The Rôle of the Element Rhodium in the Hyperbolic Law of the Periodic Table of Elements

A. Khazan
2265 Ocean Parkway, Apt. 5N, Brooklyn, NY 11223, USA
E-mail: albkhazan@list.ru

The rôle of the element rhodium as an independent affirmation of calculations by the Hyperbolic Law and validity of all its relations is shown herein. The deviation in calculation by this method of the atomic mass of heaviest element is 0.0024%, and its coefficient of scaling 0.001–0.005%.

1 Introduction

The method of rectangular hyperbolas assumes that their peaks (i.e. vertices) should be determine with high accuracy. For this purpose the theorem of Lagrange and the coefficient of scaling calculated by the Author for transition from the system of coordinates of the image of a hyperbola, standard practice of the mathematician, and used in chemistry, are utilized. Such an approach provides a means for calculating the parameters of the heaviest element in the Periodic Table of D. I. Mendeleyev [1].

In the first effect of the Hyperbolic Law it is shown that to each direct hyperbola corresponds an adjacent hyberbola: they intersect on the line $Y = 0.5$ at a point the abscissa of which is twice the atomic mass of an element [2]. This fact is clearly illustrated for Be, Ca, Cd in Fig. 1.

Upon close examination of the figure deeper relationships become apparent:

- From the centre of adjacent hyperbolas ($X = 0, Y = 1$) the secants have some points of crossing, the principal of which lie on the line $Y = 0.5$ and on the virtual axes (peaks);
- The secants intersect a direct hyperbola in two points, with gradual reduction of a segment with the increase in molecular mass;
- Behind the virtual axis of adjacent hyperbolas the secants cut a direct hyperbola in only one point;
- In conformity therewith, the magnitude of the abscissa, between a secant and a point of intersection of hyperbolas on the line $Y = 0.5$, also changes;
- For the element rhodium the secant becomes a tangent and also becomes the virtual axis of adjacent hyperbolas.

2 Mathematical motivation

On the basis of the presented facts, we have been led to calculations for 35 elements to establish the laws for the behavior of secants. The results are presented in the table for the following parameters:

- Atomic numbers of elements and their masses;
- Calculated coordinates of peaks of elements (the square root of the atomic mass and coefficient of scaling 20.2895 are used);
- Abscissas of secants on the line $Y = 0.5$ are deduced from the equation of a straight lines by two points

$$\frac{(X - X_1)}{(X_2 - X_1)} = \frac{(Y - Y_1)}{(Y_2 - Y_1)} \quad \text{(column 6)};$$

- Points of intersection of direct and adjacent hyperbolas (column 7);
- Difference between the abscissas in columns 6 and 7 (column 8);
- Tangent of an inclination of a secant from calculations for column 6.

According to columns 6 and 7 in Fig. 2, dependences which essentially differ from each other are obtained. Abscissas of secants form a curve of complex form which can describe with high reliability (size of reliability of approximation $R^2 = 1$) only a polynomial of the fifth degree. The second dependency has a strictly linear nature ($Y = 2X$), and its straight line is a tangent to a curve at the point (102.9055, 205.811). For clarity the representation of a curve has been broken into two parts: increases in molecular mass (Fig. 3) and in return — up to hydrogen, inclusive (Fig. 4). The strongly pronounced maximum for elements B, C, N, O, F, Ne is observed.

At the end of this curve there is a very important point at which the ordinate is equal to zero, where (the line of rhodium in the table) the data of columns 6 and 7 coincide.

Thus it is unequivocally established that for rhodium the secant, tangent and the virtual axis for an adjacent hyperbola are represented by just one line, providing for the first time a means to the necessary geometrical constructions on the basis of only its atomic mass (**the only one in the Periodic Table**), for the proof of the Hyperbolic Law.

Graphical representation of all reasoning is reflected in Fig. 5 from which it is plain that the point with coordinates (205.811, 0.5) is the peak of both hyperbolas, and the peaks of Ca and Ta are on both sides of it. Below are the calculations for the basic lines of rhodium on these data:

1. A secant: —
$$\frac{(X-0)}{(205.811-0)} = \frac{(Y-1)}{(0.5-1)}\,,$$
whence
$$Y = -0.0024294134X + 1\,.$$
At $Y=0$, $X=411.622$; in this case coordinates of peak will be: $X=205.811$, $Y=0.5$.

