Astrophysicists chronicle the history of mathematical cosmology

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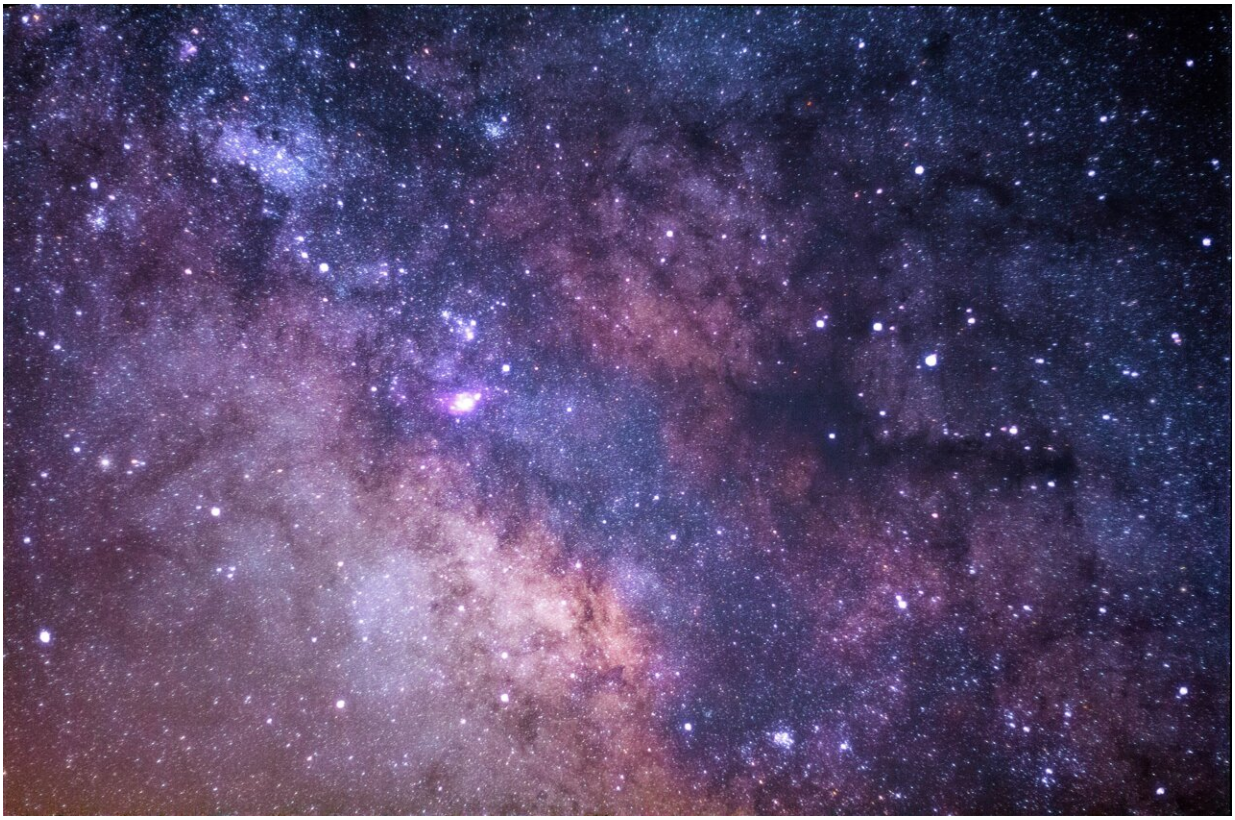

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RUDN University astrophysicists have gathered the most important discoveries of modern cosmology from 1917 to our time. The collected data became an introduction to *Philosophical Transactions of the Royal*

Society A in two parts: from 1917 to 1980 and from 1980 to our time.

Cosmology, the science of the properties and evolution of the universe, originated in ancient times as religious myths about the creation of the world. Over the past hundred years, cosmology has become one of the most dynamically developing areas of science, although one of the most complex. One of the latest issues of the *Philosophical Transactions of the Royal Society A* is dedicated to the present and future of mathematical cosmology.

RUDN professors Spiros Cotsakis and Alexander Yefremov are the editors of the issue. In the introduction, astrophysicists analyzed the entire history of the development of modern theoretical cosmology. The journal *Philosophical Transactions* is one of the oldest journals in the world, and it has been published continuously since 1665, including articles by Newton, Leibniz, Huygens, and Boyle.

"The beauty and great diversity of the ideas of modern mathematical cosmology are rooted in various kinds of geometry that need to be developed and studied in parallel and in combination with these cosmological ideas. This is necessary in order to better understand various aspects of this most majestic of the areas of theoretical physics," said Alexander Yefremov, Doctor of Science in Physics and Mathematics, Professor at the Educational and Scientific Institute of Gravity and Cosmology of RUDN University.

The authors divided the history of the development of cosmology into four stages. The first and the longest covers the time from 1917 to 1960. The next three periods last for 20 years. The year 1917, specially the date February 8, 1917, is known for the birth of modern cosmology at RUDN astrophysics, when Einstein demonstrated the first application of the general theory of relativity to the universe. He created the first modern cosmological model in which matter is motionless and has a

finite volume, but has no boundaries. The static nature of the universe according to Einstein is achieved due to the cosmological constant. Other cosmological models soon appeared.

A real breakthrough in modern cosmology was made by the Russian mathematician Alexander Fridman. In 1922 he found a solution to Einstein's equations describing a dynamically expanding universe; this theory was experimentally (and sensationally) confirmed by the British astronomer Edwin Hubble, who discovered in 1929 the so-called redshift of galaxies, which means they are running away from each other.

Later, on the basis of this information, Georgy Gamov (U.S.) formulated the theory of the hot universe (at an early stage of its existence), and a little later (1949) the process of the birth of such a model of the universe became known as the Big Bang. The term is believed to have been coined by the British astronomer Fred Hoyle.

In the late 1970s, discoveries in particle physics led to grand unification models that had an immediate impact on cosmology. Later, the inflationary model of the universe, the theory of the multiverse and other important theoretical discoveries arose. Since 1998, the main focus of cosmologists has been dark energy, the main component of the universe.

"Theoretical mathematical cosmology is not a subject that can be easily understood. To overcome the difficulty of acquiring the necessary knowledge, you need a clear compass that shows which research problems and directions are available, important, or feasible. We have described some important key developments in the field of modern theoretical cosmology since its inception in 1917. We have identified and discussed some of the important ideas that characterize the nature of this field within the framework of theoretical physics," said Spiros Cotsakis, professor at the Educational and Scientific Institute of Gravity and Cosmology of RUDN University

More information: Spiros Cotsakis et al, 100 years of mathematical cosmology: Models, theories, and problems, Part A, *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* (2022). DOI: 10.1098/rsta.2021.0191

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