and only afterwards calculating their radiated energy with the classical field theory formula that is correct for the small classical radius of a heavy particle. Second, the motion of the false particles being our main concern, we'll describe the effect of electrons on them with some averaged "background", checking afterwards the validity of this assumption varying this background within some reasonable limits. Third, we carry out the numerical solution under the same initial data for electrons as it was mentioned above for their original star. Using the final value of the particle's velocity at the center as an initial for the next cell, we'll follow its destiny in the lattice.

The full cube symmetry allows for two sub-symmetries. In the first sub-symmetry a diagonal is replaced with the false particle/antiparticle, while in the second sub-symmetry two diagonals are such. There are no other sub-symmetries in the cube, since the next replacement just brings us to the first, though with the star radius that exceeds the limiting value. In the first sub-symmetry, the trajectories of the false particles are still straight lines, whereas the remaining three electron/positron pairs move along curved trajectories, however, being identical — each one with respect to its own plane, these planes intersecting over the trajectory of the false particle. It turned out in the numerical calculation that at some value of the ratio of the false particles' mass to that of the electron, the final values of its radius and velocity in the cell, though differing from that of electrons, return to their initial values at the next cell, and this behavior repeats itself infinitely within the precision of the calculation (10^{-6}). For other mass values the disparity increases monotonously, and the construction of the regular lattice is impossible. In this equilibrium cycle, the mass of the false particle is close to that of the τ-meson. The radiation is therefore low, and it doesn't shift this value within the calculation precision.

In the second sub-symmetry, two pairs of false particles and two pairs of electrons move in their own planes: one for false particles, another for electrons. The planes intersect at right angles, and in each of them the particles move over differently curved trajectories, though in each plane they are symmetrical with respect to the center. The numerical calculation also demonstrates the existence of infinitely repeated cycles, though now consisting not of two but of four successive cells. The value of the related mass ratio in the equilibrium cycle was found roughly equal to the μ-meson mass. However, this time the calculation is by far not that reliable as for the first sub-symmetry, since for the curved trajectory and lighter μ-meson its radiation is no longer negligible. Therefore, now our result yields only the rough upper boundary of the meson mass' ratio to that of the electron. However, in view of strong differences in the ratios of the mesons' masses to that of the electron, these results look sufficiently reliable to explain the existence of the lepton families. Both mesons must possess their own neutrinos to avoid false intersections in long series of cells.

The six-dipole system of "roofs" completes the cube up to the richest Plato solid, i.e. having the maximum quantity of trajectories — the dodecahedron with its twenty vertices. These six dipoles are positioned under right angles to each other. Though not being a regular polyhedron, this system, if considered as a separate star, still possesses its own, independent of the cube equilibrium state — the common contact at the center. As distinct from a regular star, keeping its equilibrium upon the motion of the particles toward the center for any dependence of the interaction potential on distance, the six-dipole system keeps the equilibrium only if this potential increases as the distance squared. This property is not something specific to this system only. It holds for any sphere with equally charged particles if the sum of all their position vectors is zero. However in this case, it is important that after the removal of a regular structure — the cube — from an also regular structure — the dodecahedron — something capable of supporting equilibrium still remains. Of course, this potential must be attractive; otherwise the particles could not reach the center.

Such radial increasing potential has properties peculiar to the *strong* interaction, namely, confinement and asymptotic freedom. The first prevents the star comprising particles to leave the cell. These particles are called *quarks*. The second property suggests the trajectory of a body scattered in the vicinity of the star center to move freely experiencing no influence from the quarks, that is, to behave much like measuring trajectories.

Just as for the weak interaction, we have first of all to take care for this new force not to destroy the cube symmetry. The influence of the strong interaction on the cube particles is removed simply with the condition for leptons not to feel this force. However, the own arrangement of the six-dipole system doesn't define as yet the full dodecahedron symmetry. First, we have to specify in a way the angular position of this system relative to the cube by means of photon oscillation counting. Second, the reciprocal angular positions of the quarks themselves isn't specified completely, because the equilibrium of their arrangement under the strong interaction would not be destroyed in deformations leaving the opposite quarks on their common diagonal upon its rotations.

The correct positions of the quarks as respective to the basic cube, so also among themselves, by means of oscillations numbers counting with the usual electromagnetic photons implies the quarks to be electrically charged. No distribution of this charge is able to completely remove their adverse influence on cube symmetry, and it is also impossible to remove the back influence of the leptons on the quarks. However, under some conditions these perturbations might be small, while the oscillations numbers counting might be carried outside the individual star, using the regularity of the full lattice (see below — Fig. 6.4 and the related discussion).

Let us try to arrange a regular lattice comprised of stars-dodecahedrons. We had already the lattice of cubes (Fig. 6.3). Now we are to complete it with the inter-cell transitions connecting the six-dipole systems. But this is forbidden with the quarks confinement by the radial increasing strong attractive potential. Therefore, this potential must weaken at a larger radius. Only then the united twelve quark system would be able to decay in six dipoles, since the distance between quarks in a dipole is less than that between each of them and any other quark in the system. With an appropriate choice of intensity and radial function of the attraction law, it is possible to reach the minimum energy quantum bound state of the dipole, while the bound states of its quarks with other quarks were impossible. The necessary suppressing of the strong force on large distances is interpreted as reciprocal compensation of the strong charge outside the dipole. Hence, the dipole must consist of quark and anti-quark just as it takes place on the diagonals of the twelve quarks system inside the dodecahedron. The bound state of quark and its anti-quark are called π-mesons. They are just these sub-systems of the full dipole system that are suggested to tie together the sequences of the stars in the total regular lattice (Fig. 6.4).

To reduce the influence of charged quarks on the own cube symmetry measurements, their merging in mesons is to be completed in the vicinity of the center where the disparity between the tetrahedrons cannot be collected as yet for one photon oscillation. The meson must be electrically neutral (π^0) in their disparity collection dominating zone. On the other hand, the strong interaction must not destroy the weak interaction. For this to be the case, the characteristic range of the strong interaction should be of the order of 10^{-15} cm.

Then the π^0-mesons are to be transformed in the auxiliary octahedrons to create the charged $\pi^{\pm}$-mesons for the symmetry to be checked on with the oscillating photons ratios counting at their intersection point. These ratios must be equal 1.

