141/241 Midterm Project: The “Mice” Collision

Units Chosen

L=16.5 kpc

M = 10^11 M_Sun

t = 10^8 yrs

dt = 10^7 yrs

V = 16.5 kpc / 10^8 yrs

G = x L V^2 / M

→ x = 1

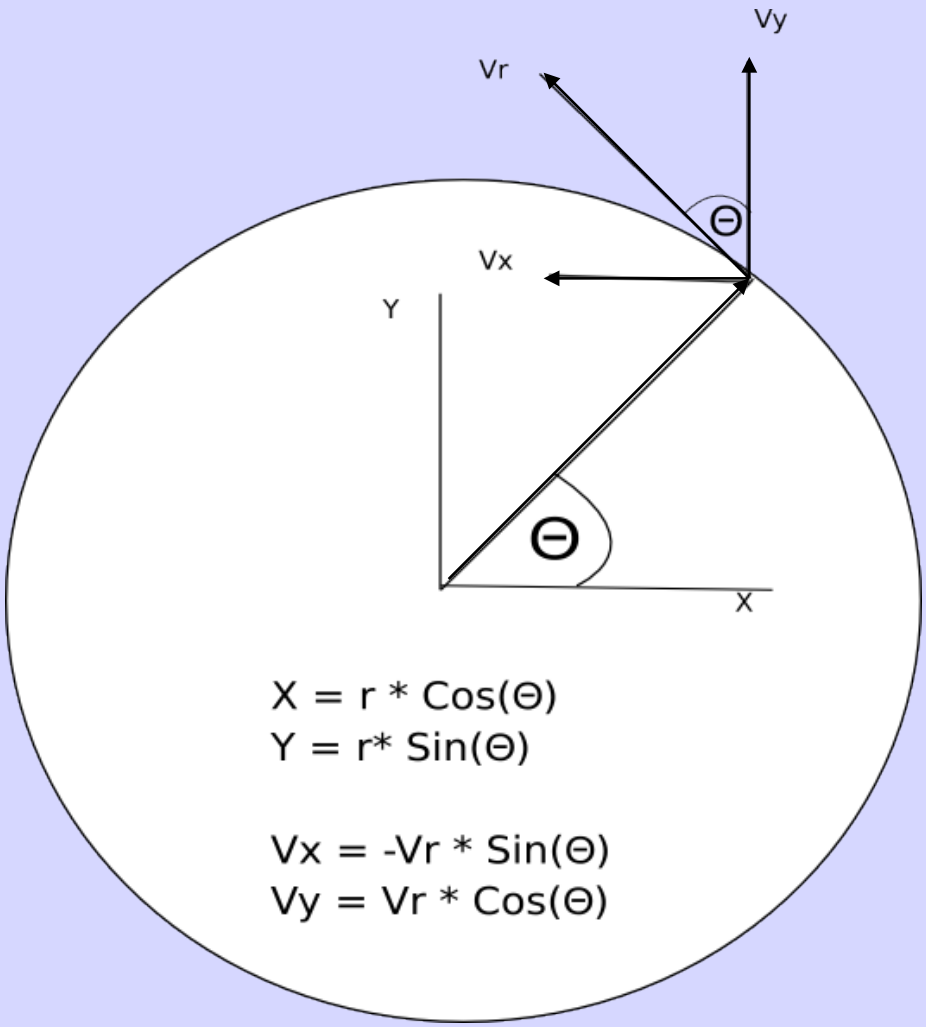
G = L^3 / (t^2 M)

Galaxy Setup

- Rmin = 25kpc
- 10^11 M_Sun at origin
- 11 concentric rings from 0.2 Rmin → 0.7 Rmin
- dRmin = 0.05 Rmin
- nParticles from innermost to outermost ring =

  {12,15,18,21,24,27,30,33,36,39,42}
- Total Particles = 297
- vParticles = Sqrt(GM/r) ← w.r.t. galaxy center

