The Calendar of the Greek Orthodox Church

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Abstract

At the Orthodox Church Council in 1923 in Constantinoupolis a proposal concerning the reform of the calendar, elaborated by the Serbian astronomer Milutin Milancovic together with professor Maksim Trpkovic, was submitted, providing for a more exact calendar than the Gregorian one. Instead of three days in 4 centuries one should omit 7 days in 9 centuries or 0.0077 days per year. This means that only 2 years out of 9 ending the centuries, would be leap years. The rule is that those years whose ordinal number ends with two zeros are leap years only provided that the number of centuries they belong to, divided by 9, yields the remainder 2 or 6. For instance the year 2000, ending the 20th century, is a leap year since 20 divided by 9 equals to 2 plus the remainder 2. Milancovic's proposal implies a much smaller difference, with respect to the true tropical year, than Gregorian calendar. Further improvements concerning the approaching to the duration of the tropical year are not necessary since that duration itself undergoes changes over longer periods.

1 Introduction: Milutin Milancovic's work in Astronomy

Milutin Milancovic (Dalj, May 28, 1879 - Belgrade, December 12, 1958) went down in the History of Science as the man who proposed an astronomical theory for the explanation of the Ice Ages, which is presently referred to as the Milancovic hypothesis. He calculated the variations of the fluctuations of solar insolation caused by the variation of the orbital parameters of the motion of the Earth, and he hypothesized that these demarcate the major climatic events, like the Ice Ages.) Milancovic elucidated also the history of the Earth's climate as well as that of other planets, being in addition the author of the mathematical theory of climate and of the Earth's pole motion. He promoted the Celestial Mechanics by introducing into it the vector calculus, making besides several original contributions to the solution of the three-body problem. Since 1909 Milancovic was teaching astronomical subjects at the Belgrade University. He authored university textbooks: *Celestial Mechanics*, *History of Astronomical Science from its Beginnings up to 1727* and *Astronomical Theory of Climatic Changes and its Application to Geophysics*, the last one being dedicated to the post-graduate students and doctoral candidates. Milancovic made also important contribution to the popularization of Astronomy, his book *Through the Universe and Centuries* having gone through several editions.

2 The Gregorian calendar and the Milancovic proposal. The New Rectified Julian calendar

In Europe, from the 16th to the 20th Century the astronomically more accurate Gregorian calendar became accepted only with a great difficulty. The Roman Catholic countries applied it almost immediately, but not the Protestant and the Orthodox ones. The German and Danish Protestants accepted it in 1700, the British in September 1752, and the Swedes in 1753. The Orthodox countries accepted it, one after the other, only in early 20th Century, and only because the old calendar was isolating them calendrically from the rest of Europe. We note that Orthodoxy did not accept the Gregorian calendar, but during an all-orthodox Congress by the Oecumenical Patriarch Meletios IV, which took place in Constantinoupolis (May 1923), it suggested a new calendrical cycle of 900 years. This cycle is more accurate than the Gregorian cycle of 400 years. This was a proposal of the famous Serbian astronomer Milutin Milancovic in collaboration with professor Maksim Trpkovic. **The proposition stated that from the years ending a century, only the ones whose number of century gives remainder 2 or 6 when divided by 9 will be considered leap**. For the rest years the Julian rule continues to be valid. I.e., instead of the leap years 400, 800, 1200, 1600, 2000 etc. of the Gregorian calendar, it considered as leap the years 200, 600, 1100, 1500, 2000 etc. In this calendar, a cycle of 900 years contains 218 leap ones, the average duration of the tropical year being approximated thus with the number 365.24222222... days, that is the error amounts to approximately 2.03 seconds annually. This means that astronomically it is the most accurate from all the proposed calendars up to now! If it has not been adopted by the rest Christian Churches, the reasons are certainly non-scientific. The New Rectified Julian calendar was adopted on 10 March 1924, which was identified with 23 March 1924, because the difference from the reality had since then increased to 13 days. Milancovic made a great contribution to the organization of Astronomy in Yugoslavia. From 1936 till 1939 he was the president of the first National Committee for Astronomy through which Yugoslavia became a member of the International Astronomical Union (I.A.U.). He was a part-time Director of the Belgrade Astronomical Observatory up to January 27, 1951, when he became full-time Director, a post he held until June 26, 1951.