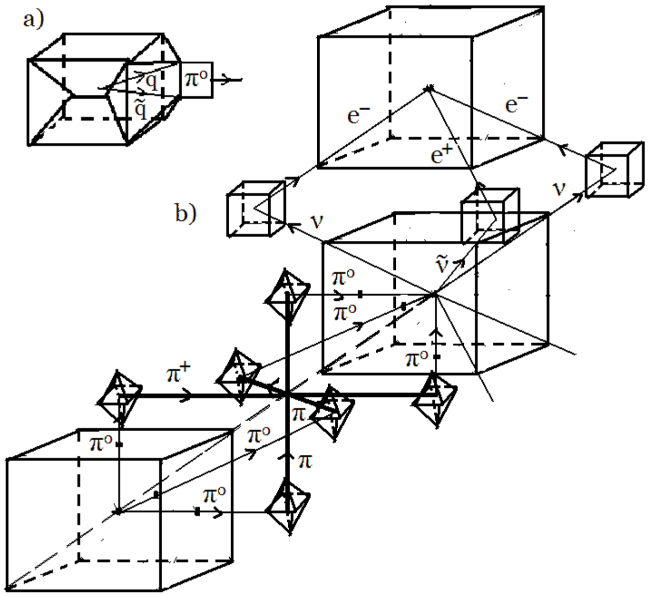

Fig. 6.4: a) Creation of the π-meson out of quark and anti-quark. b) Inter-cell transitions with π-mesons in the full regular lattice.

Besides this condition violation, the symmetry could also be destroyed if the triple contact decays into two simple, so that some of these ratios turn infinite. The total lengths of the three-leg meson trajectories could always be so chosen that in the next dodecahedron its center be reached by all the particles at once.

Again, it turns out that this task cannot be achieved exactly. Even in the neutral as a whole octahedron, there is no equilibrium distribution of its six charges. An approximate equilibrium, as specified by the condition of their missing the center at a distance less than that for the utmost short-range weak interaction, is possible only with the increase of the meson mass. In particular, it is just the weak interaction that is responsible for the charge exchange in quarks upon the transformation of the neutral mesons in the charged ones and vice versa. The estimation of the deviation of the π-meson from the center within the weak interaction zone yields for it mass the value of the order of 200 electron's mass.

In Fig. 6.4, the meson trajectories needed for the gauge of the strong interaction have not two legs as it was for the weak interaction but three legs, so allowing for three strong charge switches to constitute its triplet. In analogy with the human color vision these charge states are named as red, green and blue. The color exchange is realized in the triple contact of the charged π-mesons. In these terms, the slowing down of the increase of the strong potential at large distances might be interpreted as the reciprocal compensation of the colors, for example, that of the red quark and its anti-red partner bounded in the π-meson.

With the values of the strong interaction range and the π-meson's mass, it is possible to estimate the masses of the quarks belonging to the lightest family, considering the ground state of the full six-dipole system near the star center and their bound states, mesons, at larger distances. In the intermediate range, the interaction potential must change in such a way that the correct contact scheme be observed.

Importantly, it is just the irregularity of the six-dipole system that makes the decay possible. It cannot happen in a regular star with its equal inter-ray distances. The possibility for the six-dipole system to decay into separate mesons determines the coupling constant value and the form of the strong potential that correspond to the first quantum level. With these data we can determine the force accelerating the quarks toward the center. This force has no transverse components, since the equilibrium is inert with respect to rotations of the oppositely positioned quark/anti-quark line around the center. On the opposite, for the electric field only the lateral component is important, while the longitudinal might be neglected as compared to the strong field. This gives the estimation of the range for "missing" the center by a quark, and its mass is determined by the condition, that this range does not exceed the weak interaction range. In the simplest model with the potential, increasing squarely to be replaced with rectangular "bag", this mass turns out to be about 10 times more than that of the electron — close to the known value.

However, the accelerated by the strong force electrically charged quarks must lose their energy by radiation under so high strong field acceleration. And then, quite similarly to what we met with for the cube, they would not be able to overcome the exit potential barrier with a noticeable probability, and the system of the dipoles would not be able to decay into separate mesons. However, the strong interaction must emit its own "photons" as well, and this radiation must be much more intensive than the electromagnetic radiation due to the higher value of the strong charge. Then, the radiation reaction would be accordingly strong, making the resulting acceleration small, so suppressing electromagnetic radiation, while the quanta of the strong interaction, gluons, must be deprived of leaving the strong interaction zone. Otherwise, this interaction could not have that short range, so violating the basic electric charge gauge. The gluons will thus return the energy to the quarks leaving the star in its decay.

The regular lattice with the dodecahedron symmetry exhausts the totality of possible interactions. In the last account, these interactions exist and are tied together solely by the procedure of the electric charge gauging, requiring compatibility with this gauge. The intrinsic for CP constructions of trajectories in terms of contacts define the interactions that we are able to recognize in Nature, to distinguish and comprehend what we should pay attention to, aiming in reliable predictions. Being designed in accord with CP, our experimental devices are capable to discern only these interactions. As for gravitation, actually it is not a force at all, but rather a general geometrical structure of force-free trajectories.

Part Two. What For?

> The answer to a question which philosophy fails to answer is this that the question should be asked in a different way.
>
> G. W. Hegel

Chapter 7. Repeatability

> Like ordinary knowledge, in dealing with things science is concerned only with the aspect of *repetition*. Though the whole be original, science will always manage to analyze it into elements or aspects which are approximately a reproduction of the past.
>
> H. Bergson, *Creative Evolution*

The demand for the universal repeatability of all constructions is fundamental in the Method. For this to be possible, the mental constructions contained in the theory must satisfy the condition of non-ambiguity. In the same way, the result of an experiment is regarded as being satisfactory only if it provides a non-ambiguous result, surviving the related check-on always and everywhere. To this end, in the very setup of the experiment, one has to ensure *pure* conditions, and it is the main concern of the experimenter to reach a result that is free from circumstances, if these are unaccounted for and/or brought about by particulars. The experiment is by no means to be confused with experience!

Structures considered in previous chapters are suitable only as a framework of the Method, as basics of the systematic approach. They do not provide predictions themselves, still requiring knowledge of external influences up to the final contact. They are formal, hence useless for immediate applications. This is a property of all mental — mathematical — schemes. For example, expansions in infinite functional series yield nothing, since to specify all the coefficients is the same as to specify the initial function. Only limited precision (for appropriate convergence of the series) makes sense, letting one to take into account only a finite number of the expansion members. For the same reason, true physics consists of particular cases, such as the field of a point charge, oscillations, collisions etc. In all such cases external interaction is given everywhere in advance. The Method is useful only as a general line of thought.

Unlike simple repeatability that is in the heart of any experience, some sufficiently artificial conditions on experiments related to basic constituents of the Method are to be fulfilled to ensure universal and non-ambiguous repeatability. Therefore, the very question, which is intended to be answered by the experiment, should be sufficiently primitive for the result of the study to be somehow used in real life. Even then, the restrictions on the setup coming from the non-ambiguity requirement are so heavy, that usually only thoroughly arranged set-ups, made up of diverse and not exactly repeatable elements of Nature, are capable to withstand them.

However meager, the set of satisfactory constructions is in the base of all our technology, just because of the possibility of unlimited repeating and combining simple and standard operations, each one being diligently verified in the related experiment.

