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# THE DEBATES ON THE PHILOSOPHY OF SCIENCE IN SERBIA AT THE BEGINNING OF THE XX CENTURY

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**Abstract.** We consider the first activities related to philosophy of science in Serbia in the first decades of XX century. Roles of major figures, like Mihailo Petrović, Milutin Milanković, Svetomir Ristić, and especially Branislav Petronijević, are briefly highlighted.

After the liberation from the Turkish yoke and the achievement of full liberation of Serbia, conditions for rapid development of the country were created. Already in the last decades of the XIX century numerous talented students ("blagodejanci") have been sent to most important centers of contemporary European culture: Leipzig, Berlin, Heidelberg, Paris, and to Russia. After their return, as a fully formed scientists and technical experts, they have often taken distinguished positions at the university, in schools and in the state administrative bodies, giving an invaluable impetus to the further development of Serbia.

Many of them engaged in scientific research in various fields and achieved significant results. The latter were published not only in domestic, but in the leading international research journals of the time. Among those scientists, one cannot avoid to mention Mihailo Petrović, Kosta Stojanović, philosopher Branislav Petronijević who successfully worked in various scientific disciplines, Ivan Djaja[1], Svetomir Ristić[2], Djordje Stojanović, Sima Marković. These scientists and philosophers not only gave important specific results, but also attempted to reflect upon many results of the explosive development of international science, and interpret them. Some of this effort was synthesized in a philosophical manner reminiscent of the philosophy of science emerging at the same time in the European centers where they were educated.

[1] Ivan Djaja *A man and creative life*, (Paris, 1955), translation Dr. Božidar S. Marković (Belgrade,1999), with afterword *Philosophical Synthesis of Ivan Djaja* by Radomir Djordjević.

[2] Radomir Djordjević *The Beginnings of the Philosophy of Science in Serbia: Svetomir Ristić* in "Razvoj astronomije kod Srba II" (*The Development of Astronomy among Serbs II*), ed. By M.S.Dimitrijević, Belgrade, 2002, pp. 71-75.

A special mention is reserved for Milutin Milanković[3] who came from Vienna, led by patriotic motives, to contribute to the cultural development of Serbia. In the same time, there have been many scientists not of Serbia origin, who worked in Serbia in a true spirit of international scientific endeavor, like Josif Panić, a Croatian biologist, who has written numerous papers in botany. These (and other) scientists have not only contributed to their particular fields, but also have pioneered philosophy of science in Serbia in the modern sense of the term. Mathematician Mihailo Petrović has constructed a particular natural philosophy – phenomenology, in his books *The Elements of Mathematical Phenomenology* (1911) and *Phenomenological Mapping* (1933). Physicist and statesman Kosta Stojanović also developed some phenomenological ideas independently of Mihailo Petrović, and used them to interpret the epistemological basis of physics. Branislav Petronijević wrote much on the philosophical underpinnings of natural sciences, in addition to creating a novel kind of discrete geometry. Physicist and astronomer Djordje Stanojević explicated some of the basic philosophical foundations of physics in his voluminous university physics textbook, while the biologist Ivan Djaja gave important syntheses of knowledge not only in the domain of biology, but other sciences as well, especially in his book *A man and creative life*. Milutin Milanković not only gave well-known results in explanation of ice ages and the mathematical theory of Earth's climate, but also wrote much on the history of science, being the first modern historian of science in Serbia. His epochal significance also lies in interpretation of scientific results and attempts at explaining the nature of creative process and discovery in sciences – topics still open and attractive to researchers in the modern epistemology, in spite of the piles of literature on the subject during the last century.

An interesting example of this pioneering discourse in the philosophy of physics at the beginning of XX century in Serbia is the debate of Branislav Petronijević and Svetomir Ristić on the meaning of the Second Law of thermodynamics and the universal entropy gradient in 1901-1910. The debate, raging mainly in the pages of "Srpski Književni Glasnik" ("Serbian Literary Herald"), reflected nicely some of the very modern, European atmosphere of the scientific and philosophical debates of the time; some of this modernity and spirit has been, unfortunately, lost in the course of subsequent century.

The discussion on universal entropy and heat death has been very present in the contemporary physics, philosophy and astronomy. Authorities such as lord Kelvin, Eddington, Jeans, Boltzmann, Zermello have participated in the controversy surrounding the universal applicability of the second law of thermodynamics. In brief, the basic question is the following: if entropy always increases in realistic processes, tending toward the maximal value characterizing the state of thermodynamical equilibrium, how is it possible that the universe has not already–in the course of supposed infinite duration of time–reached this state? In the Petronijević's sometimes opaque formulation[4] (p. 128, translation M. M. Ć.):

"This principle constitutes in statement that at some time a state of absolute

[3]Radomir Djordjević *Philosophical Ideas of Milanković and Their Actuality* in "Razvoj astronomije kod Srba," (*The Development of Astronomy among Serbs*), ed. M.S.Dimitrijević, J.Milogradov-Turin, L..Popović, Belgrade, 1997, pp. 171-177.

