Other Earths: Search for Life and the Constant Curvature

Megan M. Khoshyaran

Economics Traffic Clinic-ETC, 34 Avenue des champs Elyses, 75008 Paris, France
E-mail: megan.khoshyaran@wanadoo.fr

The objective of this paper is to propose a search methodology for finding other exactly similar earth like planets (or sister earths). The theory is based on space consisting of Riemann curves or highways. A mathematical model based on constant curvature, a moving frame bundle, and gravitational dynamics is introduced.

1 Introduction

The objective of this paper is to propose a search methodology that could show the way to finding other exactly similar earth like planets (or sister earths). The main idea in this paper lies behind the theory that space contains of what is called highways. The term highway refers to a path with no obstructions. Examples of obstructions are black holes and stars or any celestial objects with significant masses and gravitational forces. Paths are non-linear graphs.

Space is composed of these highways, on which there is at least one sister earth. Topologically highways are made up of constant Riemann curvatures, [1]. It is posited that sister earths are located at the points of constant curvature; more accurately, these are the points where two oppositely directed highways (or paths) with identical constant curvatures share a moving tangent frame where the coordinate frame is the derivative of their gravitational tensors with respect to the (x) coordinate.

A sister earth comes with its satellite (or a moon) just as earth has its satellite, the moon. A satellite is found at the point of intersection of two oppositely directed highways. The earth's moon provides a parallel highway to the earth's highway. So far the methods of detecting earth like exoplanets consist of observation through Hubble space telescope of extrasolar giant planets and their gravitational influence on parent stars, [2,3,4]. Transit method, [5], orbital brightness modulations, [6], timing variations, [7], gravitational microlensing, [8], direct imaging, [9], and polarimetry, [10], are among methods currently used for the detection of earth like exoplanets. In all these methods the main element of study is observation of light and gravitational changes as it distorts light around planets.

The advantage of the current theory proposed in this paper is that it provides an analytical approach based on Riemannian curvature, and the dynamics of gravitation mathematically represented by differential gravity calculations around the points of constant curvature. The important first step is to find pathways (or space highways) with constant curvatures. One Riemann path or space highway with constant curvature is known, and that is the Riemann path of the earth. The Riemann path of the moon is another known pathway or space highway that is parallel to the earth's Riemann path. Other Riemann paths can be traced out parallel to the earth's and the moon's Riemann paths or space highways. A path to a sister earth can be traced out assuming that it has the same curvature with different gravitational tensor described in the following section.

2 Space highways

Space highways are paths that extend to infinity. The word infinity is used to imply very long distances. These paths can be considered as Riemannian curves with constant curvatures. Riemann paths with constant curvatures contain no obstacles. Here, obstructions are mainly black holes, and massive stars, or any significant electrostatic system, moving with a certain velocity (v) corresponding to an electromagnetic momentum, (H).

In other words, any significant mass with inertia, momentum, and thus velocity that produces gravitational and electromagnetic forces. Vector ($\mathbf{H}$) represents the electromagnetic direction and magnitude. The electromagnetic momentum can be expressed as the multiplication of the vector ($\mathbf{H}$) by the velocity ($\mathbf{v}$), as ($\mathbf{H} \cdot \mathbf{v}$). The assumption of Riemann paths in dark regions of space is fundamental to the structure of the model to be introduced.

The earth's Riemann path with constant curvature can be constructed given the coordinates of the sun and the earth. Let's assume that the earth is in a stationary system ($\mathbf{K}$), where [$\mathbf{x}_\tau = (x, y, z, t) \in \mathbf{K}$] denotes the coordinates and the system ($\mathbf{K}$) holds a homogeneous gravitational field, and gravitational acceleration equal to [$\gamma = (\gamma_x, \gamma_y, \gamma_z)$]. In system ($\mathbf{K}$), Newtonian laws hold in their most basic form, the same basic laws equally hold with respect to any other coordinate system moving in uniform translation with respect to ($\mathbf{K}$).

Let system ($\mathbf{K}$) represent the sun system. It is assumed that the coordinates of the sun are $(0, 0, 0, 0)$, meaning that the sun is considered to be the first solar system of its kind. Let's assume that earth is located in a second coordinate system ($\mathbf{K}'$), where [$\mathbf{x}_\sigma = (x', y', z', t') \in \mathbf{K}'$] signifies the coordinates in this system. It is also assumed that for any other coordinate system outside of the two systems ($\mathbf{K}$) and ($\mathbf{K}'$), the laws of general relativity hold with respect to the two coordinate systems.