Coordinate Transformation



The Angles of Inclination

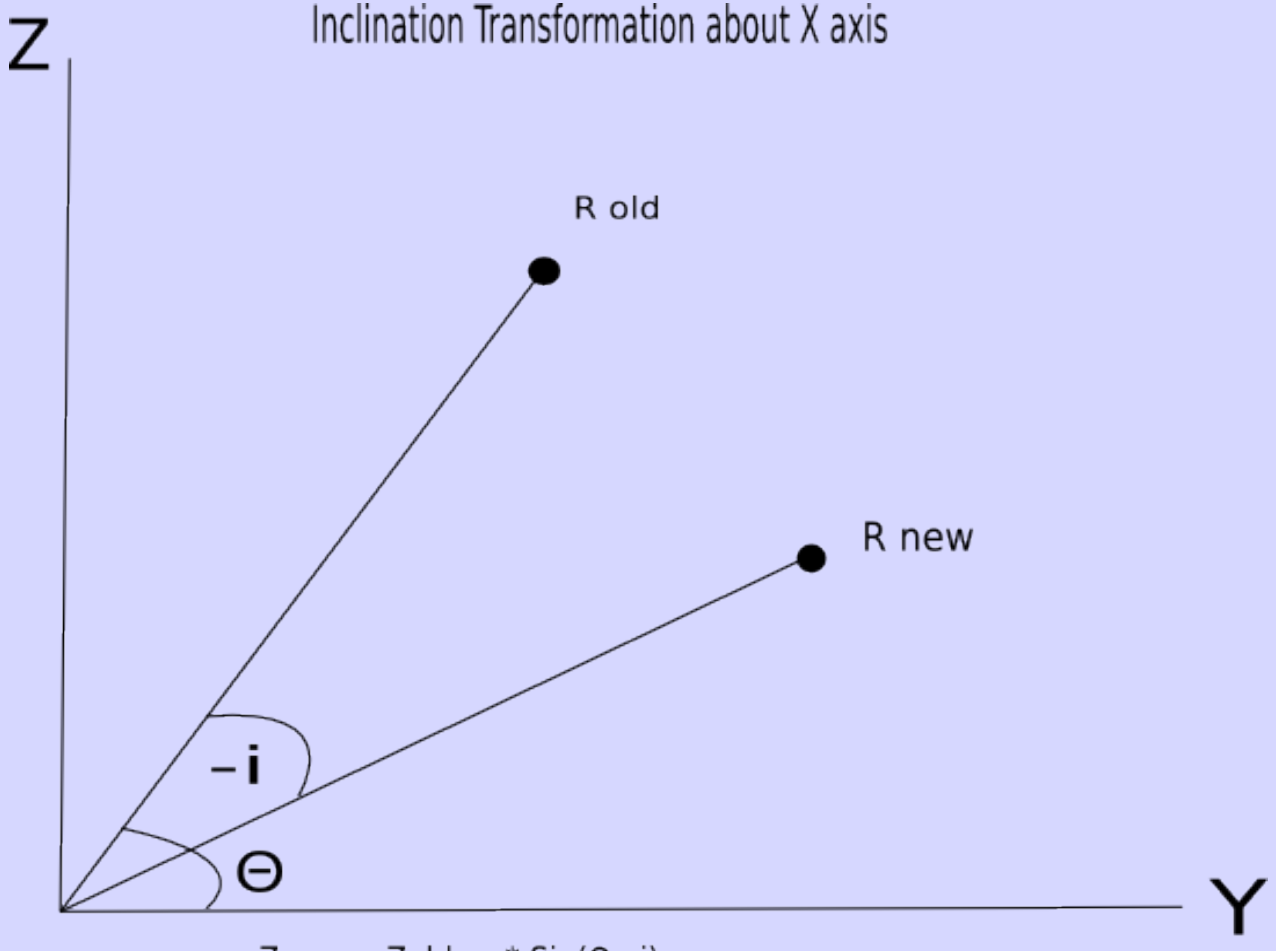
- Node-to-peri angles:

  $\omega_A = \omega_B = -90°$
- Inclination angles:

