Scientific session of the Division of General Physics and Astronomy, USSR Academy of Sciences, and the Division of Physico-mathematical and Technical Sciences, Estonian Academy of Sciences (Tallin-Tartu, 20–23 April 1976)

Usp. Fiz. Nauk 120, 497–514 (November 1976)

A joint scientific session of the Division of General Physics and Astronomy of the USSR Academy of Sciences and the Division of Physico-mathematical and Technical Sciences of the Estonian Academy of Sciences was held from April 20 to April 23, 1976 at Tallin and Tartu. The following papers were delivered:

1. *Ya. B. Zel'dovich*, The Structure of Galactic Systems.

2. *J. E. Ěinasto*, The Structure of Systems of Galaxies.

3. *A. A. Sapar*, Interaction of Radiation and Matter in Stellar Atmospheres.

4. *U. H. Uus*, The Appearance of Elements Synthesized in the Interior of a Star on Its Surface.

5. *A. Ya. Kipper*, The Ambiguity of the Quasar Red Shift.

6. *V. L. Ginzburg*, Superconductivity and Superfluidity (Certain Contemporary Problems).

7. *K. K. Rebane and P. M. Saari*, Hot Luminescence and Relaxation Processes in the Luminescence Centers of Crystals.

8. *Zh. I. Alferov*, Contemporary Problems in the Physics of Semiconductor Hetero Structures.

9. *Ch. B. Lushchik and I. L. Kuusmann*, Luminescence, Autolocalization, and Decay of Excitons in Ionic Crystals.

10. *H. H. Oiglane*, Symmetry Properties of the Lagrangians of the Four-Fermion Interaction.

11. *N. N. Kristofel' and P. I. Konsin*, The Vibronic Theory of Ferroelectricity.

12. *G. G. Liĭd'ya*, Decay of Triplet-State Luminescence of the Autolocalized Exciton (X_2^{2-} Quasimolecule) of Alkali Halide Crystals in a Magnetic Field.

13. *Ė. T. Lippmaa*, High-Resolution Magnetic Resonance of Rare Nuclei in Solids.

We publish below brief contents of some of the papers.

J. E. Ěinasto. *The Structure of Galactic Systems.* Much attention has been given in recent years to the mass paradox in galaxies and systems of galaxies. The paradox is that the mass of the system calculated from the mean motion of the galaxies in it is found to be an order of magnitude larger than the total mass of the visible galaxies.

The following alternatives can be proposed to explain the mass paradox:

a) galactic systems are not physically and gravitationally bound, but are accidental and temporary clumps of independently formed galaxies;

b) galactic systems are disintegrating;

c) galactic systems are gravitationally bound clumps of independently formed galaxies;

d) galactic systems are gravitationally bound aggregates of simultaneously formed galaxies.

In the aggregate, data on the structure of galactic systems favor the last alternative.

Galactic systems are isolated from one another by space in which the galactic density is very low. Field galaxies form hypergalaxies—systems consisting of dwarf galaxies and the intergalactic matter surrounding the giant galaxies.[1]

In hypergalaxies, the galaxies are segregated by morphological types: elliptical satellites are strongly concentrated toward the main galaxy, while spiral and irregular galaxies are not as strongly concentrated.[2] In the mean, the morphological types of nonelliptical satellites are later the farther the satellite is from the main galaxy. The average luminosity of the satellites is higher the higher the luminosity of the main galaxy; the activity types of central giant galaxies and peripheral dwarf galaxies are different.[1]

There is a close correlation between the dynamic characteristics of galaxies and galactic systems. The velocity dispersion of stars in the main galaxy is approximately equal to the velocity dispersion of the satellite galaxies in the system. The velocity dispersion of the stars within the satellite galaxies is smaller the farther the satellite is from the main galaxy.[3]

The satellites of our Galaxy (dwarf galaxies and gas clouds) have both positive and negative velocities with respect to the Galactic center. This eliminates the possibility that our Hypergalaxy is a nonstationary and expanding system.[4] The age of the galaxies also

TABLE I.

Nature of hypergalaxies \ Expected properties	Concentration	Segregation	Luminosity	Dynamics	Age	Morphology	Activity	Latent mass
Accidental temporary clump of independently formed galaxies	−	−	−	−	0	−	−	−
Gravitationally bound clump of independently formed galaxies	0	−	−	−	0	−	0	+
Disintegrating system of simultaneously formed galaxies	+	−	+	−	−	+	+	−
Gravitationally bound system of simultaneously formed galaxies	+	+	+	+	+	+	+	+

speaks against nonstationarity.

A summary of the observational arguments appears in Table I, where the following symbols are used: "+" for observations confirming the particular hypothesis, "−" for observations contradicting it, and "0" when various interpretations of the observations are possible. It is seen that the only hypothesis that agrees with all data is the last of the alternatives listed above.

Therefore the traditional concept of the galaxies as isolated objects requires review. The galaxies in hypergalaxies and galactic clusters are in close physical interaction.

It follows from the above arguments that the mass paradox is explained by the presence of an invisible corona in the galactic system, i.e., of a latent mass whose nature is as yet unknown.

The motion of the satellites indicates that an invisible corona also surrounds our Galaxy. The satellites of the Galaxy form a disk that is nearly at right angles to the Galactic plane. In addition to the other objects in this disk, Australian radio astronomers[5] have recently discovered a gaseous filament—the Magellanic stream—which is approaching the Galaxy at high velocity. The mass of the Hypergalaxy can be calculated from the velocities of the gas clouds by using the virial theorem. This mass, $1.2 \cdot 10^{12} M_{\odot}$, is approximately 10 times the mass of the visible Galaxy.[4]

[1]J. Einasto, J. Jaaniste, M. Jôeveer, A. Kaasik, P. Kalamees, E. Saar, E. Tago, P. Traat, J. Vennik, and A. D. Chernin, Tartu Treated No. 48, 1974.

[2]J. Einasto, E. Saar, A. Kaasik, and A. D. Chernin, Nature 252, 111 (1974).

[3]J. Einasto, M. Jôeveer, A. Kaasik, and J. Vennik, Tartu Preprint No. 12, 1976.

[4]J. Einasto, U. Haud, M. Jôeveer, and A. Kaasik, Tartu Preprint No. 10, 1976.

[5]D. S. Mathewson, M. N. Cleary, and J. D. Murray, Astrophys. J. 190, 291 (1974).