By this it is meant that the velocity of light (c) in vacuum

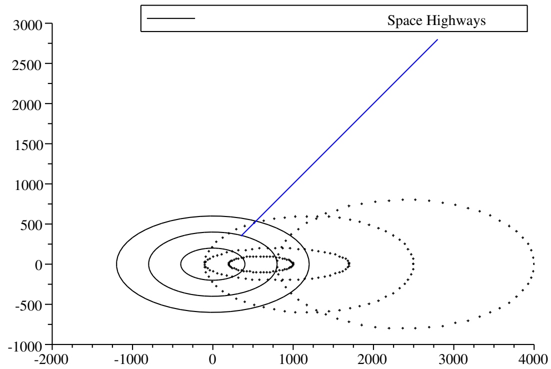

Fig. 1: A graphical representation of Riemann Paths.

is constant, [11], and in combination with the principles of relativity, follows the relativity of simultaneity, the Lorentz transformation rules, and the related laws indicating the behaviour of bodies in motion. The laws of geometry are taken directly as laws relating to relative positions of mass at rest. The laws of kinematics are to be taken as laws which describe the relation of a solid body with respect to another in terms of their distance from each other in definite length independent of the location and the orientation of the two bodies in time. An example of space highways is given in Fig. 1.

Let's consider the earth as an event point in system ($\mathbf{K}'$) in a uniform constant rotation in a finite space with respect to system ($\mathbf{K}$). The curvature from the event point to the stationary system ($\mathbf{K}$) is given by (1):

$$ds^2 = \sum_{\sigma\tau} G_{\sigma\tau} dx_\sigma dx_\tau. \tag{1}$$

(dx_σ) corresponds to differentials in system ($\mathbf{K}'$), (σ) represents the (x', y', z', t') coordinate system in ($\mathbf{K}'$), and (dx_τ) corresponds to differentials in system ($\mathbf{K}$), where τ represents the (x, y, z, t) coordinate system. ($G_{\sigma\tau}$) is the gravitation tensor, signifying the gravitational forces exerted mutually between systems ($\mathbf{K}$) and ($\mathbf{K}'$) multiplied by the differential of the electromagnetic force ($d\mathbf{H}$).

The gravitation tensor ($G_{\sigma\tau}$) is a matrix obtained by multiplying matrix ($g_{\sigma\tau}$), the matrix of the differentials of the gravitational force, given as:

$$g_{\sigma\tau} = \begin{pmatrix} \frac{\partial x'}{\partial x} & \frac{\partial x'}{\partial y} & \frac{\partial x'}{\partial z} & \frac{\partial x'}{\partial t} \\ \frac{\partial y'}{\partial x} & \frac{\partial y'}{\partial y} & \frac{\partial y'}{\partial z} & \frac{\partial y'}{\partial t} \\ \frac{\partial z'}{\partial x} & \frac{\partial z'}{\partial y} & \frac{\partial z'}{\partial z} & \frac{\partial z'}{\partial t} \\ \frac{\partial t'}{\partial x} & \frac{\partial t'}{\partial y} & \frac{\partial t'}{\partial z} & \frac{\partial t'}{\partial t} \end{pmatrix}$$

with matrix ($d\mathbf{H}$), the matrix of the differentials of the electromagnetic force or the matrix of the curl of ($\mathbf{H}$) given by (2):

$$G_{\sigma\tau} = g_{\sigma\tau} \times d\mathbf{H}. \tag{2}$$

The matrix of the curl of ($\mathbf{H}$), the electromagnetic force is given as:

$$d\mathbf{H} = \begin{pmatrix} \left(\frac{\partial H_{x'}}{\partial z} - \frac{\partial H_{z'}}{\partial x}\right) & 0 & 0 & 0 \\ 0 & \left(\frac{\partial H_{y'}}{\partial x} - \frac{\partial H_{x'}}{\partial y}\right) & 0 & 0 \\ 0 & 0 & \left(\frac{\partial H_{z'}}{\partial y} - \frac{\partial H_{y'}}{\partial z}\right) & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

In the presence of significant mass, and the electromagnetic momentum ($\mathbf{H} \cdot \mathbf{v}$), the diagonal entries of the curl of ($\mathbf{H}$) are given in (3)–(5) as:

$$\left(\frac{\partial H_{x'}}{\partial z} - \frac{\partial H_{z'}}{\partial x}\right) = \frac{1}{c} \times \rho \times v_{x'} \tag{3}$$

$$\left(\frac{\partial H_{y'}}{\partial x} - \frac{\partial H_{x'}}{\partial y}\right) = \frac{1}{c} \times \rho \times v_{y'} \tag{4}$$

$$\left(\frac{\partial H_{z'}}{\partial y} - \frac{\partial H_{y'}}{\partial z}\right) = \frac{1}{c} \times \rho \times v_{z'}. \tag{5}$$

In (3)–(5), (c) is the velocity of light, (ρ) is the volume-density charge of a mass, and the vector ($\mathbf{v}$) is the velocity of the electromagnetic momentum where $\mathbf{v} = (\mathbf{v_{x'}}, \mathbf{v_{y'}}, \mathbf{v_{z'}})$.