2. A tangent:— the equation of a direct hyperbola,
$$Y = \frac{102.9055}{X}\,,$$
its derivative at $X=205.811$, so
$$Y' = -\frac{102.9055}{205.811^2} = -0.0024294134\,,$$
$$Y - 0.5 = -0.0024294134X + 0.5\,.$$
Finally,
$$Y = -0.0024294134X + 1\,;$$
at $Y=0$, $X=411.622$.

3. A normal: — (the virtual axis),
$$Y = 0.0024294134X\,;$$
at $Y=1$, $X=411.622$.

Here are the same calculations for the tabulated data presented:

1. A secant: —
$$\frac{X}{205.82145} = \frac{(Y-1)}{(0.4999746-1)}\,,$$
whence
$$Y = -0.0024294134X + 1\,;$$
$$Y = 1\,, \quad X = 411.622\,.$$

2. A tangent: —
$$Y = \frac{102.9055}{X}\,,$$
the fluxion at $X = 205.821454$,
$$Y' = -\frac{102.9055}{205.82145^2} = -0.0024291667\,,$$
so
$$Y - 0.4999746 = -0.0024291667(X - 205.82145)\,,$$
whence
$$Y = -0.0024291667X + 0.99994928\,,$$
$$Y = 0\,, \quad X = 411.6429\,.$$

3. A normal: —
$$Y = 0.0024291667X\,;$$
$$Y = 1\,, \quad X = 411.6638\,.$$

3 Comparative analysis calculations

For a secant the results are identical with the first set of calculations above, whereas for a tangent and normal there are some deviations, close to last element calculated.

By the first set of calculations above its atomic mass is 411.622; hence the deviation is 411.663243 − 411.622 = = 0.041243 (0.01%). By the second set the size of a tangent and a normal are close to one another (an average of 411.65335) and have a smaller deviation: 411.663243 − − 411.65335 = 0.009893 (0.0024%). This is due to the tangent of inclination of the virtual axis of a direct hyperbola in the first set is a little high.

Using rhodium (Fig. 5) we can check the propriety of a choice of coefficient of scaling. It is necessary to make the following calculations for this purpose:

- Take the square root of atomic mass of rhodium ($X = = Y = 10.1442348$);
- Divide X_0 by X of the peak (205.811/10.1442348 = = 20.2885);
- Divide $Y = 10.1442348$ by Y_0 of the peak (0.5): also gives 20.2885;
- The difference by X and Y with the coefficient obtained, 20.2895, yielding the same size at 0.001 or 0.005%.

Formulae for transition from one system of coordinates to another have been given in the first paper of this series.

Using data for peaks, from the table, we get the following results:

Coordinates of peak
$$X_0 = 205.8215, \quad Y_0 = 0.49997,$$
$$X = Y = 10.1442348,$$
then
$$\frac{X_0}{X} = 20.2895, \quad \frac{Y}{Y_0} = 20.2897,$$
i. e. absolute concurrence (maximum difference of 0.0009%).

4 The rôle of the element Rhodium

However, all these insignificant divergences do not belittle the most important conclusion: that the validity of the Hyperbolic Law is estabished because the data calculated above completely coincide with calculations for rhodium is proved, based only on its atomic mass.

All the calculations for the table were necessary in order to find a zero point for rhodium, for which it is possible to do so without calculating the secant, but using only its atomic mass, thereby verifying the Hyperbolic Law.

How to get the correct choice of abscissa of a secant is depicted in Fig. 6 (using beryllium as an example) where instead of its tabulated value, 35.7434, the value equal to twice the point of intersection (36.0488) has been used. Here we

