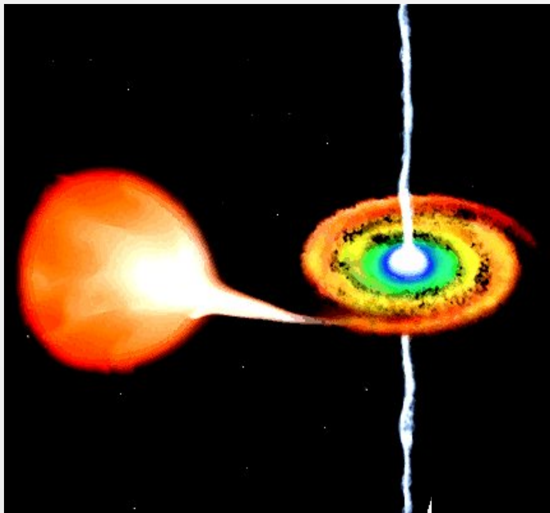
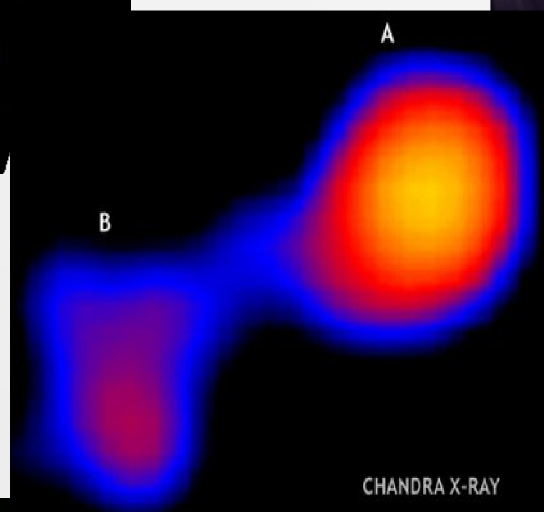
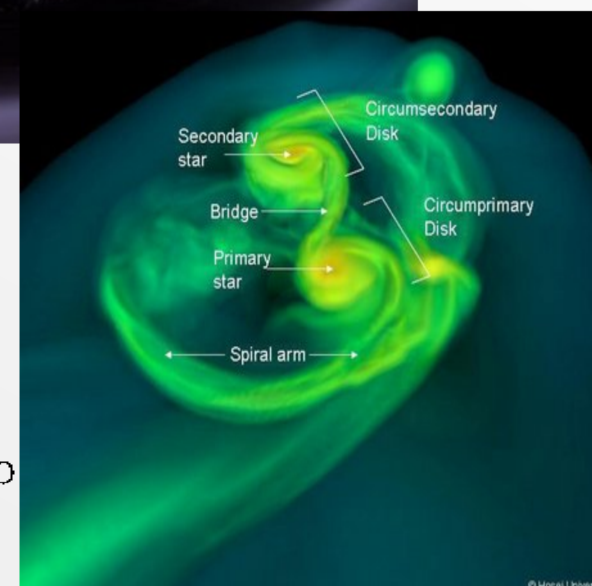
Binary Stars – Lecture 5