The curvature of the system ($\mathbf{K}$)-($\mathbf{K}'$) in a finite region between an event-point in system ($\mathbf{K}'$), and a stationary point in system ($\mathbf{K}$) such as the earth and the sun is well-known to be an ellipsoid in the form expressed by (6) as:

$$S = G_{\sigma\tau} \times \left(\frac{(\mathbf{x}_\sigma - \mathbf{x}_\tau)^2}{\mathbf{a}^2}\right). \tag{6}$$

($\mathbf{x}_\sigma$) is the vector of coordinates in the ($\mathbf{K}'$) system, where $\mathbf{x}_\sigma = (\mathbf{x}', \mathbf{y}', \mathbf{z}', \mathbf{t}')$, and ($\mathbf{x}_\tau$) is the vector of coordinates in the ($\mathbf{K}$) system, where $\mathbf{x}_\sigma = (\mathbf{x}, \mathbf{y}, \mathbf{z}, \mathbf{t})$. Equation (6) can be rewritten with respect to the coordinates given in (7):

$$\begin{aligned} S &= A_1 \times \left(\frac{(x - x')^2}{{a_1}^2}\right) + A_2 \times \left(\frac{(y - y')^2}{{a_2}^2}\right) + \\ &+ A_3 \times \left(\frac{(z - z')^2}{{a_3}^2}\right) + A_4 \times \left(\frac{(t - t')^2}{{a_4}^2}\right). \end{aligned} \tag{7}$$

The coefficients ($\mathbf{A}$) are the columns of ($G_{\sigma\tau}$), the gravitation tensor. The denominators in (7), (a_1, a_2, a_3, a_4) are constants less than 1, and the coefficients ($\mathbf{A} = (\mathbf{A_1}, \mathbf{A_2}, \mathbf{A_3}, \mathbf{A_4})$) are given at the top of the next page.

The time (t) in the ($\mathbf{K}$) system is formulated in a relativistic sense as in (8):

$$t = \frac{\left(1 - \frac{v}{c}\right) \times t'}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{8}$$

$$\mathbf{A} = \begin{pmatrix} \frac{\partial x'}{\partial x} \times \left(\frac{\partial H_{x'}}{\partial z} - \frac{\partial H_{z'}}{\partial x}\right) & 0 & 0 & 0 \\ 0 & \frac{\partial y'}{\partial y} \times \left(\frac{\partial H_{y'}}{\partial x} - \frac{\partial H_{x'}}{\partial y}\right) & 0 & 0 \\ 0 & 0 & \frac{\partial z'}{\partial z} \times \left(\frac{\partial H_{z'}}{\partial y} - \frac{\partial H_{y'}}{\partial z}\right) & 0 \\ 0 & 0 & 0 & \frac{\partial t'}{\partial t} \times 1 \end{pmatrix}$$

The elements of the coefficient matrix ($\mathbf{A}$) are:

$$A_{11} = \frac{\partial x'}{\partial x} \times \left(\frac{\partial H_{x'}}{\partial z} - \frac{\partial H_{z'}}{\partial x}\right) = \frac{1}{c} \times \rho \times \gamma_{x'} \tag{9}$$

$$A_{22} = \frac{\partial y'}{\partial y} \times \left(\frac{\partial H_{y'}}{\partial x} - \frac{\partial H_{x'}}{\partial y}\right) = \frac{1}{c} \times \rho \times \gamma_{y'} \tag{10}$$

$$A_{33} = \frac{\partial z'}{\partial z} \times \left(\frac{\partial H_{z'}}{\partial y} - \frac{\partial H_{y'}}{\partial z}\right) = \frac{1}{c} \times \rho \times \gamma_{z'} \tag{11}$$

and

$$A_{44} = \frac{\partial t'}{\partial t} = \frac{\left(\sqrt{1 - \frac{v_{x'}{}^2}{c^2}}\right)}{\left(1 - \frac{v_{x'}}{c}\right)} \times (t' - t)\,. \tag{12}$$

In (9–11), the vector (γ) is the vector of acceleration of the electromagnetic momentum ($\mathbf{H} \cdot \mathbf{v}$), where $\gamma = (\gamma_{\mathbf{x}'}, \gamma_{\mathbf{y}'}, \gamma_{\mathbf{z}'})$. The assumption is that the curvatures of Riemann paths or space highways should be formulated in exactly the same manner as the curvature formulated for the system ($\mathbf{K}$)-($\mathbf{K}'$). This assumption can be justified since any event point (earth like planet) on a Riemann curve of constant curvature should exhibit the same characteristics as the event-point earth.

An important element to consider, is how to find the coordinates of an event point (earth like planet) with respect to the coordinate system ($\mathbf{K}$). These coordinates are arbitrary since the only point of reference is the system ($\mathbf{K}$). All the same, let's assign coordinates to an event point (earth like planet) as ($\mathbf{x}_\nu$) where [$\mathbf{x}_\nu = (\mathbf{x}'', \mathbf{y}'', \mathbf{z}'', \mathbf{t}'') \in \mathbf{K}''$] denotes the coordinate system in ($\mathbf{K}''$). The coordinates of the event point (earth like planet) can be determined given that the event point is in the finite region from the sun. The event point (earth like planet) in the dark region is chosen assuming that it is on an ellipsoid parallel to the ellipsoid that contains the coordinate system ($\mathbf{K}$), with coordinates $\mathbf{x}_\tau = (\mathbf{x}, \mathbf{y}, \mathbf{z}, \mathbf{t})$, in other words the sun.

