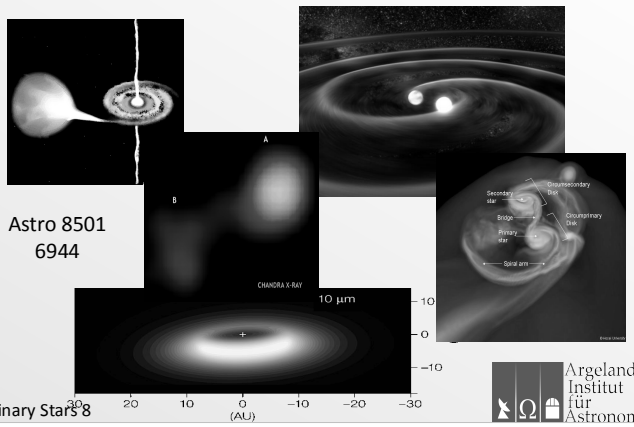
Binary Stars – Lecture 8



Astro 8501
6944

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Stability of Mass Transfer

- Zeta derivative notation
- Radiative vs convective stars
- Case A : mass transfer from a main sequence star
- Case B/C : … from a giant
- When things run away:

  Common Envelope Evolution

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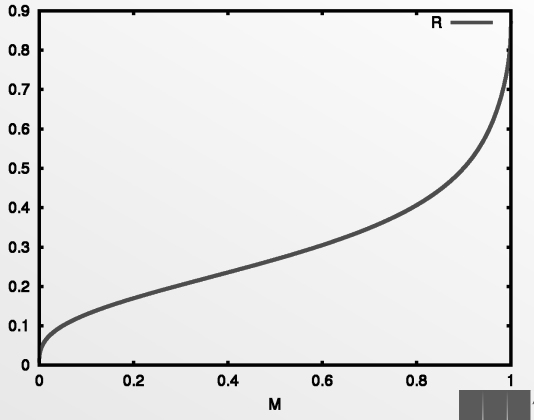
1Msun star on the ZAMS



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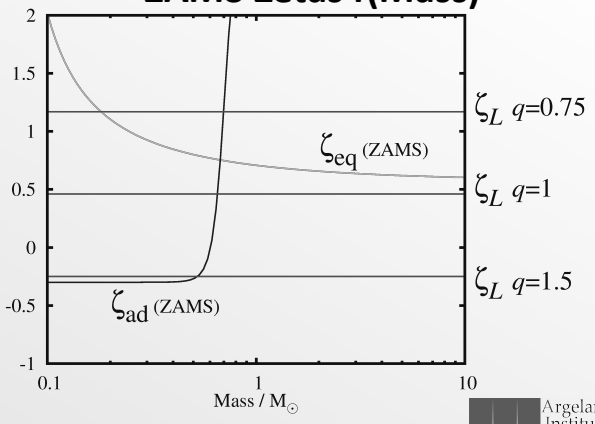
ZAMS Zetas f(Mass)



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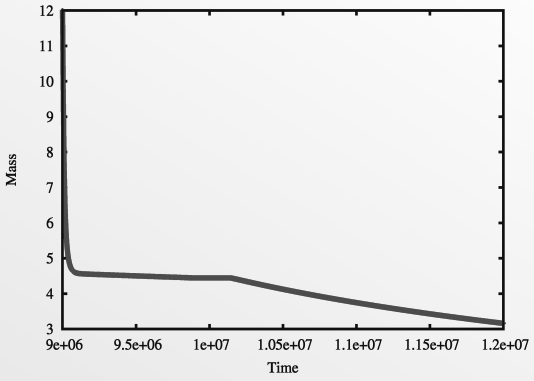
Case A mass transfer



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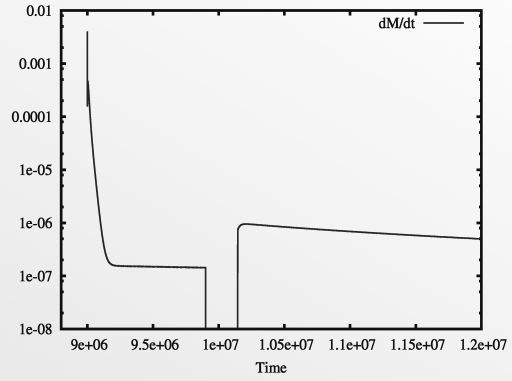
Case A mass transfer



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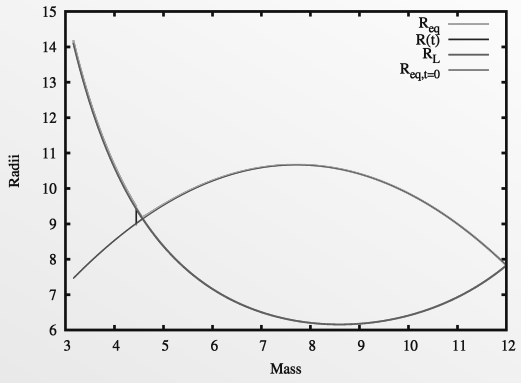
Case A mass transfer



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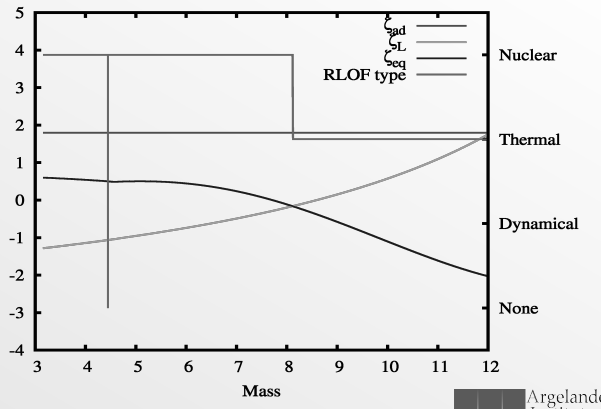
Case A mass transfer