  $i_A = 15°$

  $i_B = 60°$

Galaxy Orientation



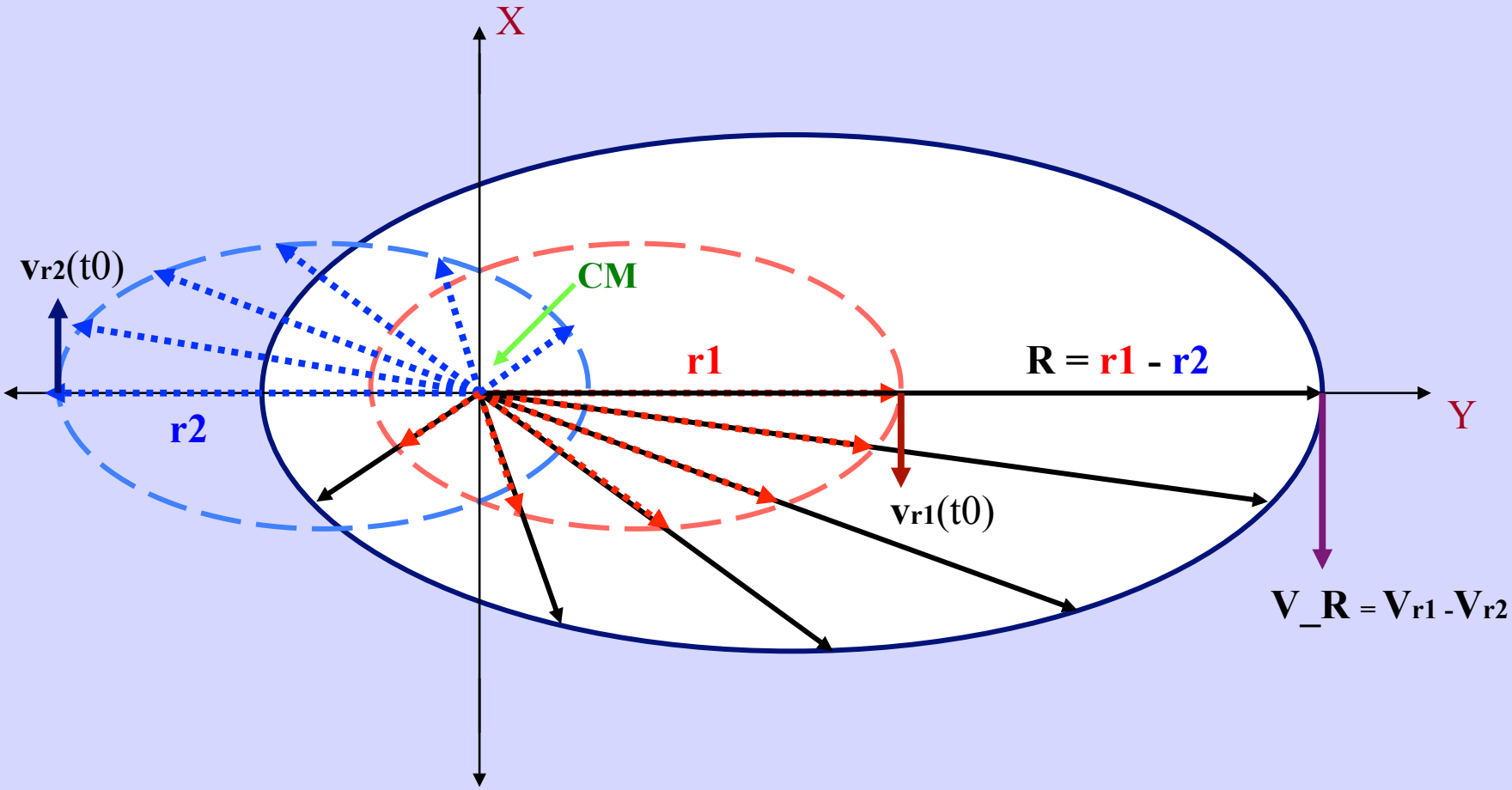
Znew = Zold - r * Sin(Θ - i)
Since Θ is Zero initially, as well as Zold, reduces to:

Znew = -Yold * Sin(-i)
Ynew = Yold * Cos(i)

Equations for the C.M. Ellipse

- k = G m1 m2
- **a** = **L**^2/(**m** k) = 2 **L**^2
- **m** = m1 m2/(m1+m2) = M/2
- **R** = a/(1+e Cos(q))
- **L** = m R^2 (dq/dt)
- dq/dt = **L** / R^2
- **v**_R = **R***(dq/dt) = 2 **L** / **R**

