ROLAND EÖTVÖS (1848–1919): THE SCIENTIST AND THE MAN[1]

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Abstract. The 100th anniversary of the death of Roland Eötvös (in Hungarian: Eötvös Loránd, 1848–1919), "physicist, geophysicist and innovator of higher education", is commemorated in association with UNESCO. After his invited Eötvös 100 lecture held at the Novi Sad Branch of the Serbian Academy of Sciences and Arts on October 30, 2019, the author was asked to summarize the multidimensional activity of Roland Eötvös. In this paper, in addition to his scientific, public and personal introduction, a summary is given about the detailed geophysical mapping made by Roland Eötvös in the direct surroundings of Novi Sad.

Roland Eötvös, the Scientist

The time of Roland von Eötvös (in Hungarian: Báró Eötvös Loránd, 1848–1919,) was a golden age for earth sciences in Central Europe, with a number of leading-edge results. Eötvös was contemporary – among others – of the following earth scientists from the region: the Austrian Eduard Suess (1831–1914), the Croatian Andrija Mohorovičić (1857–1936), and the Serbian Milutin Milanković (1879–1958).

Another Serbian mathematician and physicist played a direct role in forming the collegial relationship between Roland Eötvös and Albert Einstein. She was Mileva Marić (in Hungarian: Márity Miléva, Titel, 1875 – Zürich, 1948, mother's name: Rizuts Mária), the first wife of Einstein. She learned Hungarian in elementary school, so in Zürich she, as Einstein's companion, was able to read scientific publications from Hungary, including the works by Eötvös. When Eötvös died, Einstein called him a Prince of Physics.

The research significance of Eötvös is illustrated not only by his famous experiment, demonstrating the proportionality between the gravitational and inertial masses with a high precision, which is a necessary assumption of the Weak Equivalence Principle by Einstein. There are at least two more very important Eötvös' results: (1) the Eötvös law in capillarity ranks with the universal gas laws, and (2) the largest oil- and gas fields in the first half of the 20th century were discovered by using the Eötvös torsion balance. For this latter result, Eötvös was declared "Father of Geophysical Prospecting for Oil" (Rankine, 1948). He was nominated three times for Nobel Prize (1911, 1914, 1917), but never received it.

The number of scientific concepts and terms, which are named after Eötvös is ten. They are as follows. In capillarity: Eötvös rule, Eötvös constant, Eötvös number; in weak equivalence principle: Eötvös experiment, Eötvös parameter; instrument: Eötvös torsion balance (both laboratory and field versions); in gravitation on rotating planet: Eötvös effect and Eötvös correction; in geodesy: Eötvös tensor; in potential field geophysics: Eötvös law of magnetism. In addition, the physical unit 1 eötvös = 1 E = 10^{-9} s^{-2} is also named after him.

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Eötvös, the Man

The Baron Title was given to his great-great grandfather in 1768 by Empress Maria Theresa. His father, József Eötvös (1813–1871) was a lawyer, famous writer, Minister, and President of the Academy. Roland's literary expression, patriotism, god's love and humanism were probably largely due to his father. Roland Eötvös was, following his father, President of the Hungarian Academy of Sciences (1889–1905) and Minister of religion and public education (1894–1895). He was also Rector (1891–1892), founder of science and sport organizations, and a supporter of young talents. He was himself an athlete, among others a mountaineer. He had high-quality hobbies such as stereoscopic photography. Eötvös was not only a great scientist, he was a great man, too. Through his whole life, Roland Eötvös concentrated on selfless and deep connections, and avoided selfish and limited superficiality. In addition, when he became minister, in his response to a welcoming delegation, he declared his guiding principle: "*...in very delicate cases we take action tactfully, and preferably we do nothing that would hurt us if it happened to us*" (1894).

There are a number of nature forms named after Eötvös – Lorándite (mineral), Eötvös peak and Via Eötvös (Dolomites); Eötvös caves (Aggtelek and Crăciunești); Eötvös road (Banská Štiavnica), Eötvös crater (on the back side of the Moon); asteroid 12301 Eötvös (in the Solar System). It is a demonstration that Eötvös really was, and still has been a connecting link among scientists and among nations. Therefore, he deserves to be a role model.

Geophysical Investigations of the Fruška Gora by Eötvös

On basis of review papers (Fekete, 1930, Márton, 1989, Szabó, 2016), a brief summary is provided about geophysical measurements by Eötvös in the Novi Sad (Fruška Gora) region. The Fruška Gora Mountains (in old Hungarian: Tarcal Mountains), due to its well-defined shape and mass, offered an ideal field laboratory for Eötvös's combined gravity (torsion balance) and magnetic measurements, as did Ság hill at the time of the first torsion balance measurement in field (1891), and the Lake Balaton in the winter of 1901 and 1903. Eötvös called these years as learning period, during which he had the opportunity to try and improve his observation methods.