[4]Petronijević, B. 1901, *On the Entropy of the Universe*, "Srpski Književni Glasnik" vol. II, No. 2, pp. 125-133.

equilibrium of forces will take place in the entire universe, and that this state will be definitely unchangeable for of the universe, and that from that universal death there will be absolutely no return to life."

Many observed phenomena testify that the universe is far from thermodynamical equilibrium, notably the so-called Olbers' paradox which has played important role in the history of cosmology.[5] The far-reaching application of the second law on the universe as a whole conflicts necessarily, as Petronijević points out, with the view of eternity of the universe. This is the symptom of "crisis of physics" as Petronijević suggests, and new principles are necessary in order to build a consistent cosmological picture. His suggestion has been severely criticised by Svetomir Ristić.[6]

The conflict between Petronijević and Ristić on the issue of heat death parallels the debates raging at that time and afterwards in the mainstream of physical sciences. An excellent example, preceeding the Petronijević-Ristić debate by only a couple of years, is the exchange between Boltzmann and Zermello which took place in 1896/97, and partially covered the same scientific ground[7]. In particular, that was the first instance in which a cosmological conclusions have been drawn from the local physics. Namely, Boltzmann has argued that either the universe is of finite age (and originated in a state of exceptionally low entropy), or–and he ascribed the original idea for the alternative to his old assisstant, Dr. Shuetz–the universe is much larger than the observable system, and we are living in a finite low-entropy fluctuation, while most of the universe has reached the state of "heat death". This is very important, since the worldview at the end of XIX and beginning of XX century has strongly favored an eternally existing universe. This attitude is epitomized in the words of one of the pioneers of modern astrophysics, Sir Arthur Eddington, who in his authoritative monograph *The Nature of the Physical World* wrote: "As a scientist, I simply do not believe that the universe began with a bang." It is interesting to note that these words of Eddington preceded by more than two decades the coining of the expression "Big Bang", so they should not be interpreted as critics of a particular model (after all, the first model which could, in a loose sense, be called a Big Bang model, was constructed by Lemaître only in 1931), but as rejection of the general concept of originating of the world in a finite moment of time. It was only decades later that the universe with a finite past came to be accepted. Even later, with the advent of the classical steady-state theory in late 1940-ies, the notion of eternal universe resurfaced, and sometimes resurfaces even today, in the framework of modern quantum cosmology.

There are several points of not only historical value pertinent to both participants in the debate. For instance, Ristić is correct in claiming that, formally speaking, nothing warrants the application of the second law to the universe as a whole. Much of the research in the XX century cosmology has been devoted to investigation and elucidation of this notion. However, it has been shown that, in principle, universe has a well-defined maximal entropy, and that it gradually tends toward this value, thus essentially vindicating Petronijević's position[8]. This conclusion depends somewhat on

[5]North, J. 1965, *The Measure of the Universe: A History of Modern Cosmology* (Oxford University Press, London); Kragh, H. 1996, *Cosmology and Controversy* (Princeton University Press, Princeton).

[6]Ristić, S. 1910, *The works of Dr. Branislav Petronijevića* in "Nastavnik" ["The Teacher"], vol. 5-6, p. 195-208; vol. 7-8, pp. 291-310.

[7]For a serious elucidation see Steckline, V. S. 1983, *Am. J. Phys.* **51**, 894.

[8]For a nice contemporary account see Frautschi, S. 1982, *Science* **217**, 593.

the nature of cosmological horizons, but we cannot enter this rather subtle question in this study. On the other hand, Ristić is entirely on firm ground when arguing that Petronijević's view of the relationship between the first and the second law of thermodynamics is–in the merciful interpretation–confused. Petronijević is clearly wrong in stating that the second law can be somehow reduced to the first one (principle of energy conservation). However, it is interesting to note that, historically, the idea that the requirement of the first law should be relaxed in order to avoid the indefinite growth of entropy and retain the eternal universe has reappeared in the famous papers of Bondi and Gold, as well as Hoyle,[9] initiating the great cosmological controversy of the XX century.

[9]Bondi, H. and Gold, T. 1948, *Mon. Not. R. astr. Soc.* **108**, 252; Hoyle, F. 1948, *Mon. Not. R. astr. Soc.* **108**, 372.