3 The canon of Earth insolation

Milancovic began occupying himself with the astronomical origins of the climate changes and the mathematical theory of climate after settling in Belgrade, publishing in 1912 *A Contribution to the Mathematical Theory of Climate*, in 1913 *On the Application of the Mathematical Theory of Warmth Transmission to the Problems of Cosmic Physics* and in 1916 *Investigation on the Climate of Mars.* In his *Theorie mathematique des phenomenes thermiques produits par la radiation solaire* (Mathematical Theory of the Thermal Phenomena Caused by the Solar Radiation) Milancovic develops a theory based on the principles of Celestial Mechanics and Theoretical Physics which explains the distribution of the solar radiation throughout the interplanetary space and over the planetary surfaces. He indicates also the connection between the insolation and the temperature of the planetary layers and brings out daily, annual and secular changes of the insolation. In 1926 he published the research paper *Investigation in the Thermic Constitution of the Planetary Atmospheres.* In all of these works he devoted particular attention to the climate of the planet Mars, establishing beyond doubt the mean annual temperature on this planet's surface to be about minus 17 degrees C. His researches in the Mars climate as well as his prediction of the non-existence on this planet of any highly developed life, have been verified by the modern cosmic investigations. As for the exploration of Mars, Milancovic's scientific works have been made use of in the studies and discussion on the liquid water on Mars, on its crust and atmosphere, surface temperature and climate as well as on the astronomical theory of climate changes on that planet. In his *Canon* Milancovic collected the results of his longstanding researches, demonstrating the long-period cyclical changes in the Earth climate and the occurence of Ice Ages as being a consequence of the following causes:

(a) Changes of Earth's axis inclination between 22° and 24.5° with a 41,000 year period, owing to which the insolation on any particular point on the Earth's surface undergoes changes too;

(b) Changes of the eccentricity of the Earth's orbit about the Sun, with a 100,000 year period, bringing about changes in the Earth's distance from the Sun, which in turn gives rise to changes in the duration seasons;
(c) Precession, causing the point of the winter solstice being shifted along the Sun's annual apparent path, affecting the duration of the seasons with a 22,000 year period.

In order to solve the problem of the occurence of the Ice Ages in Quaternary, Milancovic in 1932 arrived at his famous differential equation of the Earth's poles motion. He found that some 300 million years ago, the Earth's North pole was in the Pacific ocean at 20° N latitude and 168° E longitude. At present also the North pole is moving towards its equilibrium point in Siberia, near the location of Pechora river flowing into the Arctic Ocean. The most important Milancovic's work is *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszaitenproblem* (The Canon of the Earth's Insolation and its Application to the Ice Ages Problem). It is his capital scientific work, a monograph, comprising results of his researches previously published in 28 research works. In this monograph these results are assembled in one whole, together with new analyses and supplements, including numerous examples and applications of his theory. In this capital work Milancovic presents mathematical theory of Earth's climate (applicable also to other planets), explaining the origin of the Ice Ages and exposing his theory of the Earth's poles motion. The writing of the Canon Milancovic began on March 30, 1939, finishing it in the first half of February 1941. Milutin Milancovic is the most distinguished Serbian astronomer. In honour to his scientific achievements in Astronomy a crater on the far side of the Moon (coordinates $+170°, +77°$) was given his name at the 14th IAU General Assembly in Brighton in 1970. His name has been given also to a crater on Mars (coordinates +147°, +55°) at the 15th IAU General Assembly in Sidney in 1973. In 1982 a small planet, provisorily designated 1936 GA, discovered in 1930 by M. Protic and P. Djurkovic, received its permanent name: 1605 Milankovitch.

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