It is of no wonder therefore (though having frequently been under discussion) that almost *any* mathematical device, though arising initially as pure mental exercises, happens to find further on some applications to the theories of the Method. This is because they are being developed under *the same* conditions of non-ambiguity. Just as the experiment depends on a priory conceptions (Einstein: "One cannot measure the velocity of light otherwise than having in advance a ready concept of velocity."), so also the theory rejects any ambiguity. Just as physics studies what "is", i.e. what do we wish and are capable to discern, so also mathematics studies what "could be", i.e. what we are capable of recognizing. It is the most important deduction from the first part of this book, that the demand for absolute repeatability results in this that the language of the Method is so meager, squeezing words down to terms, so that everything capable of being expressed with it, would necessarily be found in the stock of reality. It follows, that also the results of experiments should, in general, be conditioned by the very language of the Method, so being predicted in advance.

As Kant noticed ("*Prolegomena to Any Future Methaphysics*"): "Even the main proposition expounded throughout this section — that universal laws of nature can be distinctly known a priori — leads naturally to the proposition: that the highest legislation of nature must lie in ourselves, i.e., in our understanding, and we must not seek the universal laws of nature in nature by means of experience, but conversely must seek nature, as to its universal conformity to law, in the conditions of the possibility of experience, which lie in our sensibility and in our understanding. For how were it otherwise possible to know a priory these laws, as they are not rules of analytical cognition, but truly synthetic extensions of it?

Such a necessary agreement of the principles of possible experience with the laws of the possibility of nature, can only proceed from one of two reasons: either these laws are drawn from nature by means of experience, or conversely nature is derived from the laws of the possibility of experience in general, and is quite the same as the mere universal conformity to law of the latter. The former is self-contradictory, for the universal laws of nature can and must be known a priori (that is, independent of all experience), and be the foundation of all empirical use of the understanding; the latter alternative therefore alone remains."

However paradoxical this might seem, all the fundamental structures of the Method could be dreamt up, and it is not necessary to perform experiments for their checking on. Indeed, whenever we fail to reach non-ambiguous repeatability, we merely say with disapproval that this is not science, because it is not suitable for the expected applications. But one might clearly find in this an *upbringing* in the spirit of rejecting as inessential everything not governed by the Method, and then of believing that everything deserving attention will sometime be "explained" by science. The widespread opinion on the *objectivity* of the Method expresses its independence of a *particular* point of view. The latter, however, plays a decisive role in applications.

Let us imagine an uneven, rough surface. Suppose it is the relief of a place. A giant with his soles much larger than the highest mountains is interested in this relief only in respect to its friction, for not to slip; a dwarf is concerned with the nearest mountain as to how to climb up; a pilot should look at the highest peaks; while somebody suffering travel sickness pays attention to the periodicity of the road profile. Which of them sees the surface "genuinely"? It might be said that there is a point-wise description of the surface as a function of some variables, and everybody could draw from this function whatever he is interested in. But how should this function be found in practice? Every measurement has some finite precision. Now, will the giant measure every mountain, or will the dwarf look for the harmonics of the structure? Everyone deals with the same surface. Everyone reveals some its features from his point of view. These features would just not be found in either a different profile, so also with a different method of analysis. It is senseless therefore to claim that the surface "objectively" possesses some particular properties. It only *admits* them. In any observation, referring to peaks and depressions, a priory intention is present to look for them, to select them out of infinite variety of features and shadows. On the other hand, the surface is not something amorphous, such that any analysis, like a stencil, would find in it everything it is tuned for. Our surface is a *unique* thing, and as such, it is not bound to obey some general rules.

In the same sense, the World as a whole is unique and it is such as it is. It might be convenient, in theoretical constructions, to imagine different worlds, e.g., a class of them, containing our World as its element. However, there are infinitely many such schemes, and they might be of value only in as much as one can draw some conclusion about our unique World with his a priory accepted point of view. By the same argument, it is impossible to "objectively" regard the World as either or not changing. Taking once again the mentioned above surface for a model of the World, assume, for instance, that its profile is changing with time. How could we not only measure, but even to detect this changing? We cannot apply an external ruler, because there is nothing external to the World. A comparison of different parts of it requires time. Over this time both the World and the ruler might change.

How to distinguish between change and measurement? This depends on the measurement precision as *assumed in accord with a priory position*. The acceptable precision is defined by the implied application of the solution, but the very fact that in every problem some finite precision must be accepted is a principal property of the Method. The main *axiom* of CP requires the meaning of the final contact to be recognized by the user *prior* to addressing the Method to receive its recommendations. The user has first to define as to what actually means for him the occurrence or non-occurrence of this contact. Recall that the Method is based just on axioms, and not on hypotheses. It contains *mental* schemes to provide non-ambiguous recommendations, if the user succeeds in according the basic concepts of the Method with his actual circumstances, just like a tool is being usually chosen for the purpose. The Method itself makes no assumptions on the "construction of Nature", and every time the user should be asked whether or not some axiom meets his purpose, and only then he might be provided with a solution to recommend him a way of action. It is in this respect only, that the putative cause-and-effect problem makes sense in the Method. The effect is something of interest of its own, while its cause might be of importance only insofar as it is capable of realizing just this effect. The effect is being defined by the user as something external to the problem, while its causes are being examined inside the problem and only in this respect. An effect might have different causes, as well as the cause might bring about different effects, but the cause-effect relationship of its own belongs to the Method.

In CP, as we have defined it in the very beginning, it is just a contact that is in question, which is a point in the contact space, rather than an "event in general" in the canonical version with its space-time given in advance. On the contrary, the contact space with its points and features, as we have found, is to be defined by the requirements of CP. One has to recognize what are *bodies*, participating in contacts. The main axiom consists just in that the user does know this, i.e. that he understands the results of the contact and develops a *definition* of body as something to take part in it. This is by no means possible in every situation: A cloud moves along its trajectory and it is expected to obscure the sun, but the cloud diffuses or thaws out. In many cases, even an experiment is needed just to learn whether or not some axiom is of interest in the given situation. The wide realm of CP applications stems, as already mentioned, from the warranty of its predictions, as soon as the problem might be reduced to CP.

However in an absolute sense, neither bodies nor their contacts — nothing like these do actually exist. Each time one has to isolate something from the participation of everything everywhere and from the interaction of everything with everything. All bodies emit various fields penetrating all others; the body might change in a way, still being considered the same in the problem; also the motion itself might have different meanings. The World is a whole, and it is the only real "thing", that possesses its absolute and perfect reality. The picking up of a *particular* body out of the World is only being possible by means of ignoring its infinite "inessential" connections and influences. Upon denoting various mountains with the same word "mountain" one implies (potentially) a definite action in respect to something so denoted in spite of various dissimilarities between particular mountains. This doesn't mean that the mountain doesn't exist objectively, independently of its perception by the subject. This does mean that without his intention to use in a way this term, he might simply not notice this mountain, it might be "of no importance" for him. Three hairs on my head — it is too few, whereas three hairs in my soup — it is too many. What is important and what is not, even if there is a many-order difference of a value, each time depends on a particular problem. How small should be the mountain for not to appear as a mountain? The wholeness of the World consists exactly in the absence of a universal measure for this importance.