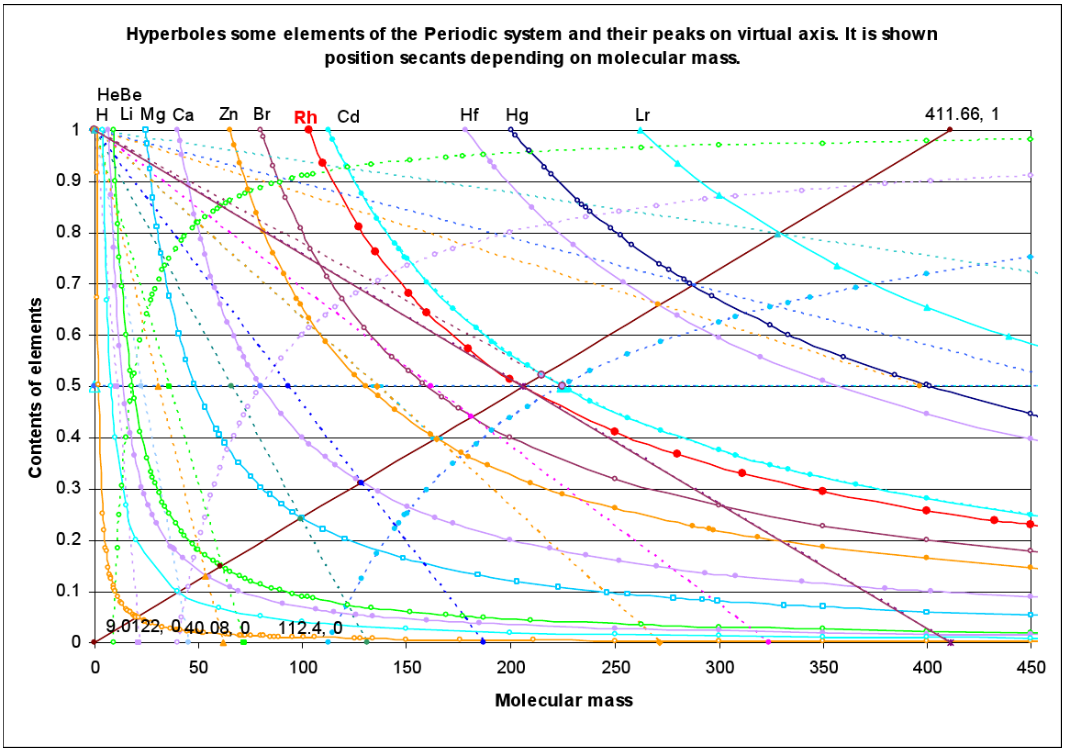

Fig. 1

tried to make a start from any fixed point not calculated (similar to the case for rhodium). It has proved to be impossible and has led to a mistake in the definition of the peak. In Fig. 7 the geometrical constructions for beryllium on the basis of correct settlement of data are given.

5 Conclusions

Previously we marked complexity of a choice of peak of a hyperbola of an element in the coordinates, satisfying the conditions $Y \leqslant 1$, $K \leqslant X$, as on an axis of ordinates the maximum value being a unit whilst the abscissa can take values in the hundreds of units. The problem has been solved by means of the theorem of Lagrange and the coefficient of scaling deduced. On the basis thereof our further conclusions depended, so it was very important to find a method not dependent on our calculations and at the same time allowing unequivocally to estimate the results. Owing to properties of the virtual axis of an rectangular hyperbola on which peaks of all elements lie, it is enough to have one authentic point.

Analyzing the arrangement of the virtual axes of direct and adjacent hyperbolas, we have paid attention to their point of intersection (205.83, 0.5), the abscissa of which is exactly half of atomic mass of the last element. As secants from the centre $X = 0$, $Y = 1$ cut direct hyperbolas any way (Fig. 1), we have been led to necessary calculations and have obtained a zero point at which the secant coincides with a tangent and the valid axis. The divergence with tabular data is in the order of 0.004%–0.009%.

Thus rhodium provides an independent verification of the method of rectangular hyperbolas for the Periodic Table of elements of D. I. Mendeleyev.

Submitted on May 08, 2008
Accepted on June 19, 2008

References

1. Khazan A. Upper limit in the Periodic Table of Elements. *Progress in Physics*, 2007, v. 1, 38.
2. Khazan A. Effect from hyperbolic law in Periodic Table of Elements. *Progress in Physics*, 2007, v. 2, 83.

