Mathematicians confirm the possibility of data transfer via gravitational waves

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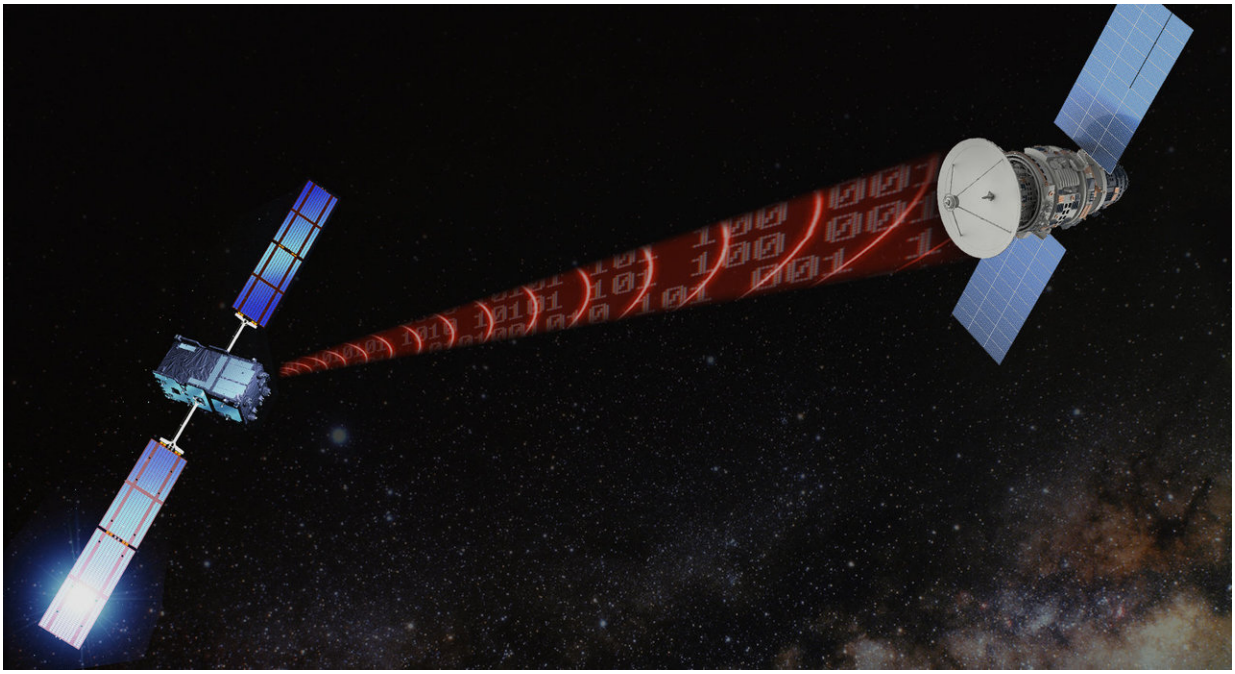

It turned out that there is the possibility of transmitting information with the help of nonmetricity waves and transferring it spatially without distortions. Credit: Allen Dressen

RUDN mathematicians analyzed the properties of gravitational waves in a generalized affine-metrical space (an algebraic construction operating on the notions of a vector and a point) similarly to the properties of electromagnetic waves in Minkowski space-time. They report the

possibility of transmitting information with the help of nonmetricity waves and transferring it spatially without distortions. The discovery could lead to a new means of data transfer in space, e.g., between space stations. Their results are published in *Classical and Quantum Gravity*.

Gravitational waves are waves of curvature in space-time, which, according to General Relativity, are completely determined by space-time itself. Currently, there are reasons to consider space-time as a more complex structure with additional geometrical characteristics such as torsion and nonmetricity. In this case, geometrically speaking, space-time turns from a Riemannian space envisaged by the General Relativity (GR) into a generalized affine—metrical space. Respective gravitational field equations that generalize Einstein's equations show that torsion and nonmetricity can also spread in the form of waves—in particular, plane waves at a great distance from wave sources.

In order to describe gravitational waves, RUDN researchers used mathematical abstraction—an affine space, i.e., a usual vector space but without an origin of coordinates. They proved that in such a mathematical representation of gravitational waves, there are functions that remain invariable in the process of wave distribution. It is possible to set an arbitrary function to encode any information in approximately same way that electromagnetic waves transfer a radio signal.

If scientists can develop a method to incorporate these constructions in a wave source, they could reach any point in space without change. Thus, gravitational waves could be used for data transfer. The study consisted of three stages. First, RUDN mathematicians calculated the Lie derivative—a function that binds the properties of bodies in two different spaces: an affine space and a Minkowski space. It allowed them to pass from the description of waves in real space to their mathematical interpretation.

At the second stage, the researchers determined five arbitrary functions of time, i.e., the constructions that do not change in process of distribution of a wave. With their help, the characteristics of a wave can be set in a source, thus encoding any information. In another point in space, this information can be decoded, providing the possibility of information transfer. In the third stage, the researchers proved the theorem of the structure of plane nonmetricity in gravitational waves. It turned out that from four dimensions of a wave (three spatial ones and one time dimension), three can be used to encode an informational signal using only one function, and in the fourth dimension with use of two functions.

"We found that nonmetricity waves are able to transmit data similarly to the recently discovered curvature waves, because their description contains arbitrary functions of delayed time that can be encoded in the source of such waves (in a perfect analogy to electromagnetic waves)," says Nina V. Markova, a co-author of the work, candidate of physical and mathematical sciences, assistant professor of C.M. Nikolsky Mathematical Institute, and a staff member of RUDN.

More information: O V Babourova et al, Structure of plane gravitational waves of nonmetricity in affine-metric space, *Classical and Quantum Gravity* (2018). DOI: 10.1088/1361-6382/aace79

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