Scientific session of the Division of General Physics and Astronomy, USSR Academy of Sciences (28–29 April 1976)

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A session of the Division of General Physics and Astronomy was held on April 28 and 29, 1976 at the Conference Hall of the P. N. Lebedev Physics Institute. The following papers were delievered:

1. *V. B. Braginskiĭ*, Status of the Prospects for Relativistic Gravity Experiments.

2. *I. D. Novikov*, Black Holes.

3. *R. A. Syunyaev*, Proofs of the Existence of Relativistic Stellar Objects.

4. *N. S. Kardashov and Yu. N. Pariĭskiĭ*, Progress and Prospects in Radiocosmology.

We publish below the brief content of one of the papers.

I. D. Novikov. *Black Holes.* The paper discusses the contemporary state of black-hole theory. This problem is of especially high priority in connection with the probable discovery of these objects in the Universe.

A black hole should appear in the final stage of the evolution of a massive star if, after gravitational collapse, the mass of the star exceeds the maximum mass M_{max} of a cold neutron star. According to recent data, $M_{max} = (2-2.5)M_\odot$ and does not exceed $3.5M_\odot$ even under extreme assumptions as to the equation of state of matter at nuclear densities. The formation of black holes with small masses at very early stages in the expansion of the Universe is a possibility. The most important questions of black-hole theory include the following:

1) Does a "horizon" that separates the black hole from the surrounding space always form on collapse of a massive body?

2) Does a singularity of space-time always occur in a black hole?

3) If a singularity does arise, is it always hidden by the horizon?

4) What are the properties of space-time around the black hole, and what is the physics of processes in the vicinity of the black hole and inside it?

We do not have complete answers to all of these questions. The first question is answered in the affirmative in the case of small deviations from spherical symmetry, and it is highly probable that a horizon always forms when the body is compressed in all directions to a size smaller than the gravitational radius $r_g = 2GM/c^2$. It has been proven that a singularity always occurs in a black hole. It is probable that the properties of space-time near the singularity are always described by the Lifshitz-Khalatnikov-Belinskiĭ solution.

The third problem has not yet been solved.

The problems listed under (4) are of the greatest physical interest. Here it has been shown that if the external field of the black hole tends to stationarity (this is probable, but not proven), the limiting field is always described by a Kerr metric.

Finally, quantum processes in the vicinity and interior of the black hole are extremely important, especially the process of slow "evaporation" of a nonrotating black hole, which was recently discovered by Hawking.

The properties of black holes are used to calculate astrophysical effects and observational predictions for the purpose of discovering them. A reliable proof of the existence of these fundamentally new objects in the Universe would be extremely important.

The following papers present part of the material of the report: Ya. B. Zel'dovich, I. D. Novikov and A. A. Starobinskiĭ, Zh. Eksp. Teor. Fiz. 66, 1897 [Sov. Phys. JETP 39, 933 (1974)]; I. D. Novikov, *ibid.* 70 393 (1976) [sic].

Translated by R. W. Bowers