1	2	3	4	5	6	7	8	9
El.	**No.**	**At. mass**	**X_0 peak**	**Y_0 peak**	**Abs. secant**	**Cross. hyperb.**	**$\Delta = 6-7$**	**$\tan a$, secant**
H	1	1.0079	20.3695	0.04948	10.715	2.0158	8.6992	−0.046664
He	2	4.0026	40.5992	0.0986	22.5163	8.0052	14.5111	−0.0222
Li	3	6.941	53.4543	0.12985	30.7155	13.882	16.8335	−0.01628
Be	4	9.0122	60.9097	0.14976	35.7434	18.0244	17.719	−0.014
B	5	10.811	66.712	0.162055	39.80692	21.622	18.18492	−0.01256
C	6	12.0107	70.3162	0.1708	42.4	24.0214	18.3786	−0.0117923
N	7	14.0067	75.9345	0.184458	46.5546	28.0134	18.5412	−0.01074
O	8	15.9994	81.1565	0.197143	50.5423	31.9988	18.5435	−0.009893
F	9	18.9984	88.4362	0.21483	56.3163	37.9968	18.3195	−0.008878
Ne	10	20.1797	91.1441	0.2214	58.5311	40.3594	18.1717	−0.0085425
Mg	12	24.305	100.0274	0.242983	66.0669	48.61	17.4569	−0.007568
S	16	32.065	114.89125	0.27909	79.6849	64.13	15.5549	−0.006273
Ca	20	40.078	128.4471	0.31202	93.3508	80.156	13.1948	−0.005356
Cr	24	51.9961	146.3042	0.3554	113.484	103.9922	9.4918	−0.004406
Zn	30	65.409	164.093	0.3986	136.428	130.818	5.61	−0.003665
Br	35	79.904	181.366	0.44057	162.0982	159.808	2.29	−0.003085
Zr	40	91.224	193.7876	0.47074	183.075	182.448	0.627	−0.002731
Mo	42	95.94	198.7336	0.482757	192.1085	191.88	0.2285	−0.002603
Rh	**45**	**102.906**	**205.82145**	**0.4999746**	**205.811**	**205.811**	**0**	**−0.00242941**
Cd	48	112.411	215.1175	0.52256	225.26	224.822	0.458	−0.00221946
Ba	56	137.327	237.7658	0.577573	281.428	274.654	6.774	−0.001777
Nd	60	144.242	243.6785	0.591936	298.5785	288.484	10.09455	−0.0016746
Sm	62	150.36	248.7926	0.60436	314.417	300.72	13.7	−0.00159
Dy	66	162.5	258.6414	0.628283	347.9	325	22.9	−0.001437
Yb	70	173.04	266.8976	0.64834	379.48	346.08	33.4	−0.0013176
Hf	72	178.49	271.068	0.65847	396.843	356.98	39.863	−0.00126
Ta	73	180.948	272.928	0.663	404.923	361.896	43.027	−0.0012348
Re	75	186.207	276.8658	0.67255	422.7646	372.414	50.35	−0.0011827
Ir	77	192.217	281.2984	0.68332	444.1376	384.434	59.704	−0.0011258
Hg	80	200.59	287.3598	0.698	475.8318	401.18	74.6518	−0.00105
At	85	210	294.0228	0.71423	514.44	420	94.44	−0.000972
Fr	87	223	302.9868	0.736	573.85	446	127.85	−0.00087
Th	90	232.038	309.0658	0.75077	620.0472	464.07612	155.971	−0.000806
Am	95	243	316.282	0.7683	682.53	486	196.53	−0.0007326
Es	99	252	322.0858	0.7824	740.0874	504	236.0874	−0.0006756

a) columns 4 and 5 contain coordinates of peaks of rectangular hyperbolas of elements;

b) in a column 6 are presented abscissas the secants which are starting with the peak center (0,1) up to crossings with line $Y = 0.5$; at prolongation they cross the valid axis in points peaks;

c) in a column 7 are resulted abscissa points of crossing of a direct and adjacent hyperbola each element presented here;

d) the column 8 contains a difference between sizes of 6 and 7 columns;

e) in a column 9 tangents of a corner of an inclination of secants are resulted; at an element "rhodium" this line crosses an axis X in a point with abscissa, equal 411.622, and its position coincides with tangent in peak; $411.66 - 411.62 = 0.04$ or nearly so 0.01% from atomic mass.

