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IN THE MEMORY OF ROLAND EÖTVÖS

On the 27th of July we celebrated the centennary of the birth of Roland EÖTVÖS, the eminent Hungarian Physicist and Geophysicist. The greatest merit of Roland EÖTVÖS is the development of new methods for geophysical researches. His torsion balance is known all over the world.

It is a great honour for Hungary, that the Eighth General Assembly of the International Union of Geodesy and Geophysics gives an occasion to pay a grateful homage to the Memory of Roland EÖTVÖS.

His father, Joseph EÖTVÖS, a celebrated literary man, was Minister of Public Education in 1848, in the epoch of the fight for freedom in Hungary. The son, Roland EÖTVÖS, already in his early youth was inclined to natural sciences and visited several German Universities. After completing his studies he returned home and at the age of twenty-four he obtained a professor's chair at the University of Budapest.

At the beginning of his scientific career he was engaged in the study of capillarity and worked out a new method for determining the superficial tension of liquids. Moreover he established an important law named after him, which is similar to the general law of gases. According to the EÖTVÖS law the molecular superficial energy of a liquid is proprotional to the difference between the critical and the actual temperature of a liquid.

The attention of Roland EÖTVÖS soon turned towards the study of gravity and terrestrial magnetism. The leading idea of EÖTVÖS in his investigations was the determination of the very small variations of gravity and terrestrial magnetism. The old method of determining gravity by a pendulum does not give the desired accuracy for exploring the gravitational field in all details. EÖTVÖS constructed a new instrument, the torsion balance, which is fit to measure just the minute variations of the gravity field. The torsion balance as a physical instrument was already used before EÖTVÖS; even CAVENDISH at the end of the 18 th century used it for the determination of the mean density of the Earth. But the aim of EÖTVÖS was quite different and new. The sensitiveness of his torsion balance essentially surpassed all other similar instruments.

The normal variation of gravity in South-North direction in the horizontal plane pro cm, i.e. the gradient amounts to 8.10^{-9} C.G.S. in average. EÖTVÖS increased the sensitiveness of his torsion balance in such a high degree, that he was able to determine the minute variation of 1.10^{-9} C.G.S. Honouring the memory of EÖTVÖS, the international scientific world called this very small variation the *Eötvös-unit.* EÖTVÖS carried out long experimements in the laboratory to prepare suitable torsion wires with the desired sensitiveness, solidity and constancy.

As it is well known, the EÖTVÖS torsion balance yields the derivatives of gravity, except the variation in the vertical direction. The knowledge of the gravity field in details is of great importance from different points of view. It is first Geodesy, that makes use of the detailed knowledge of the gravity-field. The curvature quantities of the level-surface can be easily computed from the derivatives of gravity. The difference between the greatest and smallest curvature, i. e. the horizontal directing force, is proportional to the difference between certain two derivatives of the gravity components, and moreover the direction of the principal curvatures is given too.

EÖTVÖS worked out a method in order to determine the deviations of the plumb. He showed, that if the North-component of the plumb-deviation is known by astronomical measurements on two points of an area, the plumb-deviations can be calculated from the derivatives of the gravity-components for all points of the area surveyed with torsion balance. In this way a detailed net of the plumb-deviations is available.

Another important point of view in the application of the torsion balance survey is the prospection of the earth-crust. The actual gravity-field given by the torsion balance measurements is influenced by the unevenness of the surface, by the normal effect of the Earth and by subterranean effects. Subtracting the terrain-effect, the cartographic effect and the normal-effect from the observed data, the subterranean anomalies are obtained. From the subterranean anomalies there can be drawn conclusions as to the subterranean structure. The solution of this problem is in many cases rather difficult and has not always one meaning. EÖTVÖS, for the first study of the torsion balance method, chose such areas, on which the interpretation could be done rather easily. In this way approving the reliability of the method, he was able to apply the proceeding under more complicate conditions.

Three decades have elapsed since the death of EÖTVÖS, but the importance of his scientific work has not diminished at all. After the death of EÖTVÖS the torsion balance prospecting method was developed furthermore and used for practical purposes with good results. For instance many anticlines and domes were detected by torsion

balance surveys, and, although other geophysical prospecting methods were elaborated and used with good success, the torsion balance can hardly be substituted in the detailed gravimetric work. The different gravity-meters constructed in the last epoch are very sensitive and reliable instruments, very suitable especially for practical research work, but there always remains a considerable possibility for the application of the torsion balance in the practical field work. The importance of the torsion balance as a scientific instrument is unquestionable at present and will be that in the future too. The torsion balance is and will be indispensable for all the detailed geodetic work.