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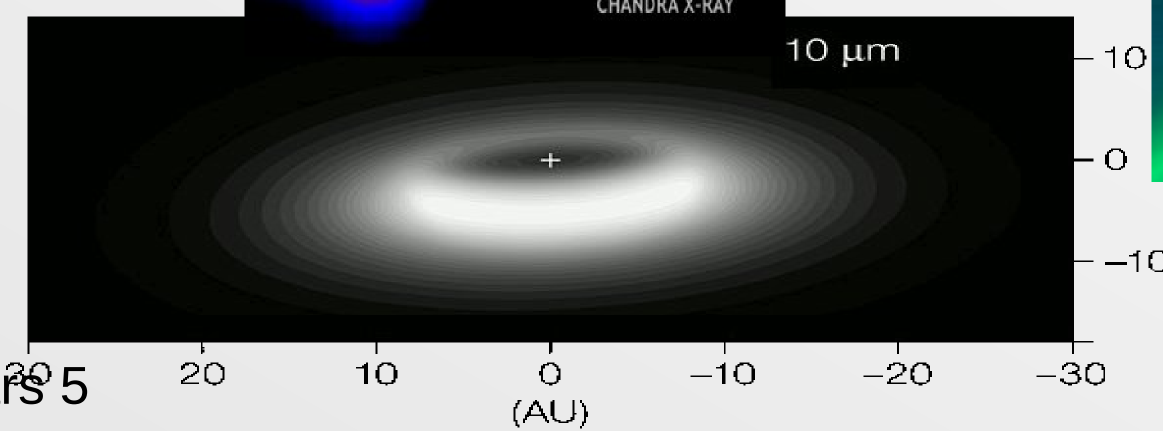
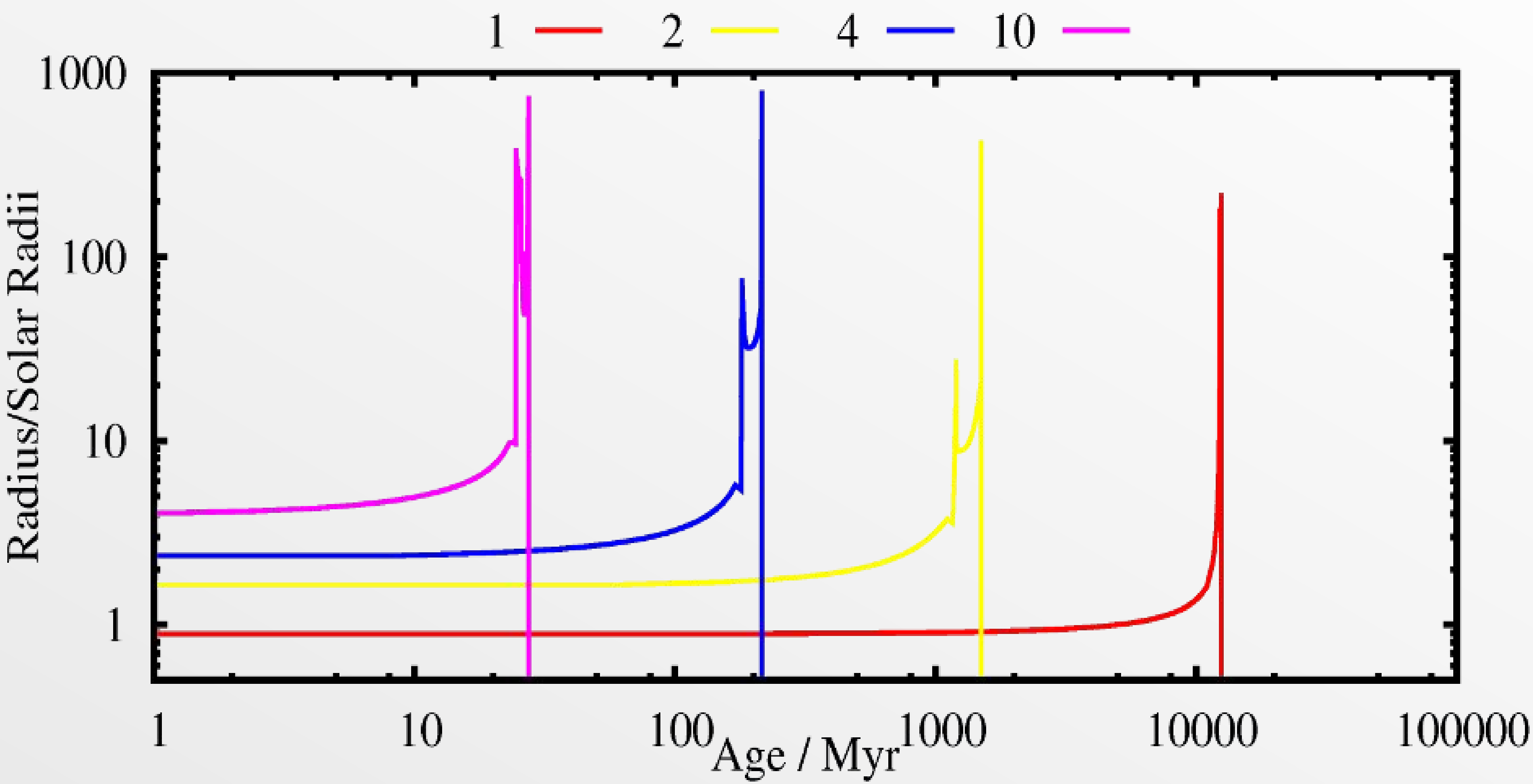


Stellar Evolution



Kepler's Laws

- Bound Orbits are ellipses
- Equal areas swept in equal times

$$P^2 \propto a^3$$

$$\dot{\mathbf{J}} = \mathbf{0} \quad \dot{E} = 0$$

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Tides Overview

- Tides synchronise, then circularise
- Rate $\sim (R/a)^{6,8}$
- Close binaries should be sync. and circular
- Assuming $\Omega = \omega \;\; \text{and} \;\; e = 0$

  we continue our analysis by moving to close, circular binaries and interaction by exchange of *angular momentum and mass*
- Some assumptions $\longrightarrow$ problem is tractable

