

### Thoughts on Alexandru Froda

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Professor Alexandru Froda was among those Rumanian mathematicians who lived –almost exclusively– in a purer Universe: at his desk or in the lecture hall.

This is why his personality was so difficult to grasp for most people, while it was a source of fascination for his students who admired and loved him.

The great human and intellectual qualities which came so happily together in the character of Professor Froda reflect a deep spiritual background. As the philosopher C. Rădulescu-Motru puts it: *it is a Rumanian spirituality which is older than Christianity and vegetated for hundreds of years without any need for its memory to be carved in stone.*

His intimate espousal of the Rumanian spirituality was not merely on a philosophical plane. One can see him, a young man of 22 –he was then a student at the “École de Ponts et Chaussées” – one can see him called up to arms, on August 15, 1916, one day before the beginning of the “ war for the Existence and Unity of the Nation”. Alexandru Froda took part in this war from the very start to the very end, in the Air Force. His self-denial and loyalty were of a rare kind.

*Very intelligent, of good appearance, of exquisite education, extremely cultured, he has excellent mathematical knowledge, notes his chief, the squadron commander, and then continues: it is an individual who respects order, with a high sense of duty, spirited by very beautiful patriotic feelings.*

At his turn, the commander in chief of the Air Force notes (1917): *Cultivated, intelligent, of uncommon work stamina, and a devotement which I have seldom encountered, this boy has rendered immense and well appreciated service to the Air Force. And further: By all these qualities, coupled with ‘classical’ modesty, I would say, this individual gained our respect, love and admiration. And, somewhere else: He takes passionate interest in all mathematical and technical questions.*

Similar remarks can be found in the written recommendation for the decoration “The Military Virtue”, the highest military distinction of that time.

Back from war, Froda finished his studies at the “École de Ponts et Chaussées” and, after working as engineer and professor at the Aeronautics School, he registered at the University of Bucharest, in Mathematics, where he graduated in 1927.

Professor Pompeiu has left a written document which testifies that the doctoral thesis of Alexandru Froda was produced in Rumania, and only defended in Paris, in 1929, in front of a prestigious committee, presided by Émile Borel; Paul Montel and Arnaud Denjoy were examiners.

\* English adaptation of an address given at the 1984 commemoration. For political reasons it couldn't be published at that time.

The Froda thesis drew a lot of attention. Up to this day one is surprised by its originality and the significance of its results. At that time it became famous because it invalidated the then wide-spread opinion that there are no universal, non-tautological, properties of real functions of one or more real variables. The Froda thesis contradicts this opinion and furnishes many significant properties which hold for all real functions defined on euclidean spaces. The most celebrated assertion is the following:

*The set of discontinuity points of the first kind of an arbitrary real function of a real variable is at most countable.*

This famous Froda theorem of 1929 has become a classic, and one can find it in various monographs, for example in the "Analysis" of Miron Nicolescu or in Gustave Choquet's "Topologie".

It is obvious that the property mentioned in the Froda thesis is invariant under the homeomorphisms of the real line and thus it belongs to **The topology of real functions**, which reminds one of another famous topic, **The topology of analytic functions**, masterly treated by professor Simion Stoilow the year before (1928).

If one meditates more deeply upon these two themes, which do not seem to be related, one has a glimpse of the sort of mathematics which attracted both Froda and Stoilow: it is a mathematics rich in ontological content, which anticipates the work of René Thom in its philosophical outlook.

Alexandru Froda did not have the joy, that other colleagues of his own generation had: to be appointed to the University immediately after his return from Paris.

He became professor at the University of Bucharest much later, in 1947.

I was fortunate to attend, as a student, his Algebra course in 1948-1949. This course covered the fundamental concepts of modern algebra, linear algebra and the theory of polynomials, including the Abel theorem, but contained also many excursions into the algebraic theory of numbers. The exercise class ('seminar') was given by Cabiria Andreian, who looked like a teenager, had barely graduated, and was much younger than most students whom she taught. And, to a great extent, it is thanks to this seminar, one of its kind, that we all, my colleagues as well as myself, could get over the initial shock provoked by the encounter with a sort of mathematics then completely new to us. Thanks to it, we were finally able to enter the universe of intellectual magic of professor Alexandru Froda.

He worked in so diverse a field as engineering, mechanics, mathematics, foundations of mathematics, philosophy of science.

For his work on the axiomatization of classical mechanics he was invited to participate at the International Symposium *The Axiomatic Method, with special reference to Geometry and Physics*, organized by the well-known mathematician and philosopher Alfred Tarski in Berkeley, California, December 26, 1957-January 4, 1958.

... *I have the honour*, writes A. Tarski, *to invite you to participate with a 45-minute address at this symposium.* (In the same letter it is made clear that both stay and transportation

expenses were to be covered by the organizers.)

Here is a list of other 45-minute invited speakers at the same symposium: Paul Bernays, Karol Borsuk, Dana Scott, Pascual Jordan, Yoshio Ueno, Karl Menger, Alfred Tarski.

Concerning this invitation a group of distinguished mathematicians and physicists at the University of Bucharest (Simion Stoilow, Gheorghe Mihoc, Emil Bădăraș, Gheorghe Vrânceanu, Grigore Moisil, Octav Onicescu, Horia Hulubei, Michel Neculce) wrote to the Ministry of Education and Culture, in the following terms: *The participation of our colleague at this Symposium is of interest to the progress of science and is a homage to the scientific contribution of our country.*

The work of A. Froda in the philosophy of mathematics and physical sciences continued to draw attention abroad. Two years later took place the *International Congress on Logic, Methodology and Philosophy of Science* (Stanford, August 26-September 2, 1960). A. Froda was again the only Rumanian mathematician to be invited with a 30-minute address (expenses covered), and his talk was scheduled in the *Symposium on the Role of Mathematics in the Formulation of Physical Theories*.

It is not hard to imagine the profound sadness of this researcher of international reputation when he was not allowed to attend these two prestigious meetings, where his scientific worth was given clear recognition, and where he would have lectured to first-rate researchers.

But he knew how to rise above these difficult moments and continued to dedicate himself to research and teaching.

It is for us to bear in mind the lesson of Professor Froda: the gift of original thought, the effort to give philosophical dimension to mathematical meditations, his attachment to Rumanian spirituality and the fundamental values of humanism, foremost importance given to spiritual dignity.

These lines, written by George Popa, when referring to the poet and mathematician Omar Khayam, may be the ones that render Alexandru Froda best: *The dignity of superior beings resembles the dignity of the cedar-tree which grows taller than the common size, in order to embrace sky and light; it also resembles the water-lilies which speak with the voice of the illuminated silence.*