Very early in his scientific investigations EÖTVÖS became aware, that his torsion balance properly adjusted and applied will be able to answer the question, what is hidden under the earth-surface ? It was just his intention to elaborate a method, which can answer this question. EÖTVÖS was anxious to know in the first place, what the structure of the strata under the Great-Plane of Hungary is like at a place, where hardly any geological evidence is to be found. But he never urged the application of the torsion balance method to detect mineral deposits, being conscious, that first the scientific basis must be well established and the application for practical purposes is coming only afterwards. It came very soon indeed, even during the life of EÖTVÖS : the torsion balance method was successfully applied for gas and oil researches in Transylvania and near Gbely in Slovakia.

Besides the torsion balance, as field apparatus, the long laboratory work of EÖTVÖS resulted in some other very interesting scientific instruments. EÖTVÖS constructed an instrument, similar to the torsion balance, being very sensitive. This instrument, called *gravitational compensator,* was able to register the variation of the water-surface of the Danube at a distance of about 100 metres with an accuracy of one cm.

Another very sensitive instrument, called *gravitational multiplicator* is based on the multiplying principle by changing the attractive mass in the oscillating period of the torsion balance.

EÖTVÖS was not only an ingenious constructor of instruments, but he was always occupied with very important theoretical scientific problems as well. By his torsion balance he determined the universal constant of attraction with a very high accuracy. Through very long experiments he investigated the question of proportionality of the attractive and the inert mass. He did not find any difference in the attraction of masses of different kinds. This result of EÖTVÖS's was the basis for the theory of general relativity of EINSTEIN.

Another important question, the variation of gravity of moving masses, called the attention of the eminent scientist too. EÖTVÖS constructed a special rotating balance, by which he could demonstrate this effect, called after his name. Moreover he derived a formula for computing the Eötvös-effect.

EÖTVÖS ruled the large territory of the attractive force by his ingenious ability of analysing. His sole expedient was the law of Newton, and on the basis of this fundamental law he built a large edifice with many rooms representing the manifold manifestations of the gravity force.

The investigations of EÖTVÖS referring the gravitational field were connected with researches of the terrestrial magnetic force. He was convinced, that there must be some relation between gravity and terrestrial magnetism. Therefore he insisted, that on each torsion balance observation station the components of the terrestrial magnetic force should be determined too. In order to reach the proper accuracy in these measurements he introduced important improvements on the usual magnetic instruments. Moreover he established a quite new method for determining the local variations of the magnetic declination. He elaborated the results of the magnetic surveys on basis of original new principles. EÖTVÖS calculated the potential of the terrestrial magnetic force, and the equipotential lines showed a very striking summary of the variations of the terrestrial magnetism. EÖTVÖS looked for the connection of gravity and terrestrial magnetism too. He produced a formula containing both gravity and terrestrial magnetic force. Regarding the interpretation of the results of field measurements as to the subsurface structures, EÖTVÖS was convinced, that the data got by two different geophysical methods must give more reliable results, than data of one method alone. This principle was largely used later on in the applied geophysics by introducing further methods, like seismic and electric proceedings.

After the death of EÖTVÖS in 1919, the Hungarian Roland Eötvös Geophysical Institute was established with the destination to continue the work of EÖTVÖS both in the pure and in the applied geophysics. In the past three decades this Institute completed a lot of surveys both in Hungary and abroad as well. Moreover the Institute did not fail to introduce new methods for geophysical researches and pure scientific work was done too.

Now I beg you to allow me telling a few words about the character of Roland EÖTVÖS. I had the luck to know him personally. I was a disciple of his and later on observer of his surveys. I remember well, that EÖTVÖS was the prototype of a modest scientist, who

never became conceited, even at his greatest successes, but he felt a great delight in each successful result. He was always busy in the laboratory and at the computing work. Laboratory observations were often done during the night and EÖTVÖS himself took part in them. But he was not an unsociable book-worm. He was always very kind to anybody and helped when he could. He was very fond of Nature, being a great tourist himself. EÖTVÖS was the first, who succeeded in climbing several peaks in the Dolomites. Roland EÖTVÖS embodied real humanity honesty and assiduity.

I have to thank cordially to the General Assembly for the kindness of giving me an occasion with a few words to characterize the significance of EÖTVÖS's activity. It was a great honour to me to do it in the Memory of my great Master. I have to remind the Honourable General Assembly of the General Congress of the « Internationale Erdmessung » held in Budapest in 1906, on which EÖTVÖS explained his gravitational method, and the members of the Congress were astonished by his ingenious invention. Nearly half a century has elapsed since that Congress, and I think, the importance of EÖTVÖS's scientific work is still increasing.