Table 1: Results of calculations for some elements of the Periodic Table

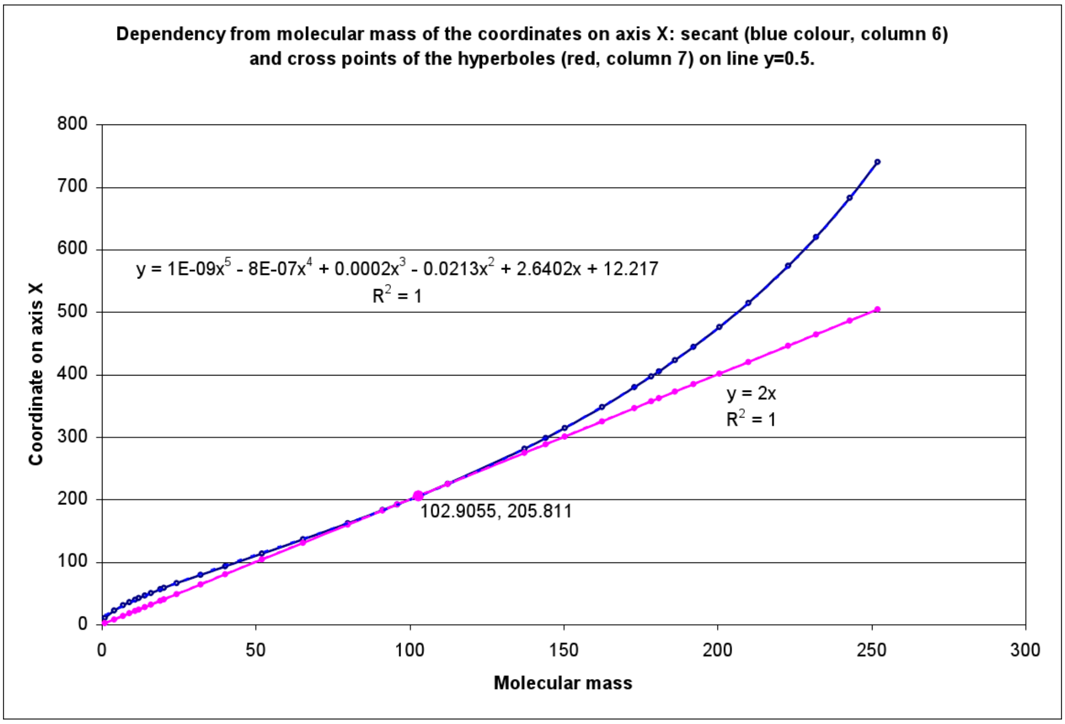
Dependency from molecular mass of the coordinates on axis X: secant (blue colour, column 6) and cross points of the hyperboles (red, column 7) on line y=0.5.
y = 1E-09x5 - 8E-07x4 + 0.0002x3 - 0.0213x2 + 2.6402x + 12.217
R2 = 1
y = 2x
R2 = 1
102.9055, 205.811
Coordinate on axis X
Molecular mass
0
100
200
300
400
500
600
700
800
0
50
100
150
200
250
300

Fig. 2

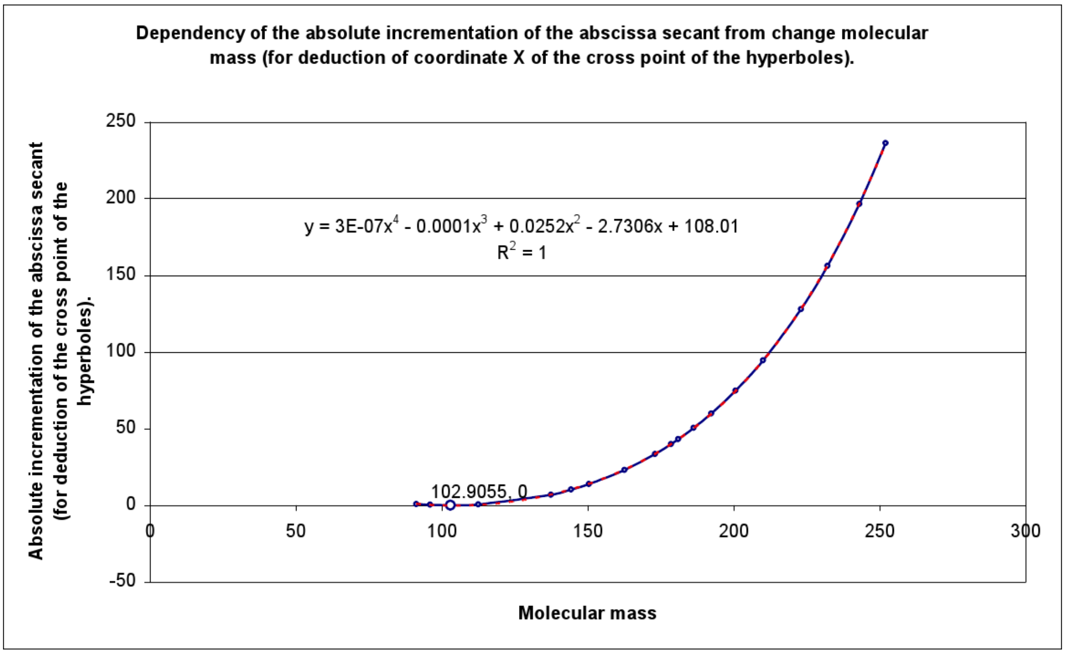
Dependency of the absolute incrementation of the abscissa secant from change molecular mass (for deduction of coordinate X of the cross point of the hyperboles).
y = 3E-07x4 - 0.0001x3 + 0.0252x2 - 2.7306x + 108.01
R2 = 1
102.9055, 0
Absolute incrementation of the abscissa secant (for deduction of the cross point of the hyperboles).
Molecular mass
-50
0
50
100
150
200
250
0
50
100
150
200
250
300