The concept of contact is the only one "entering" device that is offered in CP to the user as a possible tool to reach his purpose; it is an *operational* concept, an equivalent of the *bit of information* on whether or not the contact exists. In this sense, the contact is always point-wise, even though the bodies taking part in it are extended. The contact is not something discovered in Nature, but only a recommendation to approach the problem: What are the means the attention should first be paid to? Like all other constructions in CP, contacts are recommended for trying to single them out in order to obtain reliable predictions with the general methods of CP.

If the scheme is devoid of the top speed, then time is to be defined with the use of an external independent device — the clock. In the Einstein's relativity theory this necessity is mitigated just due to the existence of an upper limit for velocity (not necessarily being the same in different points). However, clocks are not eliminated completely, but they are only being correlated with the top speed signal. The contact schemes used above are "relativistic" from the outset, according to the very logic of the operations, so there was no need in either rods or clocks (even as an affine parameter). In the canonical version, the related to these schemes measuring procedures give rise to the existence of a *universal constant*, i.e. a top speed (light). In the same way, the minimum disturbance of motion with measurements implies another universal constant, that of Planck. This similarity in the structures of the theory of relativity and the quantum theory has been constantly appreciated by Bohr. In general, any universal constant springs up from the related measurement procedure either on its extremes or on its discontinuities. So in CP, the discreteness of the electron charge and mass results from the difference in just one photon oscillation required for the difference in these oscillations numbers to detect the cube star symmetry.

The putative successes of the technology based on the Method brought about the perception of its almighty, its capability to "explain" everything, to answer all "reasonable" questions. Complex systems, as constructed by means of simple operations of the Method, demonstrate its efficacy. Along with this, however, a question springs up about utmost capabilities of the Method, since the pressure of successes along a definite line of thought has a tendency, as a rule, to suppress the development of alternative solutions, and all the more, the asking of new unusual questions.

As an example, we consider artificial construction of a living creature. This process seems to be available at some level of technology. At least, no certain prohibitions seem to exist there, since the coherence of the quantum state of a whole system decreases with its complexity. Therefore, the individual process might be multiply repeated with arbitrary precision using the operations of the Method, so obtaining identical copies. We emphasize, that they are not just organisms with some generally described "desirable" properties that are in question, but completely identical copies uniquely reacting on everything. Is it possible to regard them as living indeed? How, for instance, will they communicate among themselves? Whatever difference will be found, this would mean the interference of something beyond the Method. And what if a further difference in the external circumstances destroys their identity, should the Method account for these as well? Then the whole World should be under control.

The process of creating a complex system inside the Method, i.e. by means of simple combining its operations, is quite arbitrary, and it is only by chance that it can produce a result to be of interest for the user. As a rule, some preliminary description of the desirable in *external* to the Method terms is needed, so that only afterward one can correspond (if possible) the definitions and structures of the Method to this particular problem. To this end, the thought scheme itself as a scheme of the transition from one state to another is important in its own right quite independently of what actually is being considered to be a state, provided it is meaningful for the given application to pick up a situation suitable for the concept of the final contact to be introduced, which might correspond to the externally defined aim. As well as a collision, it is also a transition from one state of motion to another or something else that might be in question. The thought scheme of its own might be the same, while its content, that is, the identification of required elements in the World, each time presents a practical problem. CP schemes are recommended for applications in virtue of their definite predictions.

In the description of the Method in this book, we restrict ourselves to only one of existing ways to realize repeatability, considering some basic contact schemes. These belong to that part o the Method that is called *physics*. It consists, as we have seen, in applications of CP in various situations of interest for practice. In order to get an idea about the place of physics in the general framework of the Method, it is useful to delineate, however superficially, some other means to reach a complete or partial repeatability, just for not to make impression that physics exhausts all the content of the Method. It is not always necessary to avoid contacts with a cobra; one might develop insensitivity to its poison or tame the snake.

The tendency to represent a practical situation as a combination of simpler elements, of which it "is comprised", is not a feature of only physics with its decomposition into separate contacts. Repeatability is reached, for instance, in written word, in which the decomposition elements are signs, and not at all the atoms these are being comprised of. A poem as written with different typing or spoken aloud is the same poem, though its physical realization is quite different.

In contrast to CP, in which they seek to distinguish the objects of the study according to minimum possible information, in other applications of the Method just the opposite is useful, viz., the detection of a great many fine details. For the examples, one might think of the methods in zoology, archeology or art.

Repeatability is required to make predictions basing on past experience. The sharply specified method using universally applicable elementary structures of CP implies a *strictly identical* comprehension of all its operations by all users. However, in practice, information referring to a particular person is of no less importance. Such are messages in tribe languages with their hints and reticence, not to be understood by foreigners. Such are also the items of art, as differently perceived by different people and intentionally referring to individual responses. These evident for all examples we have presented here exclusively for "to show CP its place" in the Method.

Chapter 8. Light of expired stars

> **Wagner**. Excuse me! But it is a great delight
> To enter in the spirit of the ages and to see
> How once a sage before us thought and then how we
> Have brought things on at last to such a splendid height.
>
> I. W. Goethe, *Faust*

Specifically orientated extractions (as selected according to the author's preference) from some works this chapter is devoted to, have the only purpose to present the examples of the line of thought from the past that has initiated the analysis developed in this book. The author hopes that internal logic of the above discussion is convincing of its own. However, any approach that is different from the canon creates an impression of unexpectedness, the absence of predecessors. It often occurs, however, that their particular ideas, even though of little appreciation in the following generations, create nevertheless a general intellectual air, which influences the very way of studies. To reveal this support from the past, though perhaps only indirectly, it is useful not just to appreciate the contribution of the predecessors, but also to connect the Method, narrowly specialized, as we have seen, with the ideas and trends beyond its limits and in other realms of knowledge.

The most popular question that was a demarcation between philosophers' trends ever since the ancients, concerning the materialistic or idealistic perception of the World as to "what is the first, and what is the second", refers actually not to the World of its own, but rather to *things*, comprising it in a "self-evident way". This self-evidence has been considerably shattered with the introduction of field theories in XIX century and especially of the quantum theory in XX. Unlimitedly spreading, even in bound states, wave functions form a united system upon interlacing. However many orders of magnitude these functions fall off, the condition of independence of the objects of each other completely depends on a particular problem, and no general criterion does exist. Therefore, the very subdivision of the whole World into separate, sharply isolated from each other entities, i.e. "things", that has been perceived over centuries as an unquestionable fact, became questioned. Though the roots of these problems might be followed already since ancient authors, we deem that particularly clearly they have been stated by Kant in his *Critique of Pure Reason*. We shall begin with this work, widely using (by necessity, lengthy) citations and each time comparing these with CP.

In contrast to the tradition, dating back to Plato and common to Plotinus, Spinoza, Leibniz, Hegel and many others, of "external" (though some own for each philosopher) glance at the "self", all the Kant's analysis is being carried out "on behalf of the self". In this respect, he follows the philosophic credo of Socrates, and, in turn, finds his successors, explicitly or implicitly, in the works of existentialists.

