

Contents

Preface	<i>ix</i>
Conference committees	<i>xi</i>

Part A. Classical relativity and gravitation theory 1

INVITED TALKS

1. Colliding waves in general relativity	3
<i>V. Ferrari</i>	
Introduction	
Colliding wave solutions	
Creation of curvature singularities	
Exact solutions including “null dust”	
2. How fast can pulsars spin?	21
<i>J. L. Friedman</i>	
Introduction	
Constructing models of rapidly rotating relativistic stars	
Ω_{max} for stars stable against collapse	
Conclusions	
3. Global properties of solutions to Einstein’s equations.....	41
<i>H. Friedrich</i>	
Introduction	
The asymptotic behavior of gravitational fields	

The conformal boundary	
The conformal structure of the field equations	
The global conformal structure of solutions: Case $\lambda > 0$	
The global conformal structure of solutions: Case $\lambda = 0$	
Conclusion	
4. Progress in 3D numerical relativity	61
<i>T. Nakamura</i>	
Inflationary supercomputing	
3D codes	
Coalescence of binary neutron stars	
Numerical results	
WORKSHOPS	
A1. Exact solutions and exact properties of Einstein equations	85
<i>V. Moncrief</i>	
A2. Spinors, twistors, and complex methods.....	93
<i>N. Woodhouse</i>	
A3. Alternative gravity theories	99
<i>M. Francaviglia</i>	
Introduction	
Four-dimensional theories	
Five-dimensional theories	
Miscellaneous	
A4. Asymptotia, singularities, and global structure	105
<i>B. G. Schmidt</i>	
A5. Radiative spacetimes and approximation methods.....	107
<i>T. Damour</i>	
Introduction	
Mathematical results about approximation methods	
Definition and formal properties of approximation methods	
Application of approximation methods to radiative space-times	

Proceedings of GR-12

ix

A6. Algebraic computing	113
<i>M. A. H. MacCallum</i>	
Introductory survey	
Papers presented	
A7. Numerical relativity	121
<i>J. Centrella</i>	

Part B. Relativistic astrophysics, early universe, and classical cosmology 131

INVITED TALKS

5. Gravitational lenses: theory and interpretation	133
<i>R. Blandford</i>	
Introduction	
Multiple imaging of point-like sources	
Arcs and rings - imaging of extended sources	
Cosmological applications	
Conclusion	
6. Recent observations of gravitational lenses.....	153
<i>B. Fort</i>	
Introduction	
Galaxy lenses	
The twin galaxy field 0249-186 and cosmic strings	
Cluster lenses	
What can be learned from cluster lenses?	
Discussion and next observational steps	
7. Inflation and quantum cosmology.....	177
<i>A. D. Linde</i>	
Introduction	
The “standard” inflationary scenario	
Self-reproducing universe and life after inflation	
Inflation and the wave function of the universe	

8. Theory and implications of cosmic microwave background Radiation	205
---	-----

M. Panek

Introduction	
CBR anisotropies in the standard model	
Secondary anisotropies	
Anisotropies in nonstandard models	
Spectral properties of the CBR	
Conclusions	

9. The cosmic microwave background: present status of observations, and implications for general relativity	223
---	-----

R. B. Partridge

Introduction	
The present status of the observations of the CBR	
The CBR and cosmology and gravity theory	
Concluding remarks	

WORKSHOPS

B1. Mathematical cosmology.....	241
---------------------------------	-----

J. Wainwright

The observational cosmology program	
The cosmological perturbation problem	
Isotropic singularities	
The evolution of Bianchi cosmologies	

B2. The early universe.....	247
-----------------------------	-----

M. Turner

B3. Relativistic astrophysics	253
-------------------------------------	-----

M. Abramowicz

B4. Astrophysical and observational cosmology.....	263
--	-----

B. J. Carr

Gravitational lensing	
Large-scale structure	

Cosmic strings
 Microwave background radiation

Part C. Experimental gravitation and gravitational wave detection 271

INVITED TALKS

10. Experimental tests of the universality of free fall and of the inverse square law 273	<i>E. Adelberger</i>
Introduction	
Searches for violations of the universality of free fall	
Searches for violations of the inverse square law	
Conclusions	
11. Resonant bar gravitational experiments 295	<i>G. Pizzella</i>
Interaction of a gravitational wave with a resonant antenna	
The electromechanical transducer	
The noise	
Optimum filtering and effective temperature	
Present and future sensitivity	
Brief review of the bar experiments	
Ultimate bar sensitivity	
12. Solar system tests of general relativity: recent results and present plans 313	<i>I. I. Shapiro</i>
Introduction	
Past light cone	
Future light cone	
Epilogue	
13. Interferometric gravitational wave detectors 331	<i>R. Weiss</i>

WORKSHOPS

C1. Solar system and pulsar tests of gravitation	341
<i>R. Hellings</i>	
C2. Earth-based gravitational experiments	345
<i>J. Faller</i>	
C3. Resonant bar and microwave gravitational wave experiments ..	349
<i>W. O. Hamilton</i>	
C4. Laser gravitational wave experiments	357
<i>J. Hough</i>	
Introduction	
Laser interferometer projects	
Technology development for the long baseline detectors	
Finding the signals in the noise	
Space experiments	
Prototype detectors	
Conclusion	
Part D. Quantum gravity, superstrings, quantum cosmology.....	367

INVITED TALKS

14. Self-duality, quantum gravity, Wilson loops and all that	369
<i>A. Ashtekar</i>	
Introduction	
Hamiltonian framework	
Quantum theory	
Discussions	
15. Progress in quantum cosmology	391
<i>J. Hartle</i>	

- The aims of quantum cosmology
- The quantum mechanics of cosmology
- Proposals for a law of initial conditions
- Predictions
- The place of quantum cosmology in general relativity

16. String theory as a quantum theory of gravity 419
G. Horowitz

- Introduction
- Connection between string theory and general relativity
- Quantum perturbation expansion
- Classical string theory
- Speculations
- Notes

WORKSHOPS

D1. Theories of quantum gravity I (superstring theory) 441
C. Aragone

D2. New Hamiltonian variables 449
L. Smolin

- Introduction
- Developments in the classical theory
- The role of classical general relativity in the quantum theory
- Developments in quantum general relativity
- A wild speculation

D3. Quantum cosmology and baby universes 463
L. Grishchuk

D4. Quantum field theory in curved spacetime 467
J. Audretsch

- Coarse-grained effective action
- Quantum violations of energy conditions
- Renormalized stress tensors and black holes

D5. Theories of quantum gravity II (not superstring theory)	471
<i>A. Komar</i>	
Introduction	
Recent developments	
Reported results	
Conclusion	
Part E. Overviews—past, present, and future	477
17. Views from a distant past	479
<i>E. Schucking</i>	
18. Conference summary	491
<i>J. Ehlers</i>	
Einstein's classical theory	
Cosmology	
Quantum gravity	