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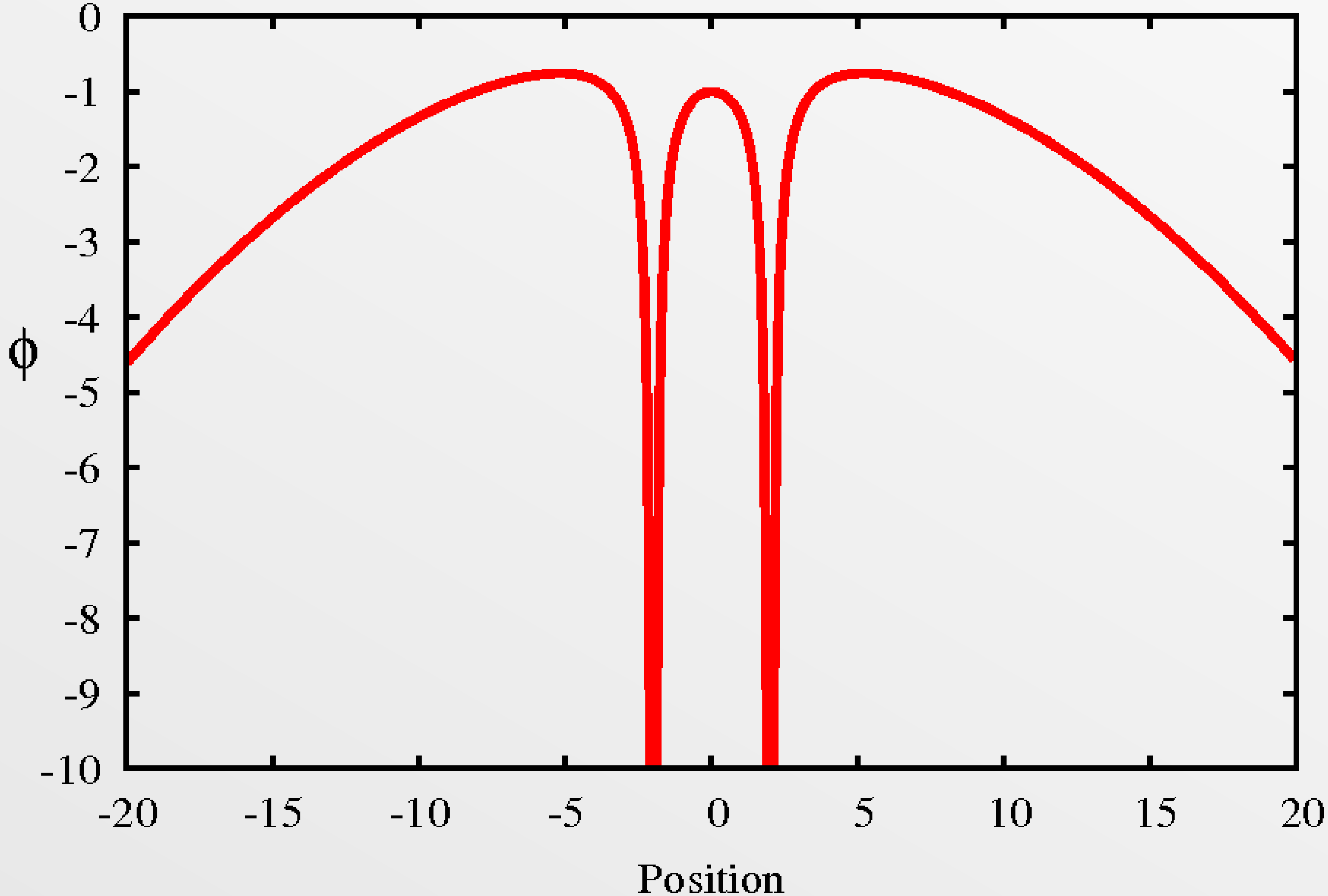
Potential

$$\phi = -\frac{GM_1}{r_1} - \frac{GM_2}{r_2} - \frac{1}{2}\omega^2 s^2$$

- Potential due to two point masses in *corotating frame*



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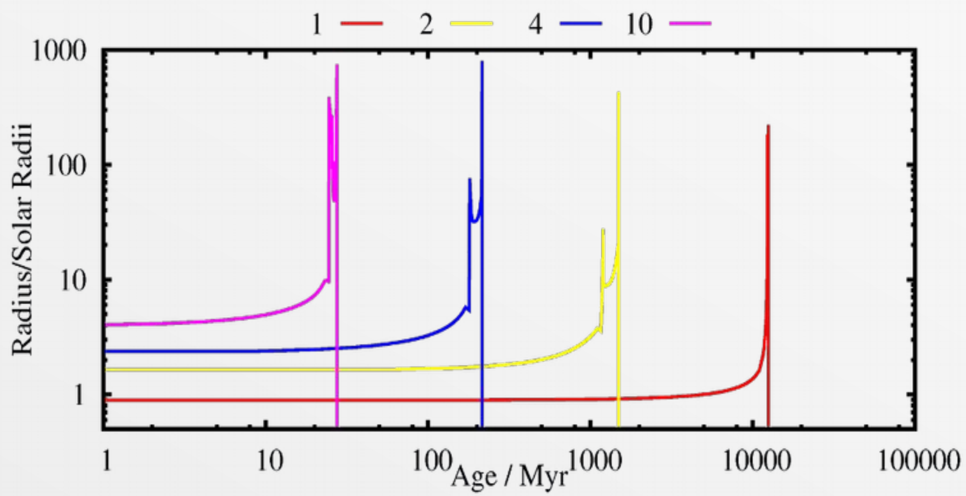
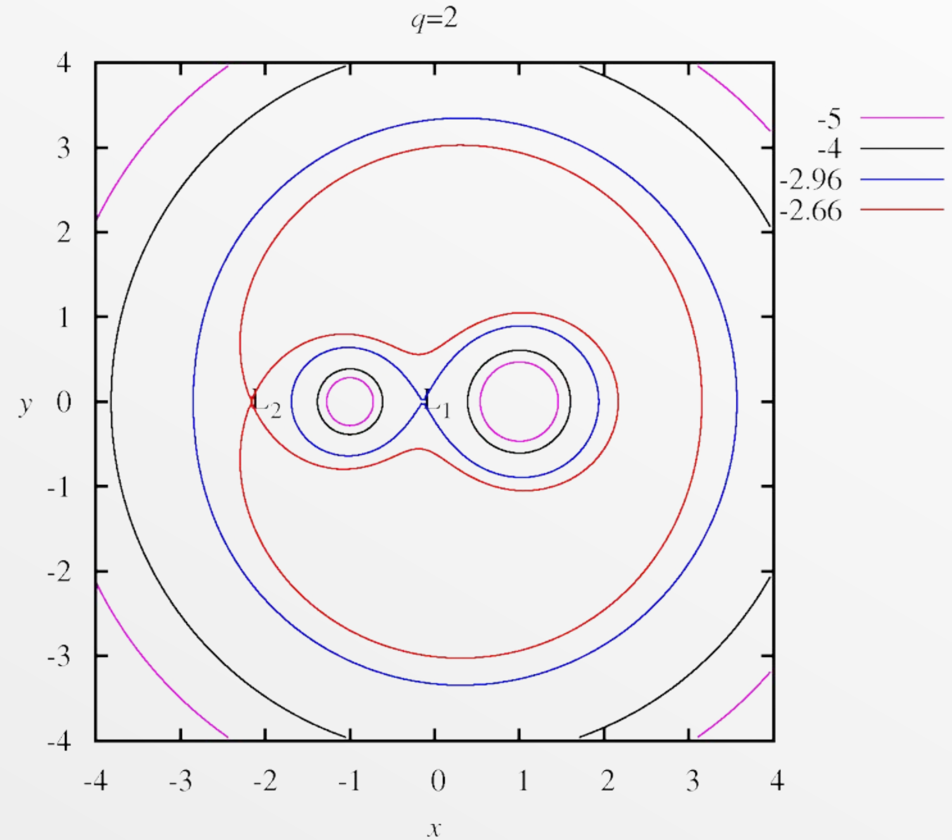
Binary Stellar Evolution