People sharing the external approach are mostly interested with general "systems of universe", as being given from scratch. They consider it (most) important to *define*, in the framework of a suggested general scheme, what is self and his destiny, what is life, what is its "meaning" and so on. On the contrary, those supporting the existentialism hold a paradigm "existence precedes essence". Contrary to Descartes, they feel no need to prove the very fact of the existence of self, even with his "doubtlessness of doubt". The existence of self is being taken as an initially given fact, requiring no further examination, and it is just from this point of view that all the other world should be perceived (including all other persons as well as "external" perceptions of the self: "my hand"), if only for this reason, that for the already existing self there is nobody to perceive this world instead of him, and, most of all, there is no need to. And the essence, i.e. "properties" of the self, as revealed by the self or somebody else and possibly changing, though not destroying its self-identification, is secondary. This approach belongs to the founded by Kant tradition, as confirmed, in particular, by a true, no doubt, existentialist Heidegger in his *Kant and the problem of metaphysics*.

Kant begins with the observation: "But, though all our knowledge begins with experience, it by no means follows that all arises out of experience. For, on the contrary, it is quite possible that our empirical knowledge is a compound of that which we receive through impressions, and that which the faculty of cognition supplies from itself..."

But it is just this duality of knowledge that is in the origin of the Method, as it has been presented above. CP is nothing else as a basing on pure logical procedures a priory scheme, the advantage of which is in the guarantee of its prediction, so long as the correspondence between the elements of the scheme and the real situation has been carried out reasonably. This is quite opposite to the approach in "phenomenology" (Husserl and his successors), in which it is proposed to choose first some actual situation, for example, some object, and further to remove, in thought, its "inessential" features, striving to extract its "ideal meaning". Such a procedure is impossible in the Method, because there is no way even to single out a particular object from the whole Nature without some a priory accepted operations that express intentions of the self.

Kant first of all subdivides knowledge on "empirical", that is, supplied by senses, and "a priory", not depending on experience. The latter might, however, turn out to result from experience (perhaps, unintentionally or partially), or from much earlier or a more general meaning. He calls some knowledge "pure", if it depends on *no experience at all*. As an example of a priory though not a pure proposition, Kant presents: "any change has its cause", though noticing that the concept "change" might be drawn from experience only.

According to the Kant's classification, a "synthetic" judgment connects things or phenomena of different kinds, as distinct from "analytical" judgments, which follow immediately from the given definitions. Thus (according to Kant's opinion) the judgment "all bodies possess extension" is analytical, whereas "all bodies possess weight" is synthetic, because in the first case the negation of the predicate ("possess extension") leads to a logically impossible judgment, while it is not so in the second. Kant considers extension as implied in the very idea of body, whereas weight is its property not contained in its definition and known only from experience. In CP, the first judgment is synthetic as well. For bodies, the sizes of which are small as compared to the distance between them, their own extension is of no importance; hence, it is not contained in the idea of "body", considered point-wise. Though in CP approach extension is not primal, but rather coming as a scheme brought into existence via point-wise — by definition — contacts, the Kant's classification of judgments as either analytical or synthetic is fundamental for the Method in general and for CP in particular.

The main question of Kant is how possible "synthetic a priory judgments", arising in mind still before sense data are presented to it. His problem roots in the impossibility of matching arbitrary "fantasies" of conscience to practical circumstances. In his XVIII century, Kant still held the traditional conception of the clear separation of "things". This conception was not shattered as yet by the ideas, due to Newton, on the gravity as connecting bodies. Newton, as well as his successors before Maxwell, never considered field an independent substance, but rather a mere property of things like color or smell.

Independently of being perceived by the subject, existing things by only some of their features acting on senses to form impressions, are being framed in the mind as intuitions, while something is always left unperceived, hidden. And it is not known how this "something" will come into play under comparing representations a priory with reality. Convinced in this that things are "objectively" separated, Kant pays nevertheless attention to the fact that the notions of reason cannot base on abstractions from something belonging to things themselves, since the senses do not perceive everything (so, the eye doesn't see ultraviolet component of light), and there is a censorship by the conscience of their data for its own need. Kant therefore distinguishes a "thing-in-itself" from a "thing-for-us", actually operating solely with the latter.

In this respect, there arises the problem of a priory possibility of the cause-effect connection, as had been stated by Hume and incited Kant to think on all these problems (according to his own confession). For the Method, as presented here, things-in-itself simply *do not exist*, because the very process of singling a thing out of the World (the only really existing thing-in-itself) depends on him who perceives, and he always do this *purposefully* ("intuits"). Then, the cause-effect relationship means nothing else than the declaration of the initial position of the self. Being interested in the event-effect, he *searches for* its events-causes, filtering away as deserving no attention everything that doesn't bring about the event of his interest. This is his perception of the World in this actual situation. The incompleteness of perception is, in effect, the same thing as the uncertainty of singling out, whereas an attempt of absolutely perfect perception implies the account of all connections, however small, that is, the involvement of the whole World in any phenomenon to be considered. "The bodies we perceive are, so to speak, cut out of the stuff of nature by our *perception*, and the scissors follow, in some way, the marking of lines along which *action* might be taken." (Bergson, *Creative Evolution*). The ten space-time conservation laws, as expressing the condition of repeatability "always and everywhere", are valid for *closed* systems (or, in virtue of the Noether's theorem, for those with some symmetry of the external field). But there are no closed systems in the World besides the same World. Each time, the cutting out an approximately closed system is performed according to a particular problem statement.

In order to prove the possibility of synthetic judgments a priory, as for any proof of existence, at least one actual example is needed. In *Critique of Pure Reason*, Kant considers the concepts of space and time as such an example:

"(a) Space does not represent any property of objects as things in themselves, nor does it represent them in their relations to each other; in other words, space does not represent to us any determination of objects such as attaches to the objects themselves, and would remain, even though all subjective conditions of the intuition were abstracted. For neither absolute nor relative determinations of objects can be intuited prior to the existence of the things to which they belong, and therefore not a priori.

(b) Space is nothing else than the form of all phenomena of the external sense, that is, the subjective condition of the sensibility, under which alone external intuition is possible. Now, because the receptivity or capacity of the subject to be affected by objects necessarily antecedes all intuitions of these objects, it is easily understood how the form of all phenomena can be given in the mind previous to all actual perceptions, therefore a priori, and how it, as a pure intuition, in which all objects must be determined, can contain principles of the relations of these objects prior to all experience. It is therefore from the human point of view only that we can speak of space, extended objects, etc."

("Form" means here a factor to organize intuitions. "That which in the phenomenon corresponds to the sensation, I term its matter; but that which effects that the content of the phenomenon can be arranged under certain relations, I call its form.")