The curvature can be formulated in (9) as:

$$ds'^2 = \sum_{\nu\sigma} g^{\nu\sigma} \times G_{\sigma\tau} \times (dx_\sigma dx_\tau)\, dx_\nu. \tag{13}$$

The tensor ($g^{\nu\sigma}$) represents the gravitational force exerted between the two coordinate systems ($\mathbf{K}$) and ($\mathbf{K}''$). Given that the coordinate system ($\mathbf{K}''$) is in a finite region with respect to the coordinate system ($\mathbf{K}$), the tensor ($g^{\nu\sigma}$) takes on values equal to the Lorentz factor as is given in the first matrix at the top of the next page.

The Lorentz factor gives length contraction and time dilation. As the function of velocity (v), the Lorentz factor starts at value (1) at ($v = 0$), and approaches infinity as ($v \to c$), the velocity of a particle approaches the speed of light (c). The solution to differential equation (9) is an ellipsoid similar to the one given in (6), and its extended form similar to (7) is given in (10) as:

$$S' = \mathbf{B} \times \left(\frac{(\mathbf{x}_\nu - \mathbf{x}_\tau)^\mathbf{2}}{\mathbf{b^2}}\right) \tag{14}$$

$$\begin{aligned} S &= B_1 \times \left(\frac{(x'' - x)^2}{b_1{}^2}\right) + B_2 \times \left(\frac{(y'' - y)^2}{b_2{}^2}\right) + \\ &+ B_3 \times \left(\frac{(z'' - z)^2}{b_3{}^2}\right) + B_4 \times \left(\frac{(t'' - t)^2}{b_4{}^2}\right) = 1. \end{aligned} \tag{15}$$

The denominators in (11), (b_1, b_2, b_3, b_4) are constants less than 1, and the coefficients $\mathbf{B} = (\mathbf{B_1}, \mathbf{B_2}, \mathbf{B_3}, \mathbf{B_4})$ are given in the second matrix at the top of the next page.

The elements of the coefficient matrix ($\mathbf{B}$) are:

$$\begin{aligned} B_{11} &= -\left(\frac{\partial x''}{\partial x} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \\ &= -\left(\frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \times |\, x'' - x \,| \end{aligned} \tag{16}$$

$$\begin{aligned} B_{22} &= -\left(\frac{\partial x''}{\partial x} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \\ &= -\left(\frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \times |\, y'' - y \,| \end{aligned} \tag{17}$$

$$\begin{aligned} B_{33} &= -\left(\frac{\partial x''}{\partial x} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \\ &= -\left(\frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \times |\, z'' - z \,| \end{aligned} \tag{18}$$

$$g^{\nu\sigma} = \begin{pmatrix} -\frac{1}{\sqrt{1-\frac{v_{x''}^2}{c^2}}} & 0 & 0 & 0 \\ 0 & -\frac{1}{\sqrt{1-\frac{v_{y''}^2}{c^2}}} & 0 & 0 \\ 0 & 0 & -\frac{1}{\sqrt{1-\frac{v_{z''}^2}{c^2}}} & 0 \\ 0 & 0 & 0 & \frac{\partial t''}{\partial t} \times \frac{1}{\sqrt{1-\frac{v_{x''}^2}{c^2}}} \end{pmatrix}$$

$$\mathbf{B} = \begin{pmatrix} -\frac{\partial x''}{\partial x} \times \frac{1}{\sqrt{1-\frac{v_{x''}^2}{c^2}}} & 0 & 0 & 0 \\ 0 & -\frac{\partial y''}{\partial y} \times \frac{1}{\sqrt{1-\frac{v_{y''}^2}{c^2}}} & 0 & 0 \\ 0 & 0 & -\frac{\partial z''}{\partial z} \times \frac{1}{\sqrt{1-\frac{v_{z''}^2}{c^2}}} & 0 \\ 0 & 0 & 0 & -\frac{\partial t''}{\partial t} \times \frac{1}{\sqrt{1-\frac{v_{x''}^2}{c^2}}} \end{pmatrix}$$

and

$$\begin{aligned} B_{44} &= \frac{\partial t''}{\partial t} \times \left(\frac{1}{\sqrt{1-\frac{v_{x''}^2}{c^2}}} \right) \\ &= \left(\frac{1}{1-\frac{v_{x''}}{c}} \right) \times (t'' - t) \end{aligned} \qquad (19)$$

where $(| x'' - x |)$ is the absolute distance.

Any event point in the dark regions of space that does not violate the Lorentz factor impact of the gravitational force between the two coordinate systems (**K**) and (**K**$''$) can be considered to be on the constant curvature. The event point earth like planet should be found on such a constant curvature. Any other significant mass such as a black hole or a star would create discontinuity and thus disrupts the Riemann path.

Fig. 2 provides a graphical representation of an ellipsoidal curve with an event point (earth). Fig. 2 depicts the rotation of the earth around the sun scaled down to (100^{-3}) of the actual size. Fig. 3 demonstrates a Riemann path with respect to the sun system. Fig. 4 demonstrates Riemann paths with respect to the sun system.