Radius increases with time

Star will eventually expand beyond R_L

… Then what?

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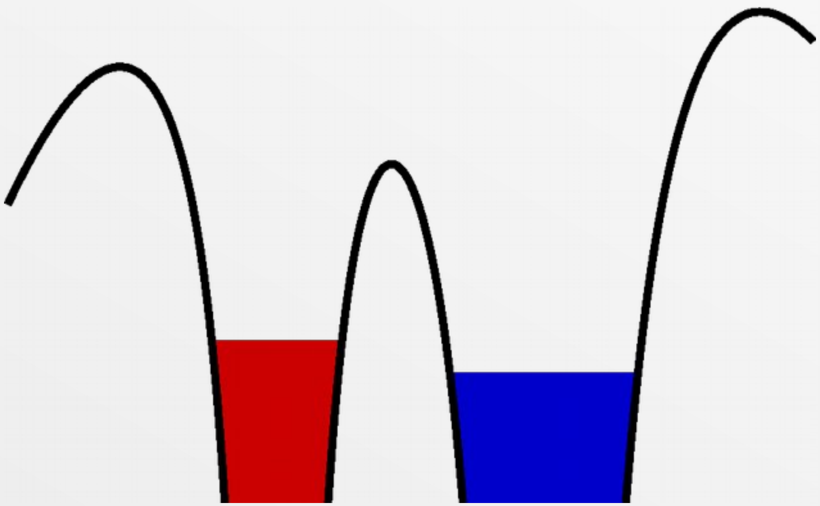
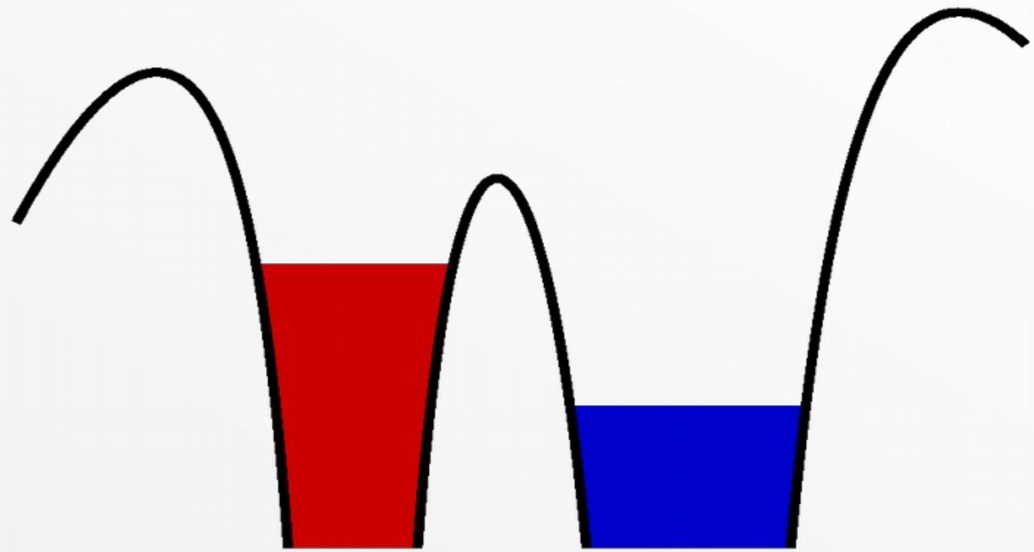
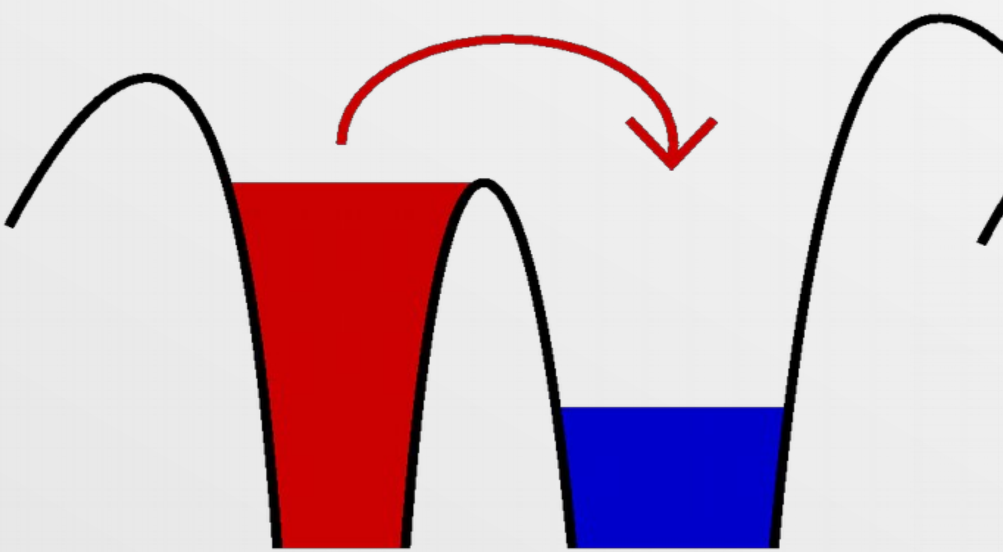
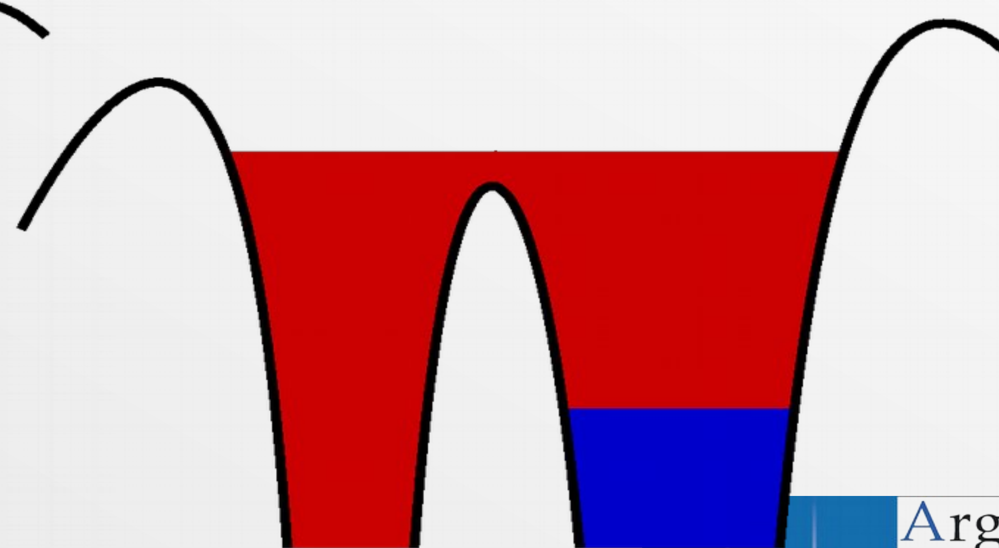
Roche configurations