And further: "But propositions of this kind cannot be empirical judgments, nor conclusions from them. Now, how can an external intuition anterior to objects themselves, and in which our conception of objects can be determined a priori, exist in the human mind? Obviously not otherwise than insofar as it has its seat in the subject only, as the formal capacity of the subject's being affected by objects, and thereby of obtaining immediate representation, that is, intuition; consequently, only as the form of the external sense in general."*

However, in these theses Kant means not a general and uncertain "philosophical" idea of space, but the quite particular to be used in physics: "For geometrical principles are always apodeictic, that is, united with the consciousness of their necessity, as: "Space has only three dimensions." Considering straight lines in this space, Kant stresses the possibility of their unlimited continuation, and, as an example of synthetic judgment, points out that the connecting two points straight segment is also the shortest, — the property, which is not directly contained in some probably implied by him definition of the straight line. Of all this Kant never asked why it is just so.†

It is only in the framework of CP the structure of physical space is developed out of its *future-owned* sub-structures and is *substantiated* by the very statement of the problem, but for

*Denying the reproaches in idealism, Kant expounds his position in *Prolegomena to any Future Methaphysics*: "My doctrine of the ideality of space and of time, therefore, far from reducing the whole sensible world to mere illusion, is the only means of securing the application of one of the most important cognitions (that which mathematics propounds a priori) to actual objects, and of preventing its being regarded as mere illusion. For without this observation it would be quite impossible to make out whether the intuitions of space and time, which we borrow from no experience, and which yet lie in our representation a priori, are not mere phantasms of our brain, to which objects do not correspond, at least not adequately, and consequently, whether we have been able to show its unquestionable validity with regard to all the objects of the sensible world just because they are mere appearances."

†One should recall, but then, that at Kant's time nobody operated with various extensions and generalizations of the concept of space, such as Riemann, symplectical, multi-dimensional and other spaces.

this to be possible, the question "Why?" is to be replaced by "What for?" in the sense of the already cited Hegel's aphorism.

Going over to the concept of time, we point out that unlike his reasoning on space, Kant implies not the physical time but rather a mere sequence of events. As a matter of fact, although time is the main concept of the Method by directly expressing repeatability, i.e. the use of past experience, but it doesn't refer to CP alone, like that of space, hence, its definition with only contact schemes might be doubtful. Everybody knows that sometimes a year is too short, while sometimes a minute is too long.

Since CP is only one particular way to reach repeatability, not exhausting a general problem of the transition to a concrete state, whatever it means in the case and however it is extracted as such from the World, no a priory measure can be there, which fits any transition, any *change* whatsoever. However, if we mean the problem for the Method, i.e. using the past to draw recommendations concerning the future, one needs to define the conditions of the very possibility to *pre*dict. In this respect, the past is something that in no way could be influenced upon, and therefore nothing in the past might be a consequence of the present or the future. Of course, in a particular situation some aim in the future might be non-reachable as well, but this is a separate problem. Also in CP, from the statement that there is no final contact, it is only the warranty for the effect of interest for the user, as it is meant in his problem, not to occur that follows. Therefore, only "affine", devoid of measure time sequence has a general meaning of warranty, while a particular way to realize this measure by means of photon oscillations is only suitable when the problem might be reduced to CP.

Only then the constructions of mechanics begin to function. According to Newton: "And if the meaning of words is to be determined by their use, then by names time, space, place, and motion, their sensible measures are properly to be understood; and the expression will be unusual, and purely mathematical, if the measured quantities themselves are meant." (I. Newton, *Mathematical principles of Natural Philosophy*.)

Also in the general structure of the Method, beyond CP, no universal measure corresponding to "change in general" exists there; for any perception whatsoever, time "stays still", if *nothing* changes. In the *Critique*, the concept of time is given as a condition of the internal perception by the self as of him, so also of the world: "Time, no doubt, is something real, that is, it is the real form of our internal intuition. It therefore has subjective reality, in reference to our internal experience, that is, I have really the representation of time and of my determinations therein. Time, therefore, is not to be regarded as an object, but as the mode of representation of myself as an object. But if I could intuit myself, or be intuited by another being, without this condition of sensibility, then those very determinations which we now represent to ourselves as changes, would present to us a knowledge, in which the representation of time, and consequently of change, would not appear. The empirical reality of time, therefore, remains, as the condition of all our experience. But absolute reality, according to what has been said above, cannot be trusted to it. Time is nothing but the form of our internal intuition. If we take away from it the special condition of our sensibility, the conception of time also vanishes; and it inheres not in the objects themselves, but solely in the subject (or mind) which intuits them."

In the Method, this general idea of time sequence meets the recommendation expected by the user for his actions, provided his aim has been recognized as a distinctly fixed final state. We repeat that all the work for the recognition of this aim he must carry out *before* addressing the Method, and this is by far not always easy. Even the experience, if reduced to words or some other conserved or reproducible cognition, mostly possesses no universal content similarly understood by all. As a rule, a message brings about different response in others or even in the self, if it comes later. Therefore, only a minor part of our experience belongs to the Method. An important role of the Method in technologies, their results being so highly valued, provides it with common appreciation and, by the way, also with trust and the feeling of "Truth". Yet, it is only the accumulated culture as a whole, not oversimplifying life that dramatically, conveys a more *precise* description of life than the Method in general, and all the more than CP do, upon encompassing also "uncertain details".

Chapter 9. From scratch. Uniqueness and repeatability

> . . . yet two times two makes four — it is not a life at all, gentlemen, but is the beginning of death.
>
> F. M. Dostoevsky, *Notes from the Underground*

> If we assume that human life might be governed by reason, then the very possibility of life would be annihilated.
>
> L. N. Tolstoy, *War and Peace*

Yet, why do we so much insist on repeatability, while no absolutely repeatable situations are there in real life? Moreover, life, which is the most valuable for the self, is absolutely unrepeatable, unique. Then, what is this Method important for? Each time, the use of the Method in a particular situation implies the disregard as *inessential* of infinitely variegated connections of everything with everything. Is it ever and within what limits possible to approximate the unrepeatable with repeatable?

According to the accepted in this book rules, we have no right to involve some new prejudices from outside in order to find the answer to any question, but only to proceed within the framework of the Method in the search of a solution, if exists, on its own limits of applications. To this end, let us analyze a particular example. Generally accepted opinions deem all substances to be comprised of atoms. Leaving aside technical complications, assume it be possible to take proper sorts of atoms in proper quantities, put them in needed positions, provide them with needed velocities, and so to obtain a man, and not a "man in general", but the copy of a particular, actually existing "I". The Method, in principle, allows for this.*

We have to ensure somehow that the construction is satisfactory. Who will judge? Other people? But often they are confusing even twins. Their judgment depends on their own state, which should be "objectively" examined as well. So, steadily proceeding from one examination to another, all the World will be involved in the judgment. It is only possible to close this infinite chain of examinations by means of asking the same "I" to judge. Of course, "I" is the subject to various external and internal influences as well, but we introduce "responsibility" for his judgment. If "I" considers the copy perfect, he has to agree that nothing would change *for him*, if he were eliminated, while the copy remains alive instead. If the perception by "I" of his uniqueness doesn't allow for exact copy, the answer is already here: Absolute repeatability with the means of the Method is impossible. In the opposite case, we continue our study. Let us weaken the precision of copying. "I" with his hairs cut is not exactly the same "I". Upon continuing (at least in the course of thought experiment) to alter "I" in various respects, using plastic surgery, transplantation of organs (including those of his brain), we repeat our question at each step. If even after such a horrible procedure, "I" still insists on his identity, we would try in addition (or instead) to persuade him to recognize his transformation into something different. On the other hand, "I" as he is now and that in his childhood is being considered by "I" as the same, though, according to some foreign judgment, the copy might seem closer to the now-existing "I".

