

MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

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Mathematical Aspects of General Relativity

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ABSTRACT. Mathematical relativity, the subject of this conference, has recently become more and more devoted to the theory of nonlinear evolution equations, with global questions becoming ever more accessible. This is reflected by the fact that more than half of the talks given were concerned with the global dynamics of solutions of evolution equations related more or less directly to the Einstein equations of general relativity. Progress was reported in understanding subjects such as black holes, gravitational radiation, cosmology and the relation of general relativity to Newtonian gravitational theory.

Mathematics Subject Classification (2000): 83Cxx.

Introduction by the Organisers

The participants of this conference included a good mixture of established workers in the area of mathematical relativity, promising young researchers in the field and experts in related subjects.

At a previous Oberwolfach conference with the same title in 2006 there were two talks related to the question of the stability of black holes. Since then that subject has developed rapidly and this development, including the most recent results, was described in the talk of Dafermos. A new influential approach to this problem using harmonic analysis was presented in the talk of Tataru. A technique with a stonger input from differential geometry was the subject of the presentation of Blue. Holzegel talked about work related to black hole stability in the context of a negative cosmological constant. Other aspects of the theory of black holes were also discussed at the conference. Alexakis described progress on uniqueness

theorems for black holes. Rein presented results on the formation of black holes due to collapse of matter. Hennig's talk was concerned with the question of whether the spin of a pair of black holes can balance their gravitational attraction.

The issue of the stability of black holes and other solutions of the Einstein equations belongs to the global theory of hyperbolic equations. Other talks in that area, concerning Einstein's equations or other nonlinear wave equations, were given by Struwe (analytical) and Bizon (numerical and heuristic). An influential model in this area is the work of Christodoulou and Klainerman on the nonlinear stability of Minkowski space. In her talk Bieri explained how she has been able to extend this result in various directions. A related topic in cosmology is the so-called 'cosmic no hair theorem'. The work reported in the talk of Speck indicates that, assuming certain hypotheses, this has now finally attained the status of a theorem, having been a conjecture for many years. Smulevici presented results of the dynamics of cosmological models with symmetry including matter and a positive cosmological constant. Heinzle explained ways in which the choice of a matter model influences the dynamics of cosmological models.

The topic of the Newtonian limit and post-Newtonian approximations is a subject of great physical importance which had been resistant to mathematical progress. In his presentation Oliynyk explained how he has been able to overcome some of the major difficulties in this subject. Beig talked about some solutions in scalar gravity which provide a simple model related to gravitational radiation. Corvino discussed the construction of initial data for the motion of many bodies. Miao gave a lucid exposition of topics related to the Brown-York quasilocal mass. Maxwell described his recent studies which show that, at least for certain simple families of initial data, the conformal methods appear to have difficulties in dealing with non constant mean curvature solutions of the Einstein constraints. Parabolic equations were represented by the talk of Mazzeo on the subject of the Ricci flow on open surfaces.

The number of talks at the conference was limited so as to leave plenty of time for discussions. On one evening an informal discussion session was arranged where anyone who wished could give a ten-minute account of a subject of their choice. This was an opportunity to share ideas not represented in the main talks.