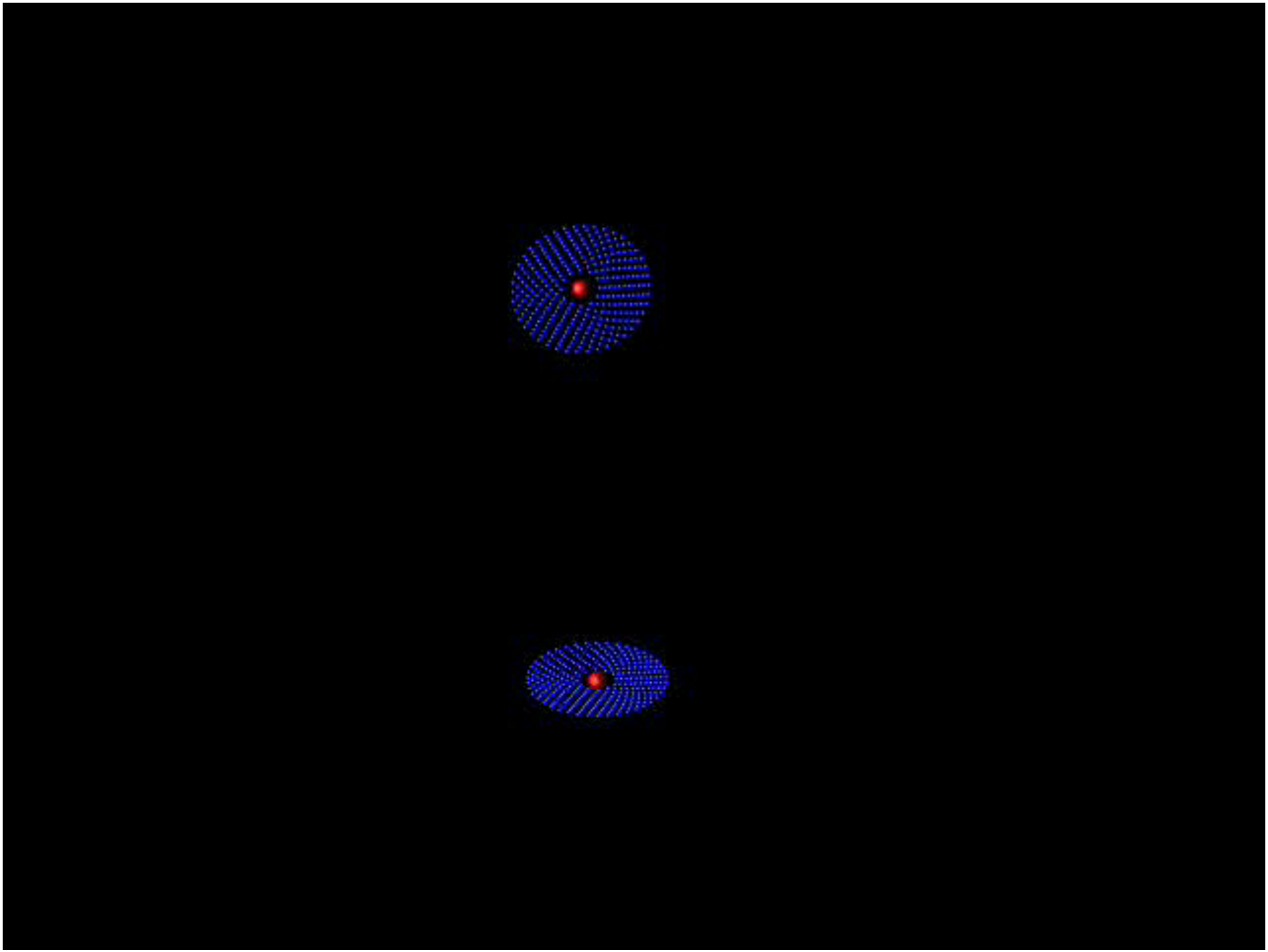
An Elliptic Encounter



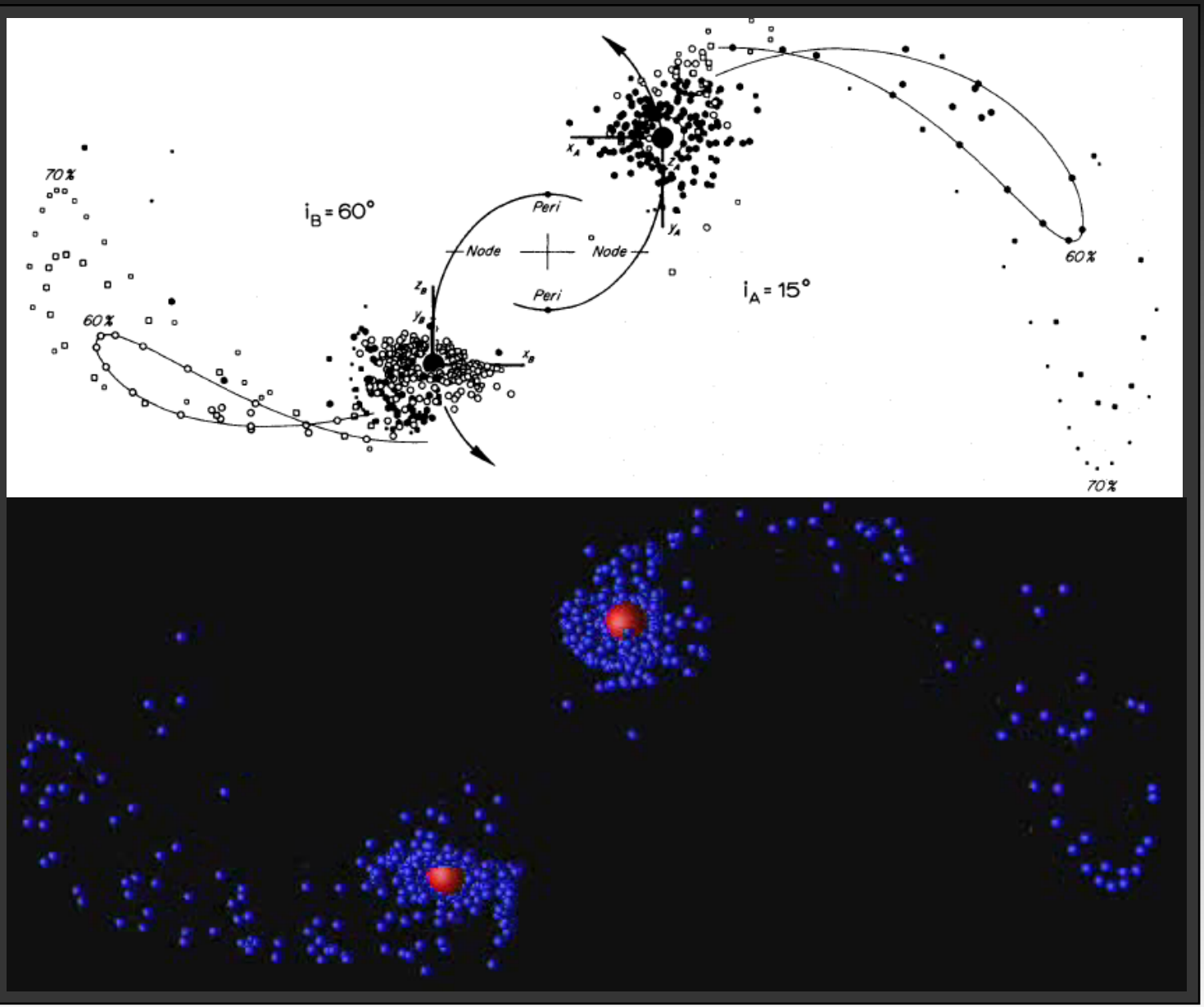
Equivalent 2-body Problem

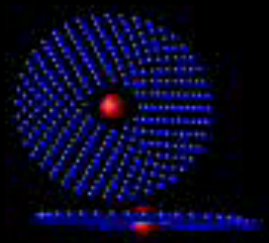
Since the masses of the two galaxies are equal:

- **R = r1 - r2**
- **v_R = vr1 - vr2**

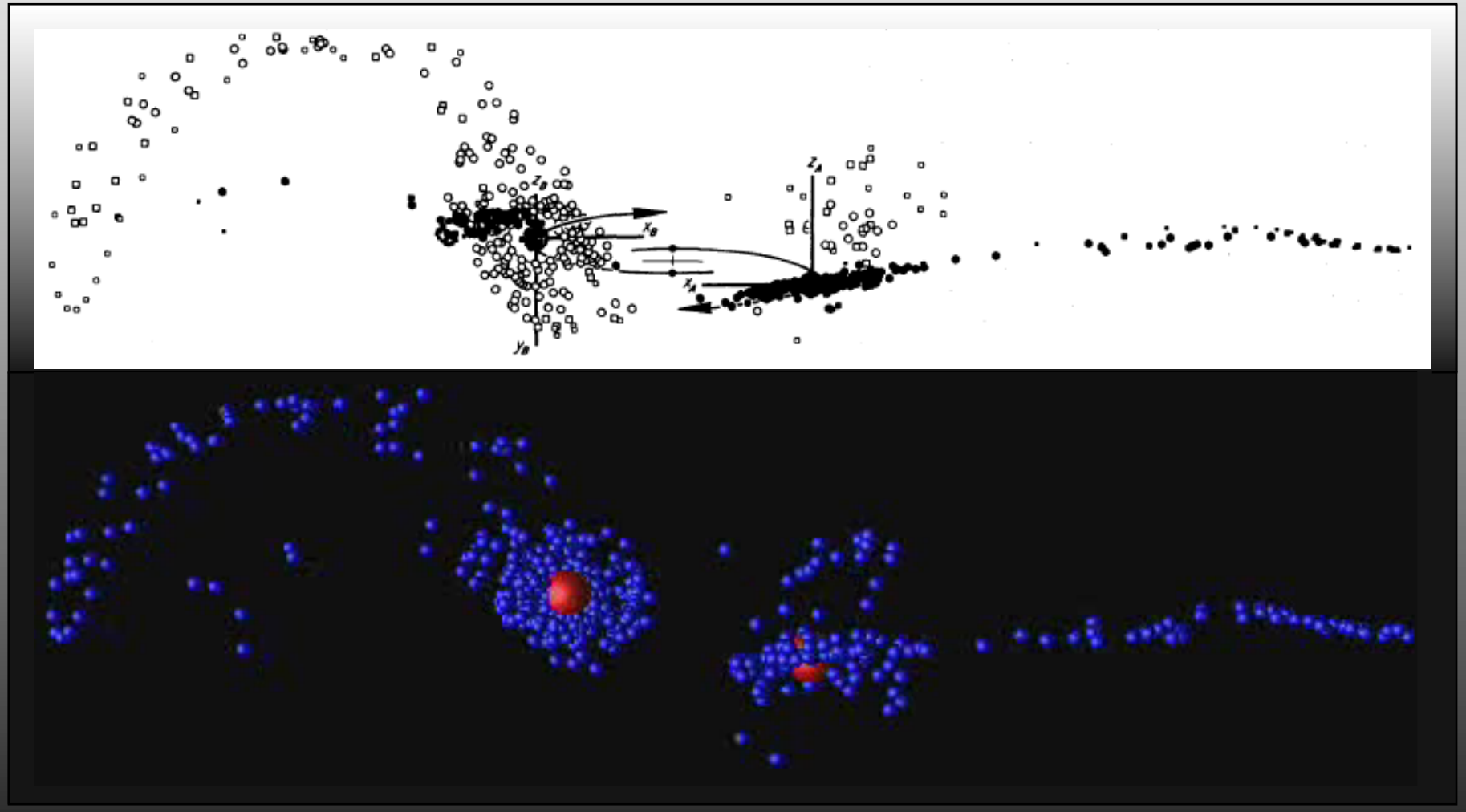


Top-View Comparison to Toomre & Toomre





Side-View Comparison to Toomre & Toomre



Explanation of Tidal Tails

- When the galaxies approach the pericenter of their encounter the massive centers are whipped around the C.M. more quickly than the stars on the outside of the collision path.