The only purpose of this offence of the common sense consists in an attempt to reach the verge of the Method, i.e. to shake the uniqueness of "I". And then the question is still here as to what is the value of the Method for so stubborn "I". If we fail, then we have to recognize the existence of something that cannot be constructed within the Method. If however, under some conditions, "I" agrees that some copy is satisfactory to replace him, then he is immortal, and various possibilities for fiction writers spring up. For instance, it becomes easy and comfortable to trip at the velocity of light: Suffice it to transmit by radio the message to make the copy. Medicine becomes superfluous, since the "I"-personality might be simply "rewritten" on some new body. Now, just like in the physics of elementary particles, there are no requirements of uninterrupted following, and "the similar" is identical to "the same".

If, however, the uniqueness, non-repeatability of "I" has been found, then the question of the value of the Method for him is still here in its entirety. So, time and again, what is it that is universally repeatable and still so important, that all everlasting over centuries efforts to develop the Method would be justified? It is only *death*, as being understood similarly by all as something absolutely final that might be the only candidate for this role. Of course, somebody might deny this position and insist on the non-finality of death in a way. It is impossible to claim an absolute judgment with respect to something not to be tested, but we may argue that for somebody *really* convinced in this, the Method is of no need and of no interest, that is, this book is not for him. Moreover, the real content of the Method refers *exclusively* to the problem of death, notwithstanding the seeming variety of applications.

Substituting the direct mentioning of death with the idea of *aim* in less important circumstances brings no important changes in this statement. Otherwise, the "scientific" communication by Mr. Pickwik, "Speculations on the Source of the Hampstead Ponds, with some Observations on the Theory of Tittlebats", would be of no less importance for science than the theory of relativity. Ultimately, the *significance* of the problem always relates solely to death, and the Method is able to say nothing else about the particular life, infinitely variegated and non-repeatable. According to Plato (*Phaedo*), Socrates emphasized: "For I deem that the true disciple of philosophy is likely to be misunderstood by other men; they do not perceive that he is ever pursuing death and dying..." The same idea, though in a broader context, has been expressed by Pasternak (*Doctor Zhivago*): "...art always, without interruptions, is occupied with just two things. It persistently thinks of death and persistently creates life by way of this." This is particularly true in the limited framework of the Method.

Death became a matter of main concern for everything alive because of this simple cause, that everything that had not been striving to survive, and even those, that had not been striving sufficiently hard, died out long ago in the process of evolution. Only those survived, that had been striving *very* hard. Extremities and all other organs have been formed just to protect the creature from death, but while developing its paw in the course of evolution, the creature had to protect the paw itself. The senses serve to protect vulnerable life. However, what a Method would elaborate an "I", which is somehow separated from the world, e.g., being blind, deaf or else? In essence, it must be the same Method, because, even lacking some means for his action, he still pursues the same purpose to protect his life, however difficult would it be for him to apply the constructions of the Method to his own practice. However, even the most primitive organisms possess some means for their orientation. Imperfect, as compared to dogs, hearing and smell of the human, though restricting his reactions, never obscure for him this main purpose of every living thing. While not suitable to describe the life completely, the Method might well be used also in situations not relating to

*In the sequel, "I" should be considered as a generic name for the subject, the problem of the Method is being stated on behalf of. As it was already mentioned, some results of the method are available for any living creature; also the "user" might be conceived as a community, provided its individuals take care solely of its destiny.

the life-and-death problem immediately, also those far from it and often even quite trifling. So, for a professional artillerist, it might be more convenient to fire sparrows with a gun than with a catapult. However, the line of thought, as developed for the life-and-death problem solving, forms a standard approach to any problem in sight, however unintentional. Just these problems constitute the content of the Method. A part of the Method belonging to the realm of physics is of interest for the user inasmuch as it is implied that the occurrence or non-occurrence of the final contact is, in a way, being connected with death, perhaps, only supposedly or probabilistically.

According to our position, we should first of all examine the firmness of the main ideas of the Method on the limits of its application. For the living creature, the principal vulnerability of the Method as applied to the life-and-death problem is in this that eventually death is unavoidable. As a matter of fact, to decide on whether or not to apply the Method, one has first to recognize the actual problem. Only *after* this step all the sophisticated machinery could come into action, including the arrangement of the system of standard bodies, sufficient to detect all the relevant measuring contacts; defining with them the space-time relations; constructing one more set of test bodies, reacting to the external forces that might effect the final contact occurrence and so on. Particularly and importantly, relevant order relations are to be established in accord with the demanded by the supposed user concrete recommendations for his actions *already before the formulation of the problem*. But as soon as death, in general, is not avoidable, and there is no a priory conception of time as yet, the task cannot be solved. What should "I" act for, if he dies anyway? Intuitively, the absurd artificiality of the so stated problem is doubtless. However, for the Method to be convincing a "proof of reason" (Pushkin) is necessary. It is clear but then, that it is one thing — death now, and quite, quite another — sometime afterwards, however small the time gap be according to any measure for it, whatsoever. Even in his last second, the hare still hopes. However, what if no time relations are necessary at all, but they are rather a mere habit, and one might get used to think somehow else? In order to overcome this difficulty, an *external* or "*mathematical*" time had been introduced, as opposed both to the measured and to the personally perceived time. This is clearly expressed in the Newton's *Mathematical Principles of Natural Philosophy*: "And if the meaning of words is to be determined by their use, then by names time, space, place, and motion, their sensible measures are properly to be understood; and the expression will be unusual, and purely mathematical, if the measured quantities themselves are meant." In the same sense, the personal I-time is replaced, in the Einstein's *The Meaning of Relativity*, with the *Einstein's simultaneity* — a means to synchronize clock readings at different points with an appropriate exchange of light signals.

However, the measurable quantitatively time in canonical version by no means depreciates the much more general and important individual I-time, which might progress quicker or slower according to personal perceptions. This time belongs to such concepts as past, now, and future without obligatory connection to seconds or years. It is used in life and communications much broader, and it is by no means less essential than time measured with clocks. Moreover, this perception is peculiar and necessary not only for humans but to any living creature.