Fig. 3

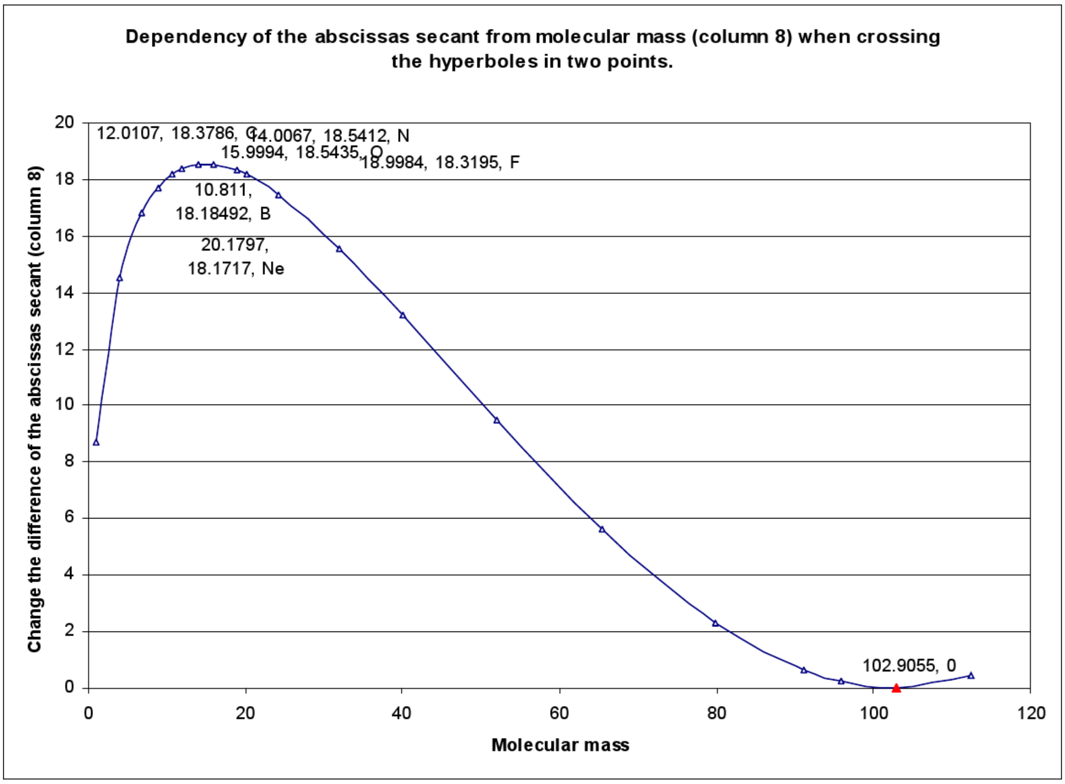
Dependency of the abscissas secant from molecular mass (column 8) when crossing the hyperboles in two points.
Change the difference of the abscissas secant (column 8)
Molecular mass
12.0107, 18.3786, C
14.0067, 18.5412, N
15.9994, 18.5435, O
18.9984, 18.3195, F
10.811, 18.18492, B
20.1797, 18.1717, Ne
102.9055, 0