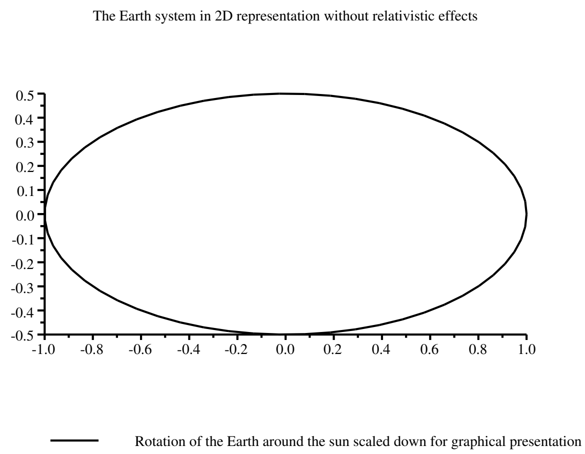

Fig. 2: A graphical representation of the rotation of the earth around the sun (the earth system).

3 Other earths

An event point (earth), is located at the point of constant curvature of two opposing Riemann paths or space highways, where the two curves share common points. Let (S') be the Riemann path of constant curvature of an ellipsoidal form given in (13). Let (S_{c_2}) be a Riemann path with a singular event point earth. The event point on (S_{c_2}) has a mass (M), and a density (ρ), and a velocity (v), equal to that of the earth. The values of mass, density, and velocity of the event point earth of the space highway (S_{c_2}) is independent of it's coordinates. Assuming that this condition holds, then the Riemann path (S_{c_2}) is in such a region of space where (S_{c_2}) is of constant curvature, and thus assumes an ellipsoidal form of type given in (13). The event point earth conserves its momentum and energy. The curvature (s_{c_2}) can be written as in (12).

The coordinates of this solar system are the same as the earth's solar system with the exception that the new sun's coordinates are that of our sun added the distance between the

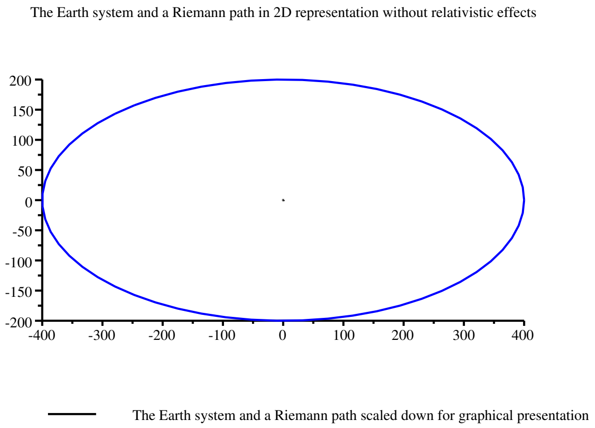

Fig. 3: A graphical representation of a Riemann path with respect to the sun system.

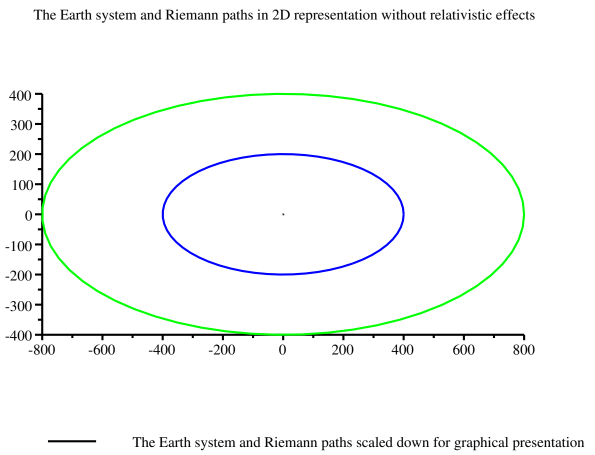

Fig. 4: A graphical representation of Riemann paths with respect to the sun system.

two stars. The coordinates of the new sun are

$$\mathbf{x}_{\tau'} = [(\mathbf{x}_{\tau'} + \mathbf{\Xi}), \mathbf{y}_{\tau'}, \mathbf{z}_{\tau'}, \mathbf{t}_{\tau'}]$$

where (Ξ) is the distance between the two stars. The coordinates of the event point earth are

$$(\mathbf{x}_{\mathbf{c}_2}\eta) = [(\mathbf{x}_{\mathbf{c}_2} + \mathbf{\Gamma}), \mathbf{y}_{\mathbf{c}_2}, \mathbf{z}_{\mathbf{c}_2}, \mathbf{t}_{\mathbf{c}_2}]$$

where (Γ) is the distance from the sun to the point of constant curvature where the two Riemann paths meet.