For both Newton and Einstein clocks remain the basis of the whole system, though checked, in a way, by motion. But as we found, the existence of top speed makes it possible to dispense with clocks for any particular problem in physics. Counting photon oscillations serves well for all these problems. And beyond physics, in different fields, there is no measure of time at all. Phases of various processes are sometimes tied to astronomical or some other conditions, but never to straight mathematical time. Nature looks then in science merely as a set of particular cases united rather by a common approach than by a single structure equipped with its own universal laws, the "World". Then the very concept of universal inexorably flowing time diffuses, being devoid of its traditional definiteness. It turns out that time does not flow on its own, but, conversely, it depends on everything. And then some very unusual questions might spring up, which touch our deepest ideas, even those of life and death. So, the principal tool in our previous analysis — infinite sequences of photon oscillations, analogous to the Zeno sequences, — brings about a doubt in the habitual understanding of the life duration.*

In respect to the Method, the fundamental difference between the "not its own" problem of the unavoidable death in general and the death possibly to occur with the final contact in CP, is quite analogous to the mathematical notion of *compactness* as the necessary presence of an exact limit. Hamlet-like meditations on the unavoidable death are always in the focus of philosophy and art. In its finality, it is just as unperceivable as the usual falling asleep, according as to philosophical considerations ("Thus, death exists neither for the living nor for the dead, since for the former it doesn't exist in itself, while the latter doesn't exist for it himself." — Epicurus, *The Letter to Menoeceus*), so also to the literature insights ("He was looking for his past habitual fear of death and found none. Where is it? What death? There was no fear at all, because no death was there. There was light instead of death... For him all this occurred in an instant, and the meaning of this instant didn't change any further. However for the witnesses, his agony elapsed two hours more." (Tolstoy, *The Death of Ivan Ilyich*). It is just the threat of death perceived as *an incentive to action*, that gives the Method its meaning for "I" at any moment of his realized life. On his way to the scaffold, the condemned was thinking: "It is not now as yet, one

*According to an aphorism, life is measured not by the number of your breathes but rather by the number of your breathes been taken away.

more turn ahead, and a long street after it. . . " Not being felt by "I" himself, his death is perceived by other people as the disappearing of the particular person. The accumulated common experience yields the doubtless statement: "Everybody will die". But the uniqueness of "I" is incompatible with this "everybody". The fact that all people have died until now, doesn't prove that "I" will die too, because *he is not the same as all others*, and he feels his uniqueness personally. Should "I" deem himself identical to all others in this most important respect, he would be immortal just for this reason, being replaceable by somebody identical.

"Not eternal for times,
I'm deathless for myself:
Perhaps, just to imagination
Their threat has anything to say,
I own the moment, and it may
Enjoy me in the same relation."
(Baratynsky, *Finland*)

We conclude that, apart from philosophizing, it is only compact life-and-death problem that is actually of interest for "I". It might be said, that the Method deals only with death, but only within the limits of life. However in the Method itself, there are at least hints of its limiting situations. In terms of CP, a Zeno sequence formed by photon oscillations should be completed with the single point determined by the sequence of its own, though *not belonging* to it. In this respect, a segment of the straight line is not equivalent to this line, whereas without its end points it is. And this statement remains true upon any its one-to-one order preserving mappings into some other straight line. Therefore, the actual meaning of the wise Zeno's paradox is in this, that initially, prior to introducing auxiliary, adapted for a particular CP external measure, it is just the sequence of discretely perceived events that is a primary, because the final contact is such. I-time "stays still" if nothing *interesting* occurs. In CP schemes, the sequence of contacts may well be infinite, and *according to this measure* Achilles will not overtake the tortoise *indeed*, and this fact in no way prevents practical applications of the Method.

As we have seen in the first part, in applications of the Method something that might occur if the final contact does occur, is always supposed to be known to the user in advance. Only when this became clear, might he ask the Method for recommendations. Otherwise, he would necessarily be asked time and again: "What do you want indeed?" However, what is good in the near future might not be that good later on. It is commonly known that the technologies, based on the Method and providing the impressive technical progress, hide many nuisances of their own. Aside from various dangers, stemming from quarrels of people and their communities, we point out only these that root in good intentions, stimulating the development of the Method.

The mentioned above uncertainty in the self-identification of "I", renders some allowed in the Method efforts to prolong the life of "I" a quite practical problem. The methods of replacing worn tissues and producing fresh organs make it possible to shift the unavoidable death still further and further in the future, while "I" goes on considering himself the same "I", endlessly keeping up his health and capabilities. In this case, if the rate of birth of new people drops to zero, then according to the perception of the living ones nothing would change from what it already was the case before. Everything reduces to a mere change in the time scale, as if the Earth was to orbit the Sun quicker, and then birthdays were celebrated more frequently. This is because the unavoidable death brings about no natural time scale. Indeed, what is infinite life? Would a thousand years be enough? How about a million? In general, to ask "naive and silly" questions is the best way to elucidate the actual meaning of conceptions. An ephemeron that is doing everything in just one day, does he lives long? Or if lived a thousand years, while sleeping on average nine hundreds of them, is this longer than hundred years straight? (Remember "*Rip van Winkle*" by Irving); or if returned from a journey in the fast space vehicle? Other people would consider him long-living indeed. However, they would notice nothing, if tripped together. And how is it "indeed"? The very variety of these questions means that they are not to be answered within the Method with its narrow universal unambiguousness.* The Method begins with the explicit presenting of the final state as the goal for all further auxiliary operations. But final state "is not seen" from the given state of a particular life. Once the birth of individuals is permitted, a life time scale is naturally defined by aging, bringing about either the expiring of any progress (and this is easier to be discerned from stagnation than from degradation) or mutual misunderstanding and non-acceptance between generations. The wretched existence of the "eternal", bothered with themselves elders of Luggnegg, as described by Swift in his "Gulliver's travels", is not in their impotence, but rather in their old-fashion mind. Then death itself becomes desirable for "I", hence, the Method is no longer of his interest. And then what are new people needed for? So all the community is steadily loosing incentive to exist, as it was already guessed (two centuries ago) by Baratynsky in his poem "The last death". Being perfected further still, the Method is steadily expanding its boundaries and claiming a more detailed approximation of life in all its variety by means of universally repeatable constructions, persuading, by the way, the users that only things that deserve heed are those that the Method is capable of providing. However, ". . . the man, always and everywhere, whoever he was, strove to act just as he wanted, and not at all as the reason and profit ordered him." (Dostoevsky, *Notes from the Underground*). And if the man acts "just as he likes", accounting for no circumstances, he never addresses the Method for its advices. Indeed, if it were

*Some people regard their life as somehow continued in their descendants, works, communities, and so on.

that protection from death be of only concern, then the organisms would be simply mechanisms to solve a particular problem; no other difference among them would be important, and nothing would prevent the substitution of one by another, so reaching "genuine" immortality. We conclude that even in its own realm, i.e. the life-and-death problem, the Method loses its importance just on the climax of its successes, where the very transition from life to death becomes indistinct.

This is its irony.

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