Fig. 4

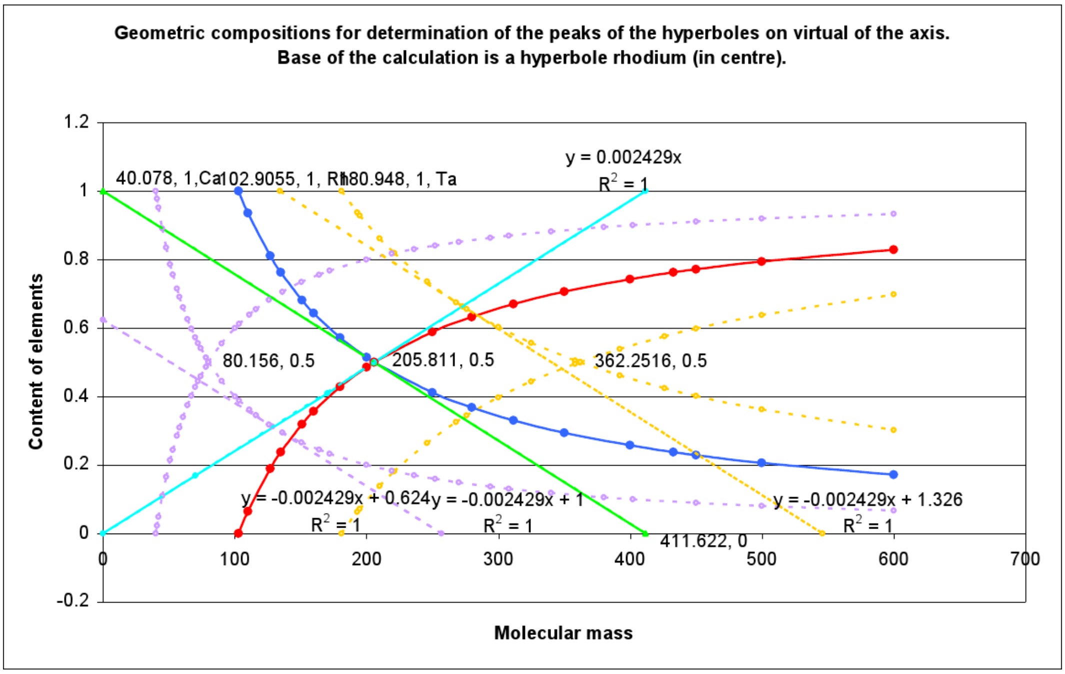
Geometric compositions for determination of the peaks of the hyperboles on virtual of the axis. Base of the calculation is a hyperbole rhodium (in centre).
Content of elements
Molecular mass
40.078, 1,Ca
102.9055, 1, Rh
180.948, 1, Ta
y = 0.002429x
R2 = 1
80.156, 0.5
205.811, 0.5
362.2516, 0.5
y = -0.002429x + 0.624
R2 = 1
y = -0.002429x + 1
R2 = 1
y = -0.002429x + 1.326
R2 = 1
411.622, 0

Fig. 5

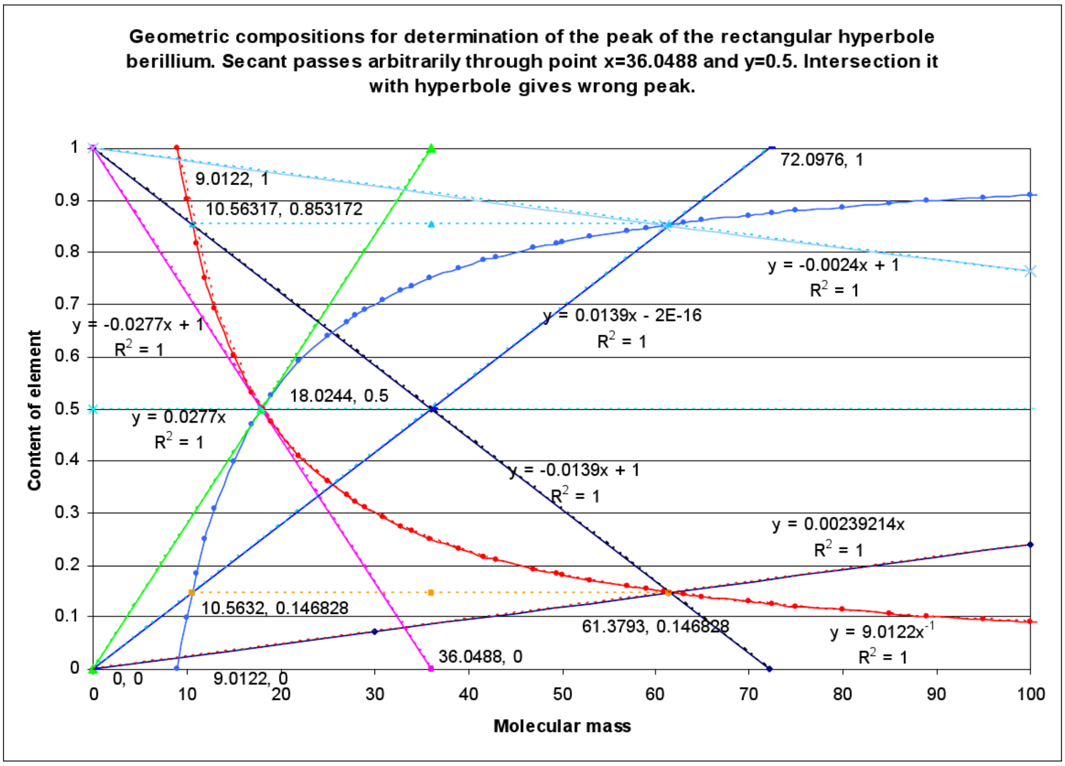
Geometric compositions for determination of the peak of the rectangular hyperbole berillium. Secant passes arbitrarily through point x=36.0488 and y=0.5. Intersection it with hyperbole gives wrong peak.
Content of element
Molecular mass
9.0122, 1
10.56317, 0.853172
72.0976, 1
y = -0.0024x + 1
R2 = 1
y = -0.0277x + 1
R2 = 1
y = 0.0139x - 2E-16
R2 = 1
18.0244, 0.5
y = 0.0277x
R2 = 1
y = -0.0139x + 1
R2 = 1
y = 0.00239214x
R2 = 1
10.5632, 0.146828
61.3793, 0.146828
y = 9.0122x-1
R2 = 1
36.0488, 0
0, 0
9.0122, 0