The ellipsoidal form of the Riemann path (S_{c_2}) is given in (13) as:

$$ds^2_{c_2} = \sum_{\tau'\eta} G^{\tau'\eta}_{c_2} dx_{\tau'} dx^{\eta}_{c_2} \qquad (20)$$

$$S_{c_2} = -\mathbf{G}^{\tau'\eta}_{\mathbf{c_2}} \times \frac{\left(\mathbf{x}_{\tau'} - \mathbf{x}^{\eta}_{\mathbf{c_2}}\right)^2}{\mathbf{b}^2_{\mathbf{c_2}}}. \qquad (21)$$

The denominators in (13),

$$\left(\mathbf{b}_{\mathbf{c_2}} = \mathbf{b}^{\mathbf{c_2}}_{\mathbf{1}}, \mathbf{b}^{\mathbf{c_2}}_{\mathbf{2}}, \mathbf{b}^{\mathbf{c_2}}_{\mathbf{3}}, \mathbf{b}^{\mathbf{c_2}}_{\mathbf{4}}\right)$$

are constants less than 1, and the coefficients

$$-\mathbf{G}^{\tau'\eta}_{\mathbf{c_2}} = (-A^{c_2}_1, -A^{c_2}_2, -A^{c_2}_3, A^{c_2}_4)$$

are given at the top of the next page.

The elements of the coefficient matrix $(-\mathbf{G}^{\tau'\eta}_{\mathbf{c_2}})$ are:

$$-A^{c_2}_{11} = -\frac{\partial x^{\eta}_{c_2}}{\partial x_{\tau'}} \times \left(\frac{\partial H_{x^{\eta}_{c_2}}}{\partial z_{\tau'}} - \frac{\partial H_{z^{\eta}_{c_2}}}{\partial x_{\tau'}}\right) = \frac{1}{c} \times \rho \times -\gamma_{x^{\eta}_{c_2}} \qquad (22)$$

$$-A^{c_2}_{22} = -\frac{\partial y^{\eta}_{c_2}}{\partial y_{\tau'}} \times \left(\frac{\partial H_{y^{\eta}_{c_2}}}{\partial x_{\tau'}} - \frac{\partial H_{x^{\eta}_{c_2}}}{\partial y_{\tau'}}\right) = \frac{1}{c} \times \rho \times -\gamma_{y^{\eta}_{c_2}} \qquad (23)$$

$$-A^{c_2}_{33} = -\frac{\partial z^{\eta}_{c_2}}{\partial z_{\tau'}} \times \left(\frac{\partial H_{z^{\eta}_{c_2}}}{\partial y_{\tau'}} - \frac{\partial H_{y^{\eta}_{c_2}}}{\partial z_{\tau'}}\right) = \frac{1}{c} \times \rho \times -\gamma_{z^{\eta}_{c_2}} \qquad (24)$$

and

$$A_{44} = \frac{\partial t''}{\partial t} = \frac{\sqrt{1 - \frac{\left(v_{x^{\eta}_{c_2}}\right)^2}{c^2}}}{\left(1 - \frac{v_{x^{\eta}_{c_2}}}{c}\right)} \times (t'' - t). \qquad (25)$$

$(-\gamma_{x^{\eta}_{c_2}})$ states that the acceleration on the Riemann path (S_{c_2}) should be opposite of the acceleration on the (S') curve. In the above matrix the (x_{c_2}) coordinate should be taken equal to $(x_{c_2} + \Gamma)$.

The event point earth is located where

$$\frac{-\partial \mathbf{G}^{\nu\eta}_{\mathbf{c_2}}}{\partial x^{\eta}_{c_2}} = \frac{\partial \mathbf{B}_{\mathbf{x}_\nu}}{\partial x_\nu}$$

the derivative of the gravitational tensor $(-\mathbf{G}^{\tau'\eta}_{\mathbf{c_2}})$ belonging to the (c_2) Riemann path with respect to the coordinates of the (c_2) solar system, is equal to the derivative of the gravitational tensor of the (S') Riemann path with respect to its coordinate system. In Fig. 5, the event point earth can be found where the green ellipse Riemann path (S') and the Riemann path (c_2) (the red ellipse) meet. Fig. 6 depicts the tangent vector at the event point earth.

It should be stated that the magnitude of the electromagnetic force of the event point earth $(\mathbf{H}_{\mathbf{x}^{\eta}_{\mathbf{c_2}}})$ is equal to the magnitude of the electromagnetic force of the solar system's earth, $(\mathbf{H})$,

$$|\, \mathbf{H}_{\mathbf{x}^{\eta}_{\mathbf{c_2}}} \,| = |\, \mathbf{H} \,| \,.$$

Consequently, the curl of $(\mathbf{H}_{\mathbf{x}^{\eta}_{\mathbf{c_2}}})$, and the curl of $(\mathbf{H})$ should be equal. Thus the density, the volume-density charge of the mass, and the velocity of the event point earth are equal to that of the solar system's earth.