From 1902 to 1904, Baron Eötvös's made in the Fruška Gora region more than one hundred gravity (torsion balance) measurements (in 1902: twenty, to the North, in 1903: nineteen, to the North, in 1904: seventy two, around the Fruška Gora) and a very detailed geomagnetic investigations (with more than 1300 magnetic measurements). After several years further Eötvös measurements were carried out in the broader region.

The Eötvös geomagnetic map of Fruška Gora represents, in a unique way, equipotential lines of anomalies. It provides a detailed and accurate picture about this magnetically highly disturbed area. In Figure 1, a re-drawn version (Fekete, 1930) is presented, where only each second isoline is shown, in order to be perceptible even with small size. In this region, the equipotential lines of magnetic anomalies, exhibit an east-west mountain-like range parallel to the visible part of Fruška Gora. The spine (the maximum potential with V = 4700 CGS) is situated at about five kilometres north of the visible mountain and north of the Danube. Nevertheless, smaller maxima and minima occur in more places. The greatest change in the horizontal magnetic field between the two extreme values is 1/15th of the whole. In north-south sections of the parallel ranges there is a striking resemblance between the corresponding magnetic anomalies. To explain these anomalies, Baron Eötvös first thought of iron ore. In lack of gravity anomalies, he interpreted the geomagnetic anomalies as serpentine at depth, having a susceptibility of 0.005, which caused much greater but quite local disturbances when it reached the top of the Fruška Gora. Farther north of Fruška Gora, under Subotica, these anomalies completely disappear.

