

CONTENTS

FOREWORD	v
DARK MATTER IN THE SOLAR VICINITY <i>John N. Bahcall</i>	1
DARK MATTER NEAR THE SUN <i>John N. Bahcall</i>	2
I. Introduction	2
II. The Method	3
III. The Input Data	4
IV. The Simplest Model for the Unseen Material	5
V. Other Models and Equation (1)	8
VI. But . . .	9
VII. The Rotation Curve and Equation (2)	9
VIII. What is It?	10
References	11
K-GIANTS AND THE TOTAL AMOUNT OF MATTER NEAR THE SUN <i>John N. Bahcall</i>	13
I. Introduction	13
II. The Data	15
III. The Equations	26
IV. Numerical Results	29
V. The Galactic Acceleration, Individual Column Densities, and Simulated Star Counts	37
VI. Summary and Discussion	40
References	46

SOME POSSIBLE REGULARITIES IN MISSING MASS	50
<i>John N. Bahcall and Stefano Casertano</i>	
I. Introduction	50
II. The Simplicity	50
III. The Numerical Characteristics	51
IV. The Local Missing Mass	54
V. Implications	54
References	56
DISTRIBUTION OF DARK MATTER IN THE SPIRAL GALAXY NGC 3198	58
<i>T. S. van Albada, J. N. Bahcall, K. Begeman and R. Sancisi</i>	
I. Introduction	58
II. Distribution of Light	59
III. Rotation Curve	61
IV. Mass Models	62
V. Discussion	65
Appendix: Dark Matter and the Tully-Fisher Relation	66
References	67
I. EVOLUTION OF GLOBULAR CLUSTERS AND THE GLOBULAR CLUSTER SYSTEM	
II. POSITIVE ENERGY PERTURBATIONS IN COSMOLOGY	69
<i>J. P. Ostriker and C. Thompson</i>	
I. Globular Clusters	69
1. Basic properties of globular clusters	70
2. Equilibrium structure of globular clusters	71
3. Methods of computing the evolution of a globular cluster	75
4. Early evolution of an isolated globular cluster	76
5. Effects of finite stellar size: heating and core bounce	78
6. External effects on the evolution of a globular cluster	82
7. Evolution of the globular cluster system: destruction of clusters	84
8. Outstanding issues	84
9. Nature of the dark halo of our galaxy	85
References	88

II.	Positive Energy Perturbations in Cosmology	
	1. Hydrodynamics in a cosmological setting	90
	2. Various self-similar solutions for blast waves	92
	3. Shell structure	96
	4. Equation of motion of a thin shell	97
	5. Gravitational instability in a shell	100
	6. Interactions between cosmological blasts	101
	References	102
DARK MATTER IN GALAXIES AND GALAXY SYSTEMS		103
<i>Scott Tremaine and Hyung Mok Lee</i>		
I.	Introduction	103
	1. Virial theorem	104
	2. History of dark matter	105
	3. A quick review of cosmology	106
	4. Mass-to-light ratio in the solar neighbourhood	109
	5. Classification scheme of dark matter	110
II.	Theory of Stellar Dynamics	111
	1. Collisionless Boltzmann equation	112
	2. The Jeans theorem	113
	3. Examples of distribution functions	114
	4. Moments of the collisionless Boltzmann equation	116
III.	Elliptical Cores and Dwarf Spheroidal Galaxies	117
IV.	The Extent of the Galactic Halo	121
	1. Local escape speed	121
	2. Magellanic stream	122
	3. Local group timing	122
	4. Kinematics of satellite galaxies	123
	5. Summary	126
V.	Binary Galaxies	126
VI.	Masses of Groups and Clusters of Galaxies	127
	1. Groups of galaxies	127
	2. Rich clusters: Coma cluster	129

VII. Summary	131
Acknowledgements	131
References	131
GRAVITATIONAL LENSES	133
<i>Roger D. Blandford and Christopher S. Kochanek</i>	
I. Introduction	134
1. History	134
2. Simple estimates	134
3. Uses	136
4. Organization of lectures	137
5. References	137
II. The Optics of Gravitational Lenses	138
1. Vector formalism	138
2. Scalar formalism: Fermat's Principle	144
3. Propagation formalism: the optical scalar equations	145
4. References	147
III. Gravitational Potential Wells	148
1. Uniform sheet	148
2. Point mass (Black Hole)	149
3. Singular isothermal sphere	149
4. Isothermal sphere with finite core	151
5. Elliptical potentials	154
6. Irregular potentials	154
7. Cosmic strings	154
8. References	157
IV. Generic Features of Images	158
1. Arrival time surfaces	158
2. Caustics and catastrophes	160
3. References	166
V. Microlensing	168
1. Order of magnitude estimates	168
2. The character of microimages: low optical depth	169
3. The character of microimages: moderate optimal depth	170
4. The character of microimages: large optical depth	172
5. References	172

VI.	Compound Lenses	173
	1. References	176
VII.	The Observational Position	176
	1. A reprise of existing candidates	177
	2. Space density of sources – quasars, galaxies, and radio sources	180
	3. Space density of lenses – galaxies and clusters	181
	4. Amplification bias	182
	5. Surveys and future prospects	182
	6. References	183
VIII.	Lenses as Probes of the Universe	188
	1. The Hubble constant	189
	2. Galactic masses	190
	3. Lensing by dark matter	191
	4. References	193
IX.	Concluding Remarks	194
	Acknowledgements	195
	AN INTRODUCTION TO INFLATION	197
	<i>William H. Press and David N. Spergel</i>	
I.	Review of Big Bang Cosmology	197
II.	Inflation	199
III.	Additional Topics Not Covered Here	204
	References	205
	WIMPS IN THE SUN AND IN THE LAB	206
	<i>William H. Press and David N. Spergel</i>	
I.	WIMPs and the Solar Neutrino Problem	206
II.	Detecting WIMPs in the Lab	212
	References	216
	AN INTRODUCTION TO COSMIC STRINGS	218
	<i>William H. Press and David N. Spergel</i>	
I.	Birth of Cosmic Strings	218
II.	The motion of a Cosmic String Loop	220
III.	Cosmic Strings and the Formation of Galaxies	224

1. Spherical accretion model	225
2. Competition between loops	227
3. Galaxy morphology	228
IV. Observing Cosmic Strings	228
References	229
A DEPARTURE FROM NEWTONIAN DYNAMICS AT LOW ACCELERATIONS AS AN EXPLANATION OF THE MASS DISCREPANCY IN GALACTIC SYSTEMS	231
<i>Mordehai Milgrom</i>	
I. Introduction	232
II. Dynamics at Low Accelerations	234
III. A Nonrelativistic Formulation	237
IV. Effects of an Ambient Field	238
V. Observational Consequences	241
References	249