Fig. 6

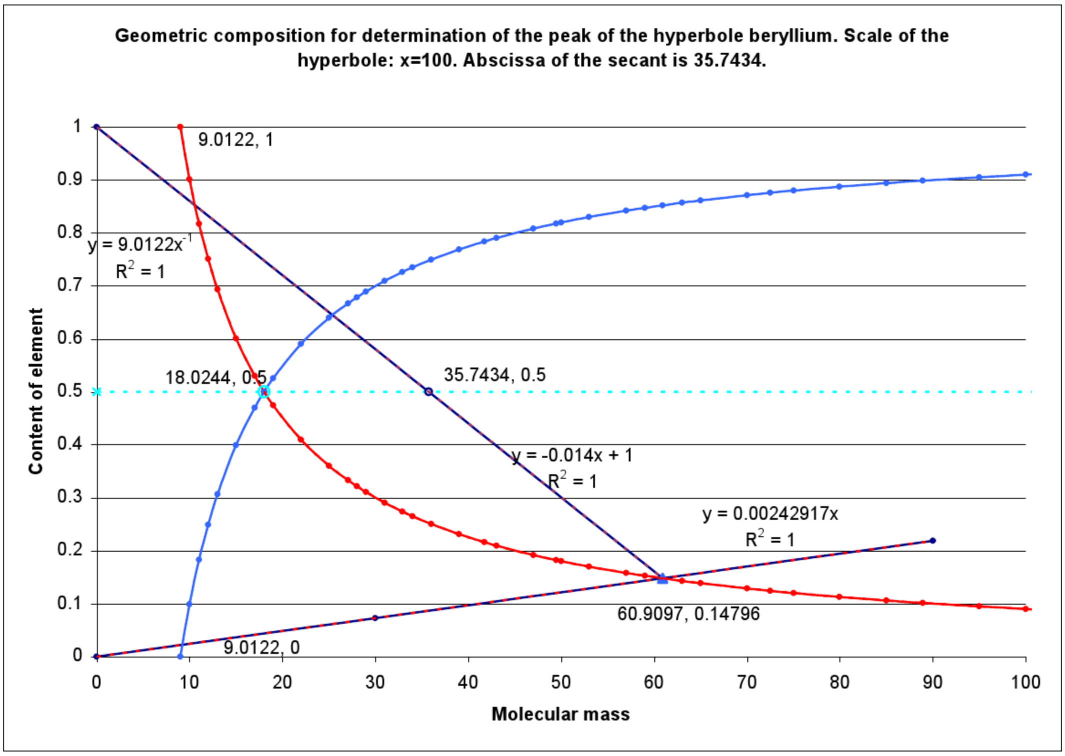
Geometric composition for determination of the peak of the hyperbole beryllium. Scale of the hyperbole: x=100. Abscissa of the secant is 35.7434.
Content of element
Molecular mass
9.0122, 1
y = 9.0122x-1
R2 = 1
18.0244, 0.5
35.7434, 0.5
y = -0.014x + 1
R2 = 1
y = 0.00242917x
R2 = 1
60.9097, 0.14796
9.0122, 0

Fig. 7