CONTENTS

CHAPTER 1. INTRODUCTION	1
Principle of mutual reversibility	3
Action and integral canonical pairs	9
Integral characteristics in the study of dynamics of natural systems	20
Method of moments: specific features in the integral approach and first moments	31

CHAPTER 2. UNIVERSALITY OF JACOBI'S VIRIAL EQUATION FOR DESCRIPTION OF DYNAMICS OF NATURAL SYSTEMS IN TERMS OF INTEGRAL CHARACTERISTICS......

Derivation of Jacobi's virial equation from Newtonian equations of motion	43
Derivation of generalized Jacobi's virial equation for dissipative systems	54
Derivation of Jacobi's virial equation from Eulerian equations	58
Derivation of Jacobi's virial equation from Hamiltonian equations	68
General covariant form of Jacobi's virial equation	69
Relativistic analogue of Jacobi's virial equation	73
Derivation of Jacobi's virial equation in quantum mechanics	76

43

87

CHAPTER 3. SOLUTION OF JACOBI'S VIRIAL EQUATION FOR CONSERVATIVE SYSTEMS

Solution of Jacobi's virial equation in classical mechanics	87
The classical approach	- 88
The integral approach	92
General case of conservative systems	95
Solution of Jacobi's virial equation in hydrodynamics	101
The hydrodynamic approach	101
The integral approach	106
Equivalence of the Schwarzschild solution and solution of Jacobi's virial equation	
(static description)	109
The hydrogen atom as quantum mechanical analogue of the two-body problem	112

CONTENTS

CHAPTER 4. PERTURBED VIRIAL OSCILLATIONS OF A SYSTEM	123
Analytical solution of generalized equation of virial oscillations	125
Solution of Jacobi's virial equation for a dissipative system	135
Solution of Jacobi's virial equation for a system with friction	139
CHAPTER 5. RELATIONSHIP BETWEEN JACOBI FUNCTION AND	
POTENTIAL ENERGY	143
Asymptotic limit of simultaneous collision of mass points for a	
conservative system	144
Asymptotic limit of simultaneous collision of mass points for non-conservative	
systems	147
Asymptotic limit of simultaneous collision of charged particles of a system	165
Relationship between Jacobi function and potential energy for a system with	
high symmetry	171
System with spherical symmetry	172
Polytropic gas sphere model	178
System with elliptical symmetry.	184
System with charged particles	191

Solution of Jacobi's virial equation for Trapezium Orion type systems	201
Damping virial oscillations	223
Application to the problem of the Moon's motion	224
Lyapunov stability of motion	237
Lyapunov stability of motion of a system described in terms of co-ordinates	
and integral characteristics	238
Stability of virial oscillations according to Lyapunov	249
Stability of virial oscillations of celestial bodies as dissipative systems	252

Velocity of gravitational contraction of a gaseous sphere	255
Equilibrium boundary conditions for a gravitating gaseous sphere	256
Relationship between potential and rotational energies of a rotating	
gaseous sphere	259

CONTENTS

Limiting value of angular momentum of a contracting gaseous sphere	261
Velocity of gravitational contraction of a gaseous sphere	262
The luminosity-mass relationship	269
Bifurcation of a dissipative system	272
Electromagnetic energy radiation by a celestial body as an electric dipole	276
Cosmo-chemical effects	283
Direct derivation of the equation of virial oscillations from Einstein's equation	287

Problems of global dynamics in geophysics	295
Unperturbed virial oscillations of the Earth	300
The differential approach	301
The integral approach	306
Solution of Jacobi's virial equation for the Earth's atmosphere	312
Perturbed oscillations of the Earth's atmosphere	321
Identification of resonance frequencies	327
Observation of the virial eigenoscillations of the Earth's atmosphere	331
CONCLUSIONS	343
REFERENCES	357
SUBJECT INDEX	361

vii