

## 8 : THEORY II : STELLAR DYNAMICS

### (8.1) Introduction

- (a) Gas/Fluid Physics & Stellar Dynamics
- (b) A Path Through the Subject

### (8.2) Potential Theory

- (a) Preliminaries
- (b) Examples of Density-Potential Pairs
  - (i) Point Mass (Keplerian)
  - (ii) Uniform Spherical Shelly
  - (iii) Homogeneous Sphere
  - (iv) Logarithmic Potentials (Flat  $V_{\text{rot}}$ )
  - (v) Spherical Systems
  - (vi) Axisymmetric Thin Disks
  - (vii) Axisymmetric Flattened Systems
  - (viii) Triaxial Ellipsoids
  - (ix) Multipole Expansion

### (8.3) Orbit Classes

### (8.4) Numerical N-Body Methods

### (8.5) The Virial Theorem

- (a) Simple Illustrations
  - (i) Circular Orbit
  - (ii) Time Averaged Keplerian Orbit
- (b) The General Case
- (c) Mass Determination
- (d) Binding Energy
- (e) Negative Specific Heat
- (f) Rotational Flattening

### (8.6) Describing Collisionless Systems

- (a) The Distribution Function (DF) :  $f(\mathbf{r}, \mathbf{v}, t)$
- (b) Collisionless Boltzmann Equation (CBE)
- (c) The Jeans Equation(s)
- (d) Applications of the Jeans Equations
  - (i) Spherical Steady State Systems
  - (ii) Rotational Flattening Revisited

**(iii) Vertical Disk Structure****(8.7) Steady State : The DF as  $f(E, I_L, L_z)$** 

- (a) Integrals of Motion & Jeans Theorem
- (b) Self-Consistency
- (c) Spherical Isotropic Systems :  $DF = f(E)$
- (d) Deriving  $f(E)$  from  $\rho(r)$
- (e) From  $f(E)d^3r d^3v$  to  $N(E)dE$

**(8.8) Model Building Using DFs**

- (a) Polytropic Sphere : Power Law  $f(E)$
- (b) Isothermal Sphere : Exponential  $f(E)$ 
  - (i) Singular Isothermal Sphere (SIS)
  - (ii) General Isothermal Sphere
- (c) King Models : Truncated Exponential  $f(E)$
- (d) Spherical Models with Rotation :  $DF = f(E, I_L)$
- (e) Axisymmetric Systems
  - (i) Thin Disks with  $DF = f(E, L_z)$
  - (ii) Thick Systems with  $DF = f(E, L_z)$
  - (iii) Thick Systems with  $DF = f(E, L_z, I_3)$
- (f) Triaxial Systems (eg Bars & Some Ellipticals)

**(8.9) Violent Relaxation****(8.10) Introducing Star-Star Encounters**

- (a) Encounter and Relaxation Timescales
  - (i) Direct collision (or tidal capture)
  - (ii) Strong Deflection
  - (iii) Weak Deflection
- (b) Timescales for Real Stellar Systems
- (c) The Fokker-Planck Equation
  - (i) Solutions to the Fokker-Planck Equation
- (d) Results : The Effects of Encounters
  - (i) Relaxation
  - (ii) Equipartition
  - (iii) Escape (Ejection and Evaporation)
  - (iv) Inelastic Encounters

**(8.11) Further Topics**