Physicist proposes a new approach in modeling the evolution of the universe

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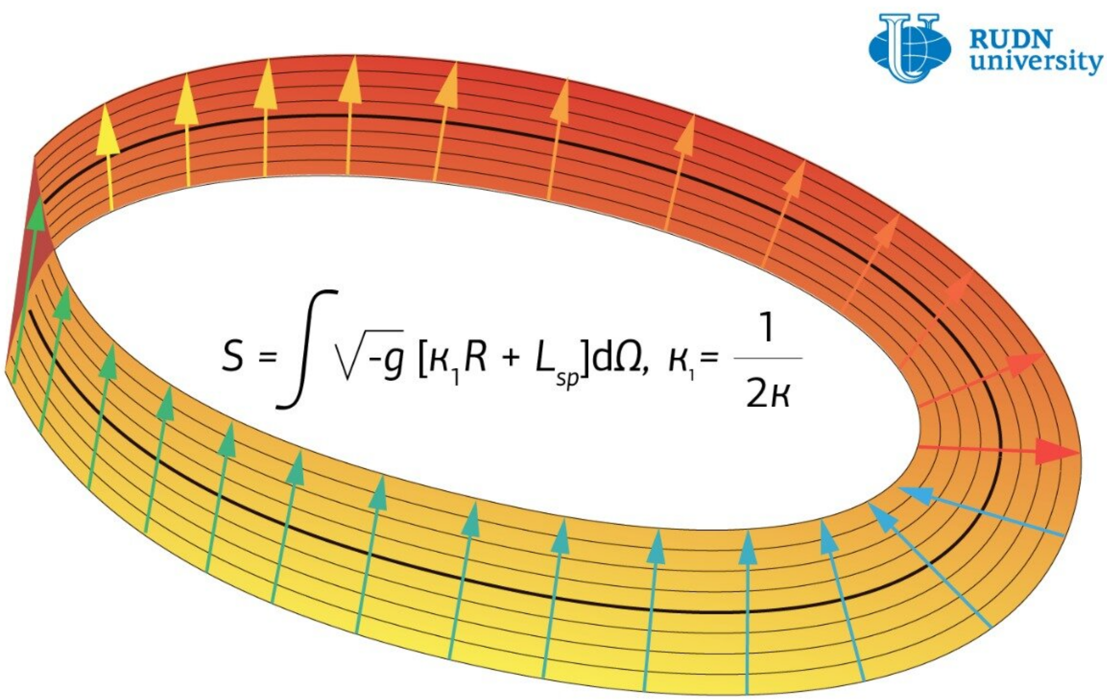

Credit: RUDN University

A physicist from RUDN University has proposed a new theoretical model for the interaction of spinor and gravitational fields. He considered the evolution of the universe within one of the variants of the widespread Bianchi cosmological model. In this case, a change in the calculated field parameters led to changes in the evolution of the universe under consideration. Upon reaching certain values, it began to shrink down to the Big Bang. The article was published in the journal *The European Physical Journal Plus*.

The spinor field is characterized by its behavior in interaction with gravitational fields. Dr. Bijan Saha of RUDN University focused on the study of a nonlinear spinor field. With its help, he explained the accelerated expansion of the universe. The study of a spinor field with a non-minimal coupling made it possible to describe not only the expansion of the universe, but also its subsequent contraction and the resulting Big Bang within the framework of the standard Bianchi cosmological model.

The basic calculations performed by Bijan Saha allow moving away from the isotropic model of the Friedman-Robertson-Walker universe (FRW) that is most often used. According to this traditional model, the properties of the universe are independent of the direction in which they are considered. The physicist has put forward an alternative: an anisotropic model in which such dependence exists. On the one hand, the "classical" isotropic model describes the evolution of the modern universe with great precision. On the other hand, there are theoretical arguments and observational data that lead to the conclusion that an anisotropic phase existed in the distant past.

The work of a cosmologist is to model the evolution of the universe theoretically, and in doing so, they pick the models that are simple to solve while giving a more or less realistic picture. In that regard, isotropic FRW model is the best one. But there is no suitable data guaranteeing that the universe was isotropic prior to recombination.

Moreover, there are theoretical arguments in favor of the existence of an anisotropic phase is the remote past, a key factor for the formation of baryonic matter. Since the Bianchi type-I universe is the straightforward generalization of the FRW one, it is customary to consider this model for studying the possible anisotropies of the universe.

The solution of the simplest anisotropic model of the universe in the presence of a spinor field inevitably leads to three options. In the first case, it turns out that space-time corresponds to The Bianchi type-I general model. In the second case, space-time imposes restrictions on the spinor field and turns into locally rotationally symmetric (LRS) Bianchi type-I space-time. That is, isotropy does not apply to the entire universe; it is assumed to have an anisotropic phase. In the third case, the calculations lead to the general case of the isotropic and homogeneous Friedmann-Robertson-Walker (FRW) space-time. But the author does not analyze the evolution of an isotropic and homogeneous universe in the FRW model. He plans to solve this problem in his future publications.

In his article, Saha considers in detail only the first two options for basic calculations. The first one does not give an acceptable answer. The resulting universe turns into a vacuum, and accelerated mode of expansion of evolution is absent. However, in the second case, in which the nonlinearity of a spinor field is considered as a power function, it is possible to simulate the process of evolution of the universe.

In this case, when certain values of a nonlinear spinor field with a non-minimal coupling are reached, the universe begins to shrink down to the Big Crunch.

"While a non-minimally coupled linear spinor field or a minimally coupled nonlinear spinor field in some cases give rise to an open universe, a non-minimally coupled nonlinear spinor field with the same parameters creates a model that is closed, that is, after reaching a certain maximum value, it begins to decrease, and finally, it shrinks down to the

Big Crunch," concludes Saha.

More information: Bijan Saha. Non-minimally coupled nonlinear spinor field in Bianchi type-I cosmology, *The European Physical Journal Plus* (2019). DOI: 10.1140/epjp/i2019-12859-7

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