Let (T) be the set of all frames at all points of Riemann path (c_2). Let $[(U_\alpha, X^\alpha)_{\alpha\in c_2}]$, represent all pairs where (U_α)

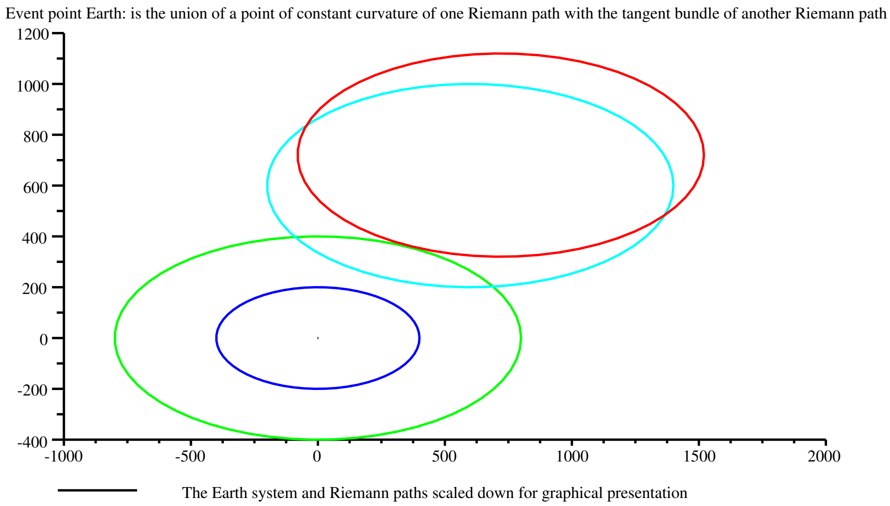

Fig. 5: A graphical representation of the event point earth.

$$-\mathbf{G}^{\tau'\eta}_{\mathbf{c_2}} = \begin{pmatrix} -\frac{\partial x^{\eta}_{c_2}}{\partial x_{\tau'}} \times \left(\frac{\partial H_{x^{\eta}_{c_2}}}{\partial z_{\tau'}} - \frac{\partial H_{z^{\eta}_{c_2}}}{\partial x_{\tau'}}\right) & 0 & 0 & 0 \\ 0 & -\frac{\partial y^{\eta}_{c_2}}{\partial y_{\tau'}} \times \left(\frac{\partial H_{y^{\eta}_{c_2}}}{\partial x_{\tau'}} - \frac{\partial H_{x^{\eta}_{c_2}}}{\partial y_{\tau'}}\right) & 0 & 0 \\ 0 & 0 & -\frac{\partial z^{\eta}_{c_2}}{\partial z_{\tau'}} \times \left(\frac{\partial H_{z^{\eta}_{c_2}}}{\partial y_{\tau'}} - \frac{\partial H_{y^{\eta}_{c_2}}}{\partial z_{\tau'}}\right) & 0 \\ 0 & 0 & 0 & \frac{\partial t^{\eta}_{c_2}}{\partial t_{\tau'}} \times 1 \end{pmatrix}$$

is an open subset of (T), and $(X^{\alpha} = (X^{\alpha}_1, ..., X^{\alpha}_n))$ is a moving frame on (U_{α}), then

$$\left(U, \frac{-\partial \mathbf{G}^{\nu\eta}_{\mathbf{c_2}}}{\partial X^{\alpha}} = \frac{\partial \mathbf{B}_{\mathbf{x}_{\nu}}}{\partial X^{\beta}}\right) \in (U_{\alpha}, X^{\alpha})_{\alpha \in c_2},$$

where $(X^{\beta} = (X^{\beta}_1, ..., X^{\beta}_n))$ is a moving frame on (S'). This gives the following set of differential equations for each $(\alpha \in c_2)$, and $(\beta \in S')$:

$$\frac{\partial}{\partial X^{\alpha}} \left(\frac{\partial X^{\alpha}}{\partial x_{\tau'}} \times \left(\frac{\partial H_{X^{\alpha}}}{\partial z'_{\tau}} - \frac{\partial H_{X^{\alpha}}}{\partial x'_{\tau}}\right)\right) = -\frac{\partial}{\partial X^{\beta}} \left(\frac{\partial X^{\beta}}{\partial x''} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right) \tag{26}$$

and

$$\frac{\partial}{\partial X^{\alpha}} \left(\frac{\partial t^{\eta}_{c_2}}{\partial t_{\nu}} \times 1\right) = -\frac{\partial}{\partial X^{\beta}} \left(\frac{\partial t'}{\partial t} \times \frac{1}{\sqrt{1 - \frac{v^2_{x'}}{c^2}}}\right). \tag{27}$$