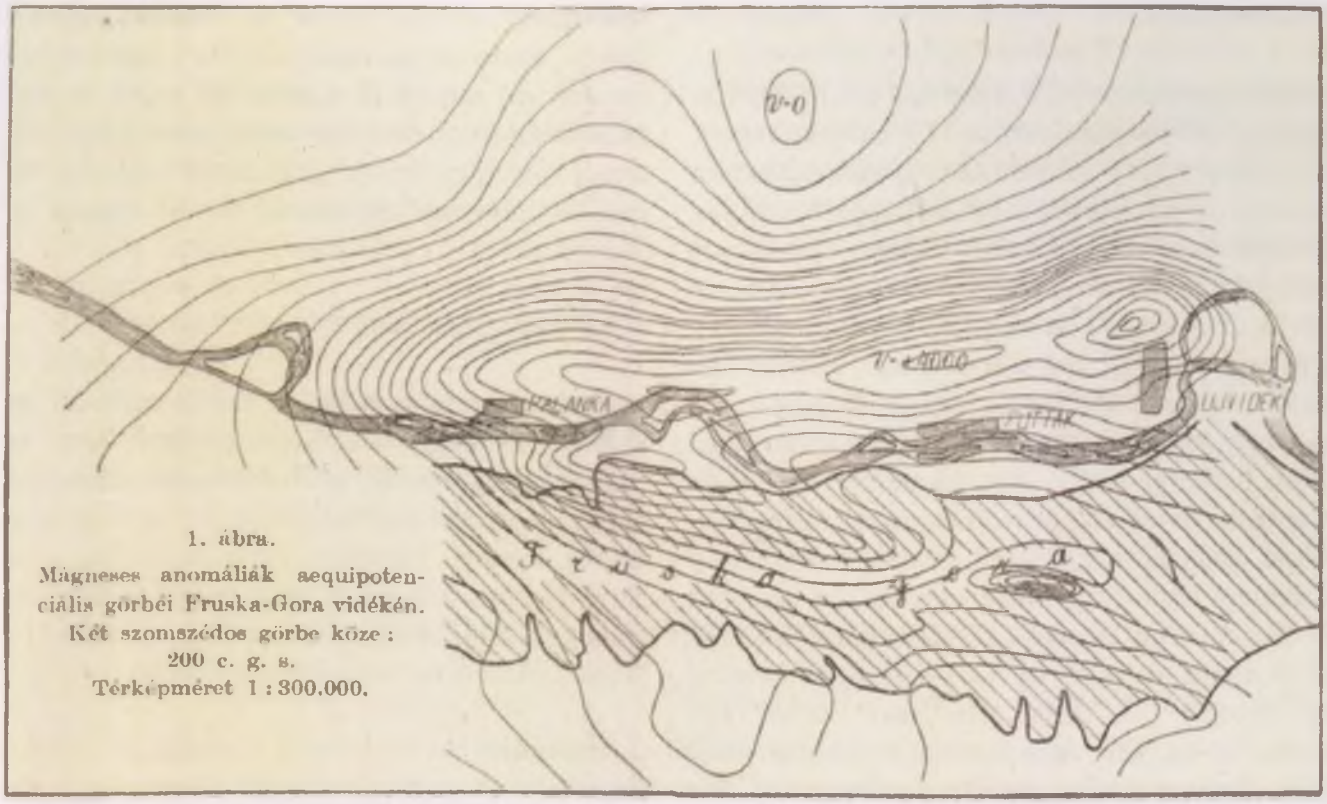

Figure 1: Equipotential isolines of geomagnetic anomalies at Fruška Gora. Interval between two neighbouring isolines is 200 CGS unit. The original scale was 1:300000. (Figure: Fekete, 1930)

Figure 2 shows a photo of Roland Eötvös, sitting on a chair in front of the measuring tent. In the background the Fruška Gora is seen. This photo (and its stereographic twin) belongs to the Eötvös Loránd Memorial Exhibition of the Mining and Geological Survey of Hungary, where more than 2000 stereoscopic photos are collected. This Fruška Gora photo has been recently published by Magyar Posta in 2019, together with a commemorative stamp. At the https://eotvos100.hu/en/page/tomorlatvany_kepek website 150 normal and stereographic photos can be seen (in different 3D: anaglyph, SBS and TB) formats (Regály, 2019), and a dozen of them were made by Eötvös himself, from Titel to Futog. The greatest Eötvös 100 attraction so far, is related to this high-quality hobby of Eötvös. At an exhibition in Toblach (South Tyrol), where Eötvös spent 42 summers mountaineering, 3D anaglyph versions of original photos, taken by Roland Eötvös in the Dolomites were presented.

Figure 2. Roland Eötvös sitting in front of the tent at the Fruška Gora measuring area (probably in 1902)

Conclusions

The significance of Roland Eötvös in 2019 is evident both for physicists and for earth scientists. At an Eötvös 100 international conference (Modern theories of gravitation) it has been confirmed that in theoretical (gravitational) physics the Eötvös experiments are more and more important again (https://eotvos100.hu/en/page/mta_kozgyules). The messages of the international Eötvös 100 earth science conferences, both in Budapest and in Gbely, Slovakia (https://eotvos100.hu/en/page/cross_border_events) are common: for earth scientists, living and/or working in the Carpathian Basin and around, Roland Eötvös represents a cohesion force. The same atmosphere was felt in the building Branch of the Serbian Academy of Sciences and Arts in Novi Sad in the evening of October 30, 2019. The two Eötvös 100 books in English, launched in November 2019 (*The Roland Eötvös Memorial Album* and *The Eötvös experiment in its historical framework*) in association of the World Science Forum in Budapest, will further demonstrate that Roland Eötvös deserves to be a role model.

Finally, Sándor Mikola told in his commemorative talk in 1929 on the 10th anniversary of the death of Eötvös: "*Baron Eötvös' truths on gravitational force and surface tension will remain in a thousand years as true and valuable as they are today, even when our actual concepts for the gravitation and for the smallest parts of the matter would happen to disappear.*"

Acknowledgements

The author is grateful to the Branch of the Serbian Academy of Sciences and Arts in Novi Sad, especially to Academician Slobodan Marković for the kind invitation, in the hope, that among Central European earth scientists, with Novi Sad and Sopron in focal points, a new co-operation could start on the path, symbolised by Milutin Milanković and Roland Eötvös.

Appendix

At the centenary of his research work in Budapest, in 2017, a Milutin Milanković commemorative plaque (Figure A1) was inaugurated at the Library of the Hungarian Academy of Sciences. It was a direct antecedent of the Eötvös 100 lecture two years later in Novi Sad.

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ЛОРАНД ЕТВЕШ (1848–1919): НАУЧНИК И ЧОВЕК

Апстракт. Стота годишњица смрти Лоранда Етвеша (на мађарском: Eötvös Loránd, 1848–1919), „физичара, геофизичара и иноватора високог образовања“, обележена је у сарадњи са Унеском. Након позива да одржи предавање на тему Eötvös 100 у новосадском Огранку Српске академије наука и уметности 30. октобра 2019, од аутора је затражено да резимира мултидимензионалну активност Лоранда Етвеша. У овом раду, поред приказа његове личности, јавног ангажовања и научног рада, дат је сажетак о детаљном геофизичком мапирању које је Лоранд Етвеш направио у непосредном окружењу Новог Сада.

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