Proceedings of the 5th Marcel Grossmann Conference on General Relativity

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D. G. Blair and M. J. Buchingham, Eds. *Proceedings of the 5th Marcel Grossmann Conference on General Relativity*, Vols. 1 and 2, World Scientific, New York, 1989.

The purpose of the conference, which was held in Australia on August 8–13, 1988, was to summarize the progress made in gravitation and the general theory of relativity since the preceding conference (held in 1986) in this series. Principal attention was paid to the mathematical foundations and physical predictions of the theory, permitting a deeper understanding of the space-time structure of the universe and a refinement of the status of experiments on checking general relativity.

The book contains 17 plenary reports read at the conference and the abstracts of reports made in 34 sectional meetings.

The book opens with a report by John Archibald Wheeler entitled "The simplicity of gravitation." Wheeler believes that it is the power of gravitation that is mainly responsible for the seeming simplicity of the theory (in spite of the applicable complicated mathematical apparatus). Mass governs space-time; it tells space-time how to curve. Space-time governs mass; it tells mass how to move. In his report Wheeler analyzes the mechanisms of this power of gravitation, the structure on which it is based, and the physically most characteristic models (for example, the Schwarzschild solution).

V. A. Belinskiĭ and I. M. Khalatnikov, Kei-ichi Maeda, T. Nakamura and Ken-ichi Ohara, and I. Bichak report on a number of modern gravitational models. Belinskiĭ and Khalatnikov study Bianchi I and Friedmann cosmological models in the presence of a massive scalar field. Maeda shows that from the dynamic standpoint the inflation model is natural, and he discusses the status of the hypothesis that if the cosmological constant exists, then any space-time asymptotically approaches the de Sitter space-time. Bichak reviews the recently constructed exact solutions of Einstein's equations, representing radiation space-time. Finally, Nakamura and Ohara present two methods of numerical three-dimensional gravitation.

There are a number of reports on the quantum aspects of gravitation and cosmology. J. Schwartz and J. Veneziano study the relation between the theory of superstrings and gravitation, both with the help of general analyses and in terms of an explicit calculation of some processes. J. Hartle attempts to overcome the difficulties of defining time in quantum cosmology by generalizing quantum mechanics. He proposes a variant of quantum mechanics in which there is no special variable playing the role of time. The central role played by time in standard quantum mechanics is not a fundamental aspect of the formalism, but rather as an approximation, suitable for those initial conditions of the universe which lead to classical space-time, when the universe becomes large.

The aspects of the theory which make it possible to explain separate gravitational effects are discussed in a number of plenary reports. F. D. Stacey gives estimates of the parameters of a phenomenological potential describing deviations from Newton's inverse square law (i.e., he refines the limits on the possible "fifth force"). S. M. Chitre describes the properties of systems that can play the role of gravitational lenses. He discusses specially the role of dark galactic halos in the explanation of the configuration of the observed patterns for several suggested gravitational lenses. J. Ables and others report on general-relativistic effects for the recently discovered millisecond pulsar in a close binary system, and T. Damour examines the role of fundamental physics in understanding the behavior of binary pulsars.

D. Blair and P. Vaitch report on the recent progress made in the construction of gravitational-wave antennas based on mechanical resonators of the Weber type and they calculate the frequency of events which such antennas are expected to detect. J. Huff reports on the prospects for detecting gravitational waves with the help of laser interferometric detectors, which now seem to be most promising.

The remaining four plenary reports are devoted to the unique event that has excited all astrophysicists—the explosion of the supernova 1987A. G. Pizzella analyzes the proof of the fact that in the time interval near the time of arrival of the signal from the supernova there was a correlation between the data from two gravitational-wave detectors (in Maryland and Rome) and from neutrino detectors (beneath Mont Blanc and in Kamiokand). M. A. Dopita and H. Sato present the results of observations of the supernova over a long period of time, and J. Wilson and R. Mile discuss the question of modeling the processes occurring in the supernova.

The book also contains reports made at six sectional meetings:

1. Rigorous and exact solutions (classical general relativity; spin, geometry, and topology; approximate methods; exact solutions; the physics of black holes: and, alternative theories and twistors).

2. Quantum gravity (critical accelerations; quantum gravity; string theories; cosmological strings, superstrings, and supergravitation; quantum cosmology).

3. Cosmology (early cosmology and the quantum theory of fields; super symmetry, multidimensional cosmology, and the Kaluza-Klein theory; theoretical cosmology; the large-scale structure of the universe; dark matter).

4. Mathematical astrophysics (algebraic calculations; numerical gravitation; astrophysics of collapsed objects; self-gravitating systems; and, the history of general relativi-

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5. Observational astrophysics (sources of gravitational radiation; relativistic astrophysics; supernova; observation of collapsed objects; and, cosmic background).

6. Precision experiments (the "fifth force"; measurement of the gravitational interaction in precision three-dimensional experiments; antennas based on mechanical resonators; laser interferometric antennas; detection of gravitational radiation; quantum technology for detection of gravitational radiation; precision clocks in general relativity).

Translated by M. E. Alferieff