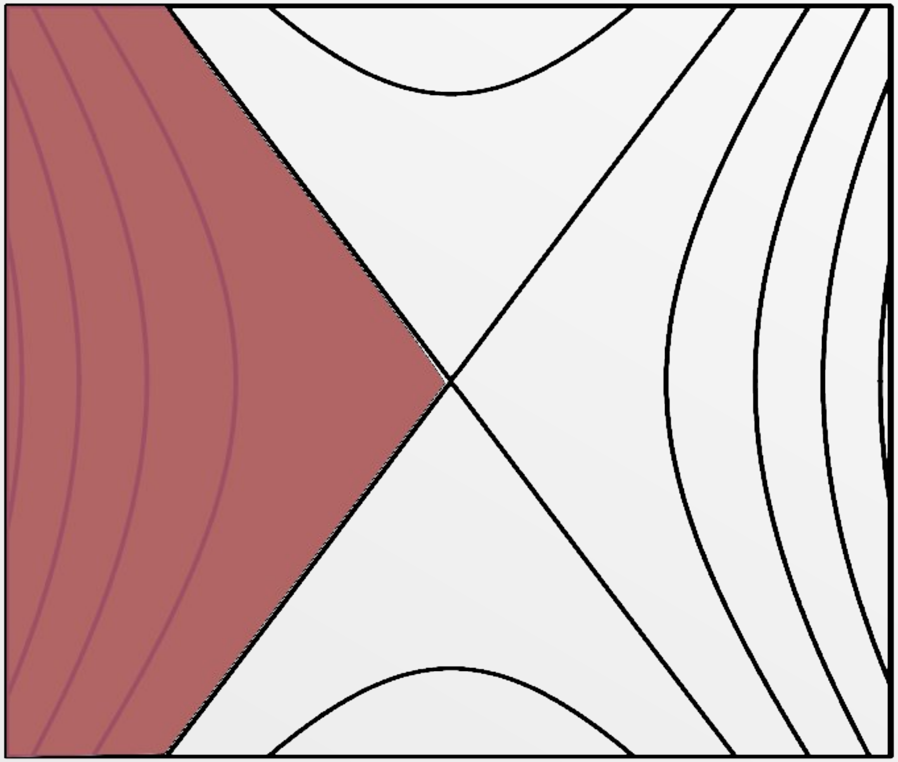


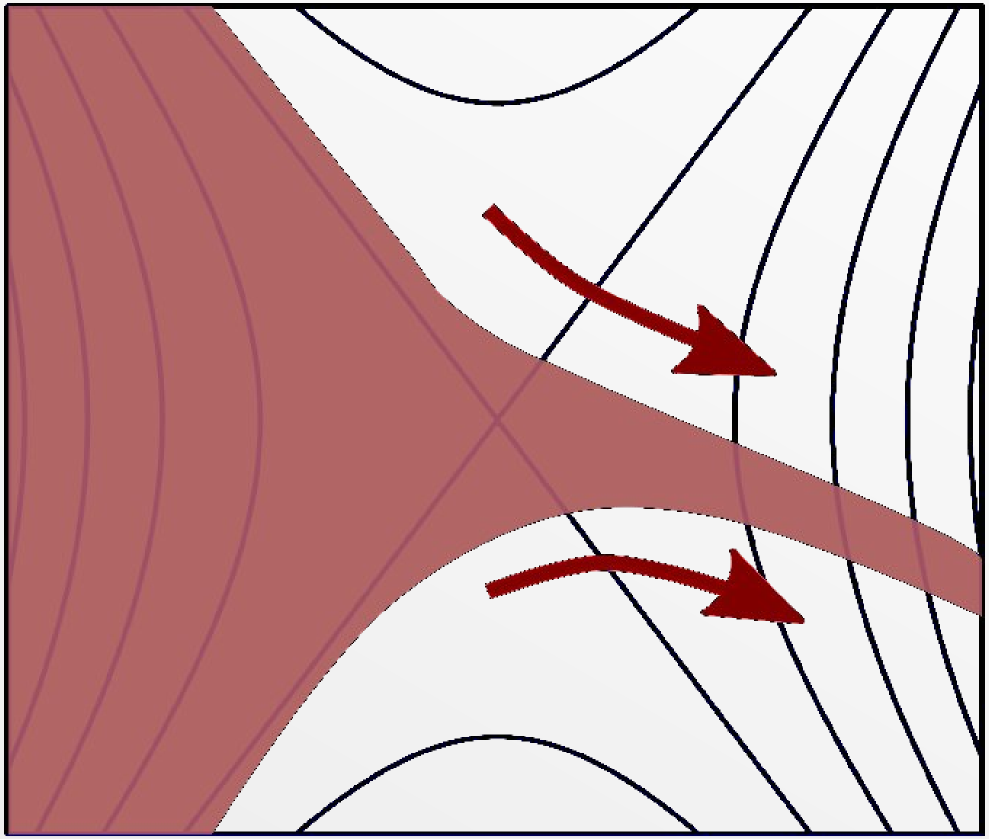
Roche Lobe Overflow





Roche Overflow





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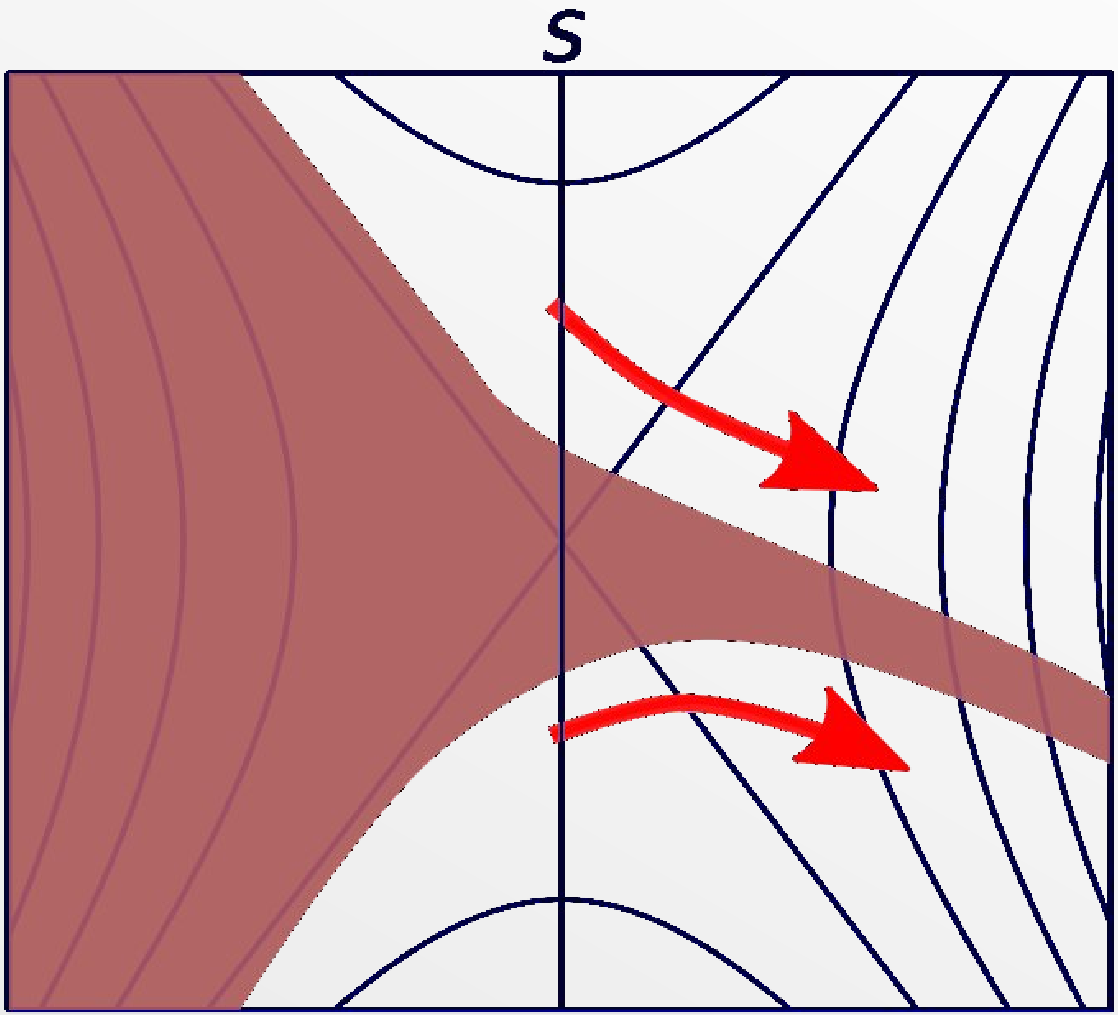
Roche Overflow



RLOF rates

- Always have $\dot{M}_1$ a strong function of ΔR

$$\Delta R = R - R_L$$

- Hence unless dynamical timescale expansion

  RLOF is self-regulating with small
- Supersonic (ballistic) flow through L_1
- Streamlines intersect: disc, eventually material hits secondary or direct impact

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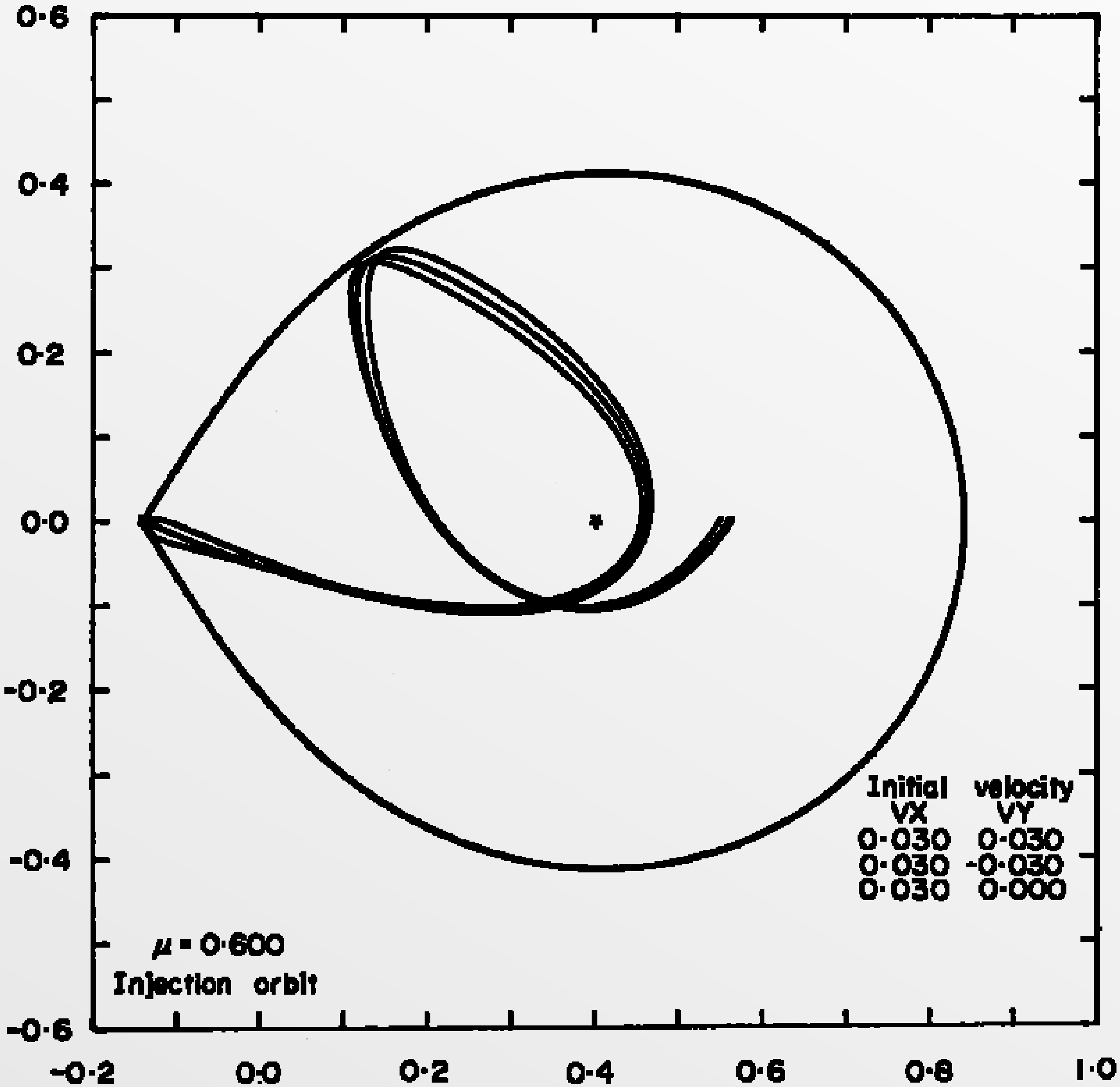
Ballistic Streamlines

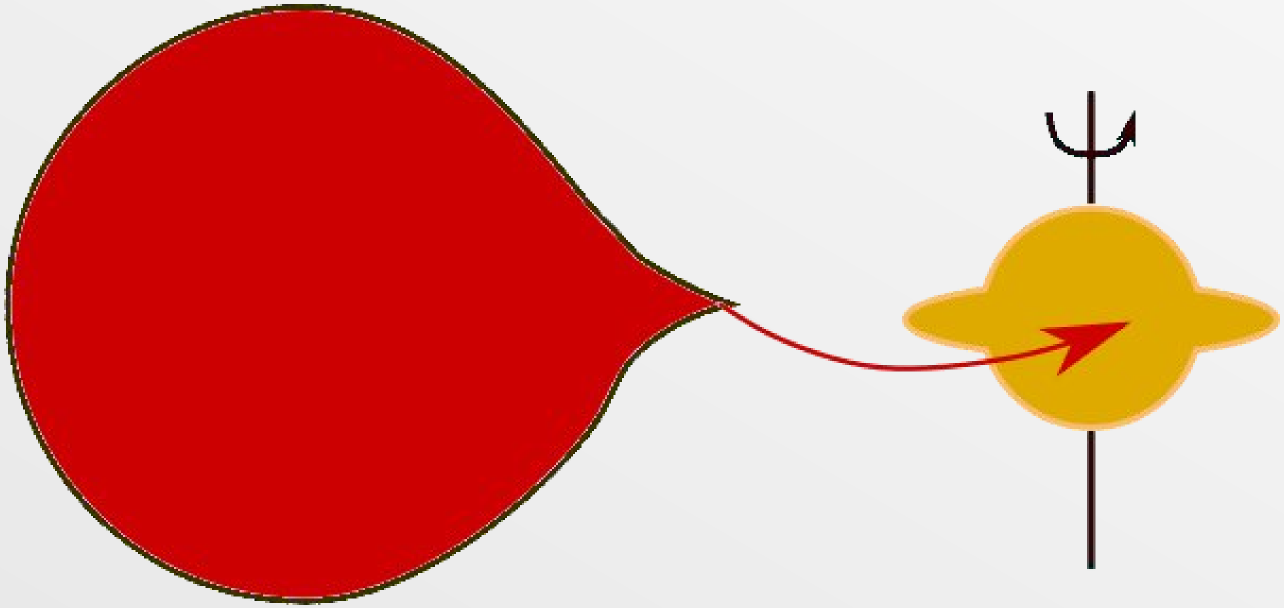


Flannery 1975
MNRAS 170,325

Spin up and break up

- Accrete from

  Keplerian disc
- If >10% of mass is accreted: break up!
- Limits accretion
- Unless angular mom. can be removed …
- Tides? Outflow?



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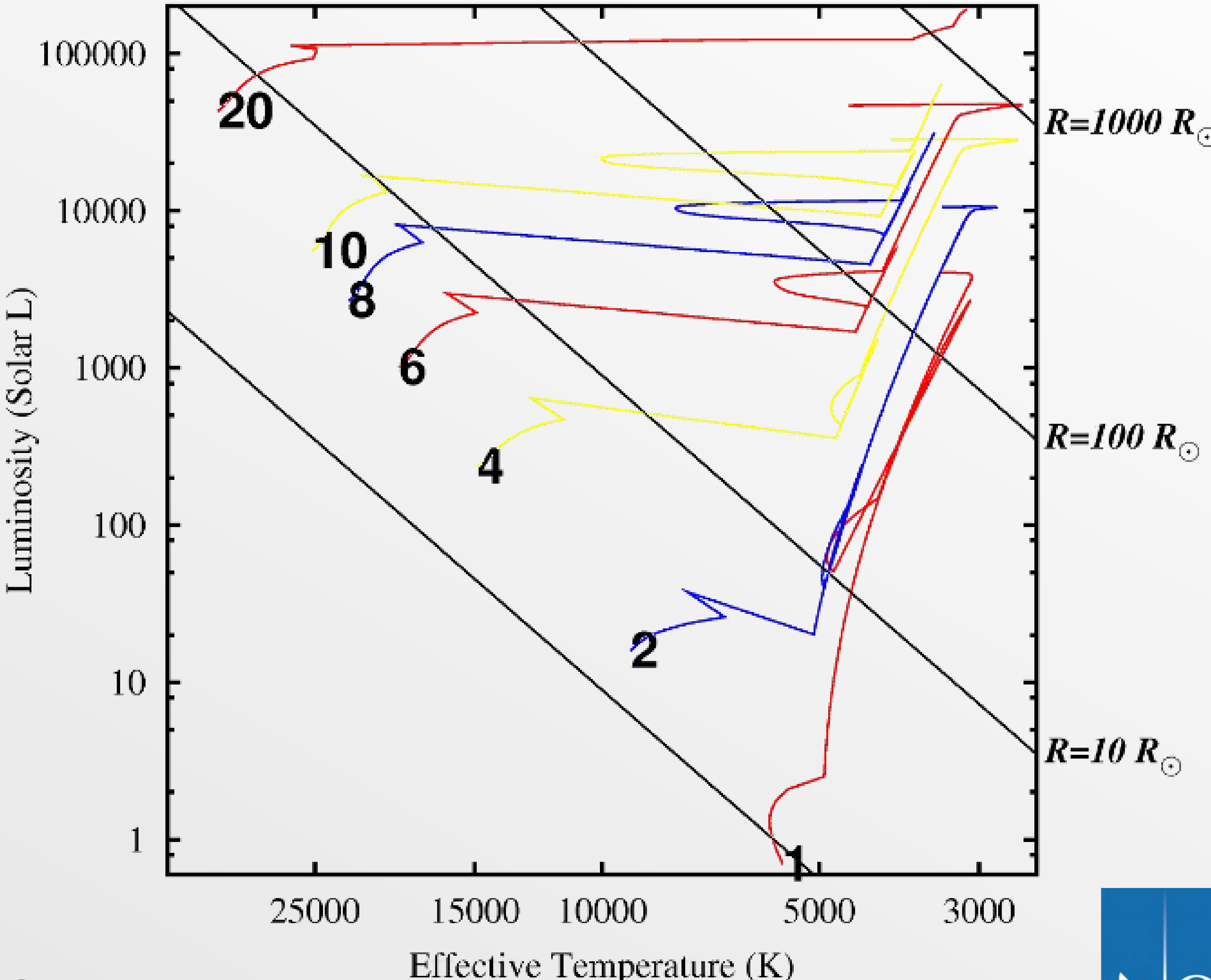
Stellar Evolution



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