

Introduction (Brief)

I.) What's a Galaxy?

- for astronomical perspective, read Binney and Tremaine, Chapt. I (while enjoying day at S.A. Zoo)

- for physics perspective:

→

galaxy = stars + gas + B-field + CR

≈ stars

→ { N-body system, gravitating point particles
CLASSICAL

→ ⊕ collisionless (more later)

N-b. interactions of galaxy ↔ F.P. problem

→ hierarchy of interactions:

stars → galaxies → cluster → ...
(multi-star) (multi-galaxy)

→ basic issues:

① - structure ↔ equilibrium
(spherical, disk, bulge, bars, triaxial, ...)

- rotation curve $v(r)$ ↔ "dark matter"

c.e. $\frac{\partial \phi}{\partial t} + \mathbf{v} \cdot \nabla \phi - \nabla \phi \cdot \frac{\partial \mathbf{F}}{\partial \mathbf{v}} = 0$

$$\nabla^2 \phi = 4\pi G \int d^3v F$$

} c.e. problem

② - stability, patterns \rightarrow description $\left\{ \begin{array}{l} \text{fluid (3/6)} \\ \text{kinetic} \end{array} \right.$

\rightarrow Jeans instability, Jeans Theorem, violent relaxation

"

\rightarrow What makes those pretty spiral arms?

- gravitational instability in rotating systems

\Rightarrow spiral density waves

③ - interactions - clusters, galactic cannibalism

- dynamical friction (= F.P. drag)

- Fokker-Planck Theory \rightarrow Coulomb interactions
(Rosenbluth potentials)

(and) - later

④ - magnetic field

- origin \rightarrow dynamo

- macro-morphology \rightarrow

- role CRs

$\left\{ \begin{array}{l} \text{Parkes} \\ \text{Instability,} \\ \text{etc.} \end{array} \right.$

→ Tools and Technical Issues.

⇒ potential theory - i.e. simple models for ρ, ϕ ($\nabla^2 \phi = 4\pi G \rho$)
⇒ phenomenological starting point

⇒ Great cure for chaos... } team as needed

⇒ particle orbits - tedious but tolerable...

- gives simple assumption on galactic gravitational potential, what do orbits look like?

- basic frequencies → linear response
- effect asymmetric → resonance
- effect slow variation (→ adiabatic theory)

* - are orbits stochastic? - chaos in galaxy...

⇒ basic fluid and kinetic theory - fascinating

- barred body: how is Vlasov equation actually derived here?

⇒ BBK closure? → analogue of $1/n^3$

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- Fluid equations - "Jeans Equations"
 - meaning, assumptions?
 - validity???

- Jeans instability is fundamental, scale-setting process/mechanism

but... intrinsic to J.I. is "Jeans swindle" ... → (egbm)

- ⇒ spiral waves - really fascinating...
- wave: momentum, energy, angular momentum, etc.

angular momentum budget in spiral waves, etc.

- linear growth ⇒ patterns (Chow handle shear ... ?)
- NL saturation ... ???

⇒ clusters

→ Fokker-Planck theory

→ self-consistent treatment of "test star" and background or "field star"

⇒ diffusion, drag (Rosenbluth potentials)