The equalities in (26) and (27) mean that the moving frame contains an open set of points $(X^{\alpha} = X^{\beta})$ where accelerations on the two Riemann paths (c_2) and (S') are equal. For (26) and (27) to hold a condition is imposed. The condition is that (26) and (27) must respect the linear translation $(L_{n\times n}, \mathfrak{R})$, where (n) is the dimension of a matrix. If (M) was a (2×2) matrix , then the Jacobian of (M) would be equal to 1, $([M] = 1)$. This implies that the tangent bundle forms an isomorphic group to $(\mathfrak{R}^1)$. Matrix (M) is given at the top of the next page. $[M]$ is given by (28) below:

$$\begin{aligned} [M] = {} & \frac{\partial}{\partial X^{\alpha}} \left(\frac{\partial X^{\alpha}}{\partial x_{\tau'}} \times \left(\frac{\partial H_{X^{\alpha}}}{\partial z'_{\tau}} - \frac{\partial H_{X^{\alpha}}}{\partial x'_{\tau}}\right)\right) \times \\ & \times \left(-\frac{\partial}{\partial X^{\beta}} \left(\frac{\partial t'}{\partial t} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right)\right) \\ & - \frac{\partial}{\partial X^{\alpha}} \left(\frac{\partial t^{\eta}_{c_2}}{\partial t_{\nu}} \times 1\right) \times \left(-\frac{\partial}{\partial X^{\beta}} \left(\frac{\partial X^{\beta}}{\partial x''} \times \frac{1}{\sqrt{1 - \frac{v^2_{x''}}{c^2}}}\right)\right) \\ & = 1. \end{aligned} \tag{28}$$

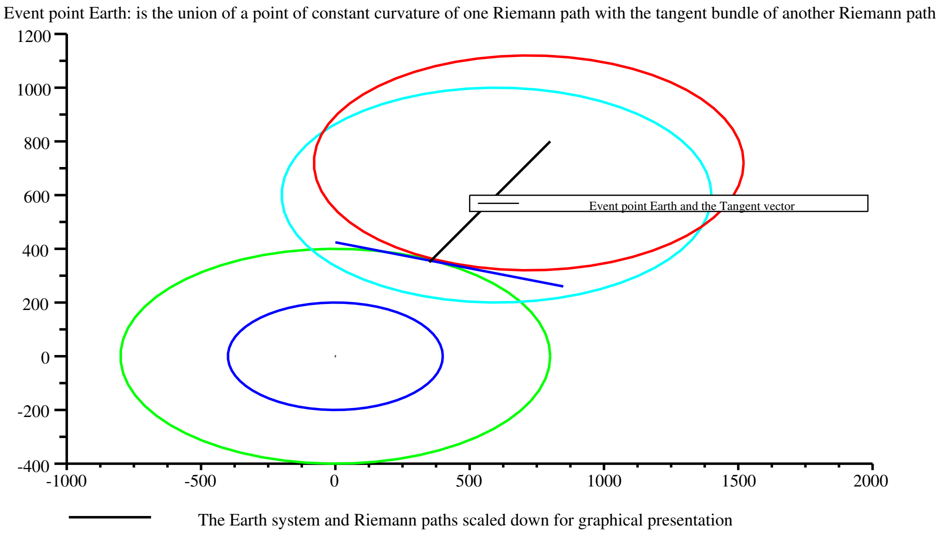

Fig. 6: Tangent vector at the event point earth.

$$M = \begin{pmatrix} \frac{\partial}{\partial X^\alpha}\left(\frac{\partial X^\alpha}{\partial x_{\tau'}}\times\left(\frac{\partial H_{X^\alpha}}{\partial z'_\tau}-\frac{\partial H_{X^\alpha}}{\partial x'_\tau}\right)\right) & \frac{\partial}{\partial X^\alpha}\left(\frac{\partial t^\eta_{c_2}}{\partial t_\nu}\times 1\right) \\ -\frac{\partial}{\partial X^\beta}\left(\frac{\partial X^\beta}{\partial x''}\times\frac{1}{\sqrt{1-\frac{v^2_{x''}}{c^2}}}\right) & -\frac{\partial}{\partial X^\beta}\left(\frac{\partial t'}{\partial t}\times\frac{1}{\sqrt{1-\frac{v^2_{x''}}{c^2}}}\right)\end{pmatrix}$$

(M) is the representation of ($\Re^1$) in the (2×2) matrix form, thus is an invertible linear transformation of the tangent bundle. Given that the Riemann path is of constant curvature, then the implication is that the tangent bundle is invariant with respect to space-time. This condition would give the point on the (S_{c_2}) path that touches the (S') Riemann path. Therefore, it traces out the movement of the event point earth.

4 Conclusion

In this paper a new methodology is introduced that gives a mathematical approach to finding other exactly similar earth like planets. The mathematical model is based on finding what is called "space highways" or "Riemann paths". The characteristic of these highways is that they are found in the dark regions or non-deformed by gravitational forces regions of space, where there are no stars, or black holes, or planets. Riemann paths are considered as paths of constant curvature. Space highways are modelled as ellipsoidal forms with coefficients as columns of a gravitational tensor.

It is assumed that the coordinates of the sun are $(0, 0, 0, 0)$, meaning that the sun is considered to be the first solar system of its kind. This assumption is justified, since there is no evidence to the contrary to this day.

Space highways or Riemann paths are parallel to each other if they are in the same direction. The location of the event point earth (or exactly similar earth type planet) is where a Riemann path or space highway intersects at points of constant curvature with another space highway coming from an opposite direction. The movement of the event point earth is traced out where the two Riemann paths share the same tangent bundle. It is hoped that the search methodology introduced in this paper opens up a new possibility of finding planets that harbor life as we know it.

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