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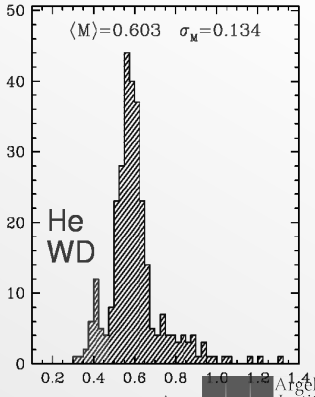
Short-Period Binaries

- 1970s: short-period binaries discovered
- Separation < giant radius
- Impossible?
- Energy+Angular momentum loss : shrinkage
- HeWDs (right)



Liebert, Bergeron, Holberg (2005)

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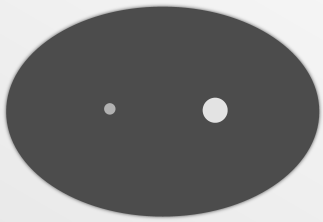
Instability???

- Unstable mass transfer $\tau_{\rm transfer} \sim \tau_{\rm dyn,1}$
- Tidal Instability? $\tau_{\rm acc} \sim \tau_{\rm thermal,2}$
- Companion engulfed
- Common Envelope Evolution



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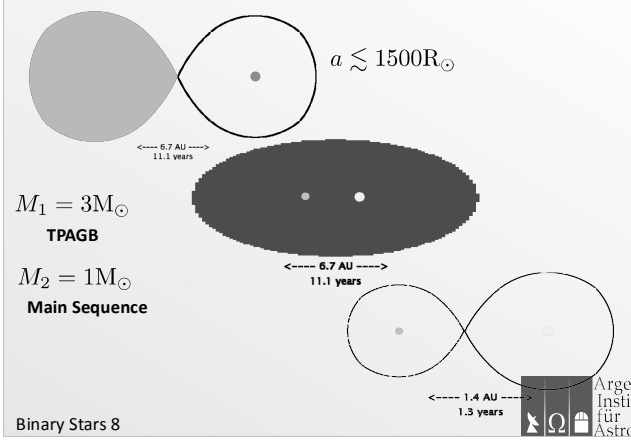
Close Binary Systems



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Common Envelope Evolution

- Drag $\dot{E} \sim \pi R_A^2 \rho v^3$
- Energy and Angular Momentum transfer
- Envelope lost?
- Cores merge?
- Energy?
- Angular momentum?

$$R_A = \frac{2GM}{v^2 + c^2}$$

See e.g. Taam & Sanquist (2000)

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Comenv Prescriptions

α

Energy of orbit
Vs
Energy of Envelope

γ

Angular Momentum of orbit
Vs
Ang Mom. of Envelope

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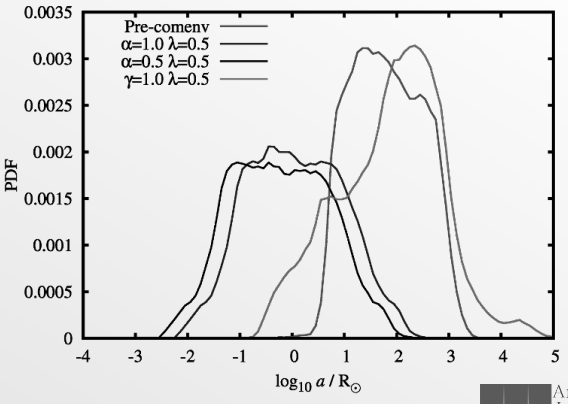
Comenv Simulations



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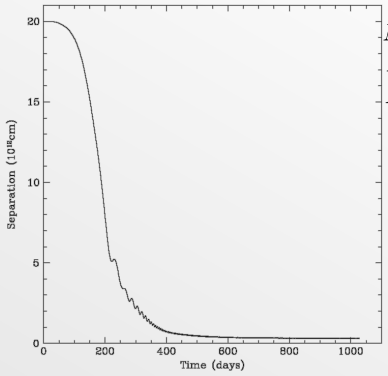
3D Simulations



$M_1 = 3\mathrm{M}_\odot$
$M_{c1} = 0.7\mathrm{M}_\odot$
$M_2 = 0.4\mathrm{M}_\odot$
$P = 0.84\mathrm{years}$

Sandquist et al. 1998/Ricker and Taam 2010

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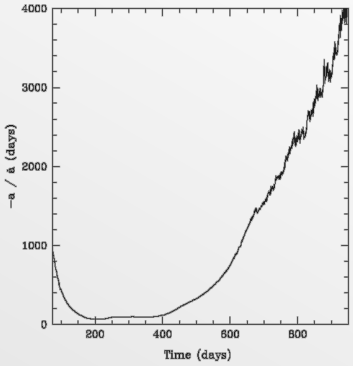
3D Simulations



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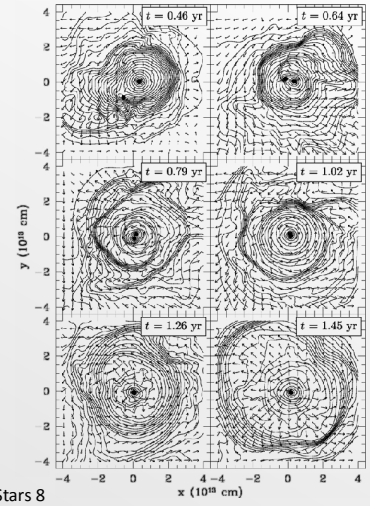

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