21. Zeldovich, Y. B. *Zu. eksperim. i teor. Fiz.*, **43**, no. 5 (11), 1962; *Voprosy kosmogonii*, **9**, 240, 1963.
22. Doroshkevich, A. G., Zeldovich, Y. B. *Astr. Zu.*, **40**, 807, 1963.
23. Dmitriev, N. A., Zeldovich, Y. B. *Zu. eksperim. i teor. Fiz.*, **45**, 1150, 1963.
24. Zeldovich, Y. B. *Astr. Zu.*, **41**, 19, 1964.
25. Shirokov, M. F., Fisher, I. Z. *Astr. Zu.*, **39**, 899, 1962.
26. Zeldovich, Y. B. *Uspekhi Fiz. Nauk*, **78**, no. 4, 1962; *Adv. in Astr. and Astrophys.*, 1964 (in press).
27. Staniukovich, K. P. *Dokl. Ak. N. SSSR*, **147**, 1348, 1962; *Vestnik Moscov. Univ.* ser. 3, no. 5, 71, 1961; no. 1, 78, 1962; *Arch. Mech. Stosowanej* (Warszawa), 3/4, **14**, 1962.
28. Staniukovich, K. P. *Dokl. Ak. N. SSSR*, **151**, 546, 1963.
29. Shklovsky, I. S. *Astr. Cirk. U.S.S.R.* nos. 250 and 256, 1963.
30. Pskovsky, Y. P. *Voprosy kosmogonii*, **8**, 32, 1962.
31. Zasov, A. V. *Astr. Zu.*, **40**, 868, 1963.

APPENDIX 4 (SUPPL.). SUPPLEMENT TO THE SUMMARY OF WORK DONE IN THE U.S.S.R. ON COSMOLOGY AND RELATED TOPICS OF GENERAL RELATIVITY

(prepared by A. L. Zelmanov)

G. M. Idlis (**32**) considered the principle of causality as the base of cosmology and proposed cosmological consequences from this principle.

A. J. Kipper (**33**) proposed a solution of the gravitational paradox problem in newtonian theory by introducing a generalized integral (called by him 'integral with an actually infinite volume of integration') for the potential, and in connection with this solution, introduced two systems (scales) for space and time, measuring called gravitational and atomic systems.

The behaviour of a gravitating homogeneous ellipsoidal distribution of dust matter with a linear velocity field, including homogeneous deformation (not isotropic in general) and rotation was considered in non-relativistic theory by Y. B. Zeldovich (**34**). The infinite homogeneous distribution of matter was treated as a limiting case of an ellipsoidal homogeneous distribution. A comparison between the non-relativistic treatment of the problem and the relativistic one was given.

Using free-falling non-rotating systems of reference both in non-relativistic gravitational theory and in general relativity, H. Keres (**35**) proposed a method for the comparison of fields described by these theories.

A refinement of Birkhoff's theorem was proposed by A. P. Ryabushko (**36**) according to which any spherically symmetrical field in the empty space, satisfying Einstein equations, is equivalent to Schwarzschild field or to a part of it, if the continuity of coordinates transformations and one-to-one correspondence are not required.

The works (**5**) and (**14**) by I. D. Novikov were continued by their author in (**37**). In particular, the propagation of light and the motion of particles in the regions of essential non-stationarity were considered and a conclusion about the possibility of an arbitrary behaviour of the volume of a medium element on an infinite interval of time was drawn.

G. M. Idlis (**38**) regarded the Metagalaxy as a quasi-autonomic cosmical system, which can be approximately represented by a closed homogeneous isotropic model with the Hubble parameter equal to 75 km sec^{-1} Mpc^{-1} and with the prevalence of the radiation over the matter,

https://doi.org/10.1017/S0251107X00014917 Published online by Cambridge University Press

the respective densities being $(1.1 \pm 0.2) \times 10^{-29}$ and $(2.0 \pm 0.5) \times 10^{-31}$ g cm^{-3}. Additional forces in the Metagalaxy due to the prevailing radiation were considered by G. M. Idlis, Z. H. Kurmakaev and T. B. Omarov (**39**).

Accepting relativistic cosmological models, using astronomical observational data for the determination of the emission of a volume element of the Metagalaxy, and making various assumptions concerning the change of this emission with time, A. G. Doroshkevich and I. D. Novikov (**40**) calculated the mean density and the spectrum of the radiation in Metagalaxy from ultra-violet up to radiofrequencies.

The work by Y. P. Pskovsky (**41**) contains a determination of the mass of Coma cluster by means of a new method—on the orbital revolution of its peripherical galaxies. According to this determination and accepting the Hubble parameter as 100 km/sec^{-1} Mpc^{-1}, the mean mass density in the Metagalaxy is found to be 7×10^{-30} g cm^{-3}.

The conclusion drawn by I. D. Novikov and L. M. Ozernoi (**42**) according to which the total mass of collapsed stars in the Galaxy is definitely smaller than that of the visible matter may be of interest in connection with the estimation of the mean density of matter in the universe.

Following Y. B. Zeldovich (**20**), V. B. Yakubov (**43**) considered nuclear reactions and the physical state of the matter at the early stages of the expansion of the homogeneous isotropic universe.

According to I. D. Novikov (**44**) the gravitational instability of the relativistic expanding homogeneous isotropic universe might lead to the formation of cosmic objects of various sizes up to clusters of galaxies with dimensions of the order of hundreds Mpc, if fluctuations arose at sufficiently early stages of expansion when the density was yet much greater, than the nuclear one.

According to the hypothesis of the same author (**45**), the superstars are parts of Friedman world (cores), delayed in their expansion, with initial dimensions smaller than their gravitational radius, recurrent outbursts being also possible. An exact solution of Einstein equations is given, describing a cosmological model with delayed and subsequently expanding cores. The possibility of the formation of such cores at the contraction stage, which could preceed the stage of expansion is also discussed.

Estimating the probability of the rise of super-stars in Friedman world, Y. B. Zeldovich (**46**) came to the conclusion, that in the past they were rising apparently not more frequently than at the present epoch.

V. L. Ginzburg and L. M. Ozernoi (**47**) considered the gravitational collapse of a spherically symmetrical gaseous mass possessing a magnetic moment. A solution is given of the problem concerning the behaviour of the magnetic and vortical electric fields during the relativistic phase of the collapse. Questions are also discussed connected with the rôle of the magnetic field in case, when the process of collapse is used for explaining the observing phenomena (radiogalaxies, superstars).

The work (**24**) of Y. B. Zeldovich was continued by V. M. Dashevsky and Y. B. Zeldovich in (**48**).

BIBLIOGRAPHY

32. Idlis, G. M. *Izv. astrofiz. Inst. Ak. N. Kazakh. SSR,* **12,** 37, 1961.
33. Kipper, A. J. *Voprosy kosmogonii,* **8,** 58, 1962.
34. Zeldovich, Y. B. *Astr. Zu.,* **41,** 873, 1964; *Mon. Not. R. astr. Soc.,* 1964 (in press).
35. Keres, H. *Zu. eksper. i teor. fiz.,* **46,** 1741, 1964.
36. Ryabushko, A. P. *Zu. eksper. i teor. fiz.,* **46,** 2046, 1964.
37. Novikov, I. D. *Soobšč. gos. astr. Inst. Sternberga,* no. 132, p. 3 and 43, 1964.

38. Idlis, G. M. *Izv. astrofiz. Inst. Ak. N. Kazakh. SSR,* **15,** 3, 1962.
39. Idlis, G. M., Kurmakaev, Z. H., Omarov, T. B. *Izv. Ak. N. Kazakh. SSR., ser. fiz.-mat. nauk,* no. I, Astrofizika, **16,** 3, 1963.
40. Doroshkevich, A. G., Novikov, I. D. *Dokl. Ak. N. SSSR.,* **154,** 809, 1964.
41. Pskovsky, Y. P. *Astr. Zu.,* **42,** 1965 (in press).
42. Novikov, I. D., Ozernoi, L. M. preprint; *Nature, Lond.* 1964 (in press).
43. Yakubov, V. B. *Astr. Zu.,* **41,** 884, 1964.
44. Novikov, I. D. *Zu. eksper. i teor. fiz.,* **46,** 686, 1964.
45. Novikov, I. D. *Priroda,* no. 8, 92, 1964; preprint, 1964; *Astr. Zu.,* **41,** 1075, 1964.
46. Zeldovich, Y. B. *Astr. Zu.,* **42,** 1965 (in press).
47. Ginzburg, V. L., Ozernoi, L. M. *Zu. eksper. i teor. fiz.,* **46,** 242, 1964 (in press).
48. Dashevsky, V. M., Zeldovich, Y. B. *Astr. Zu.,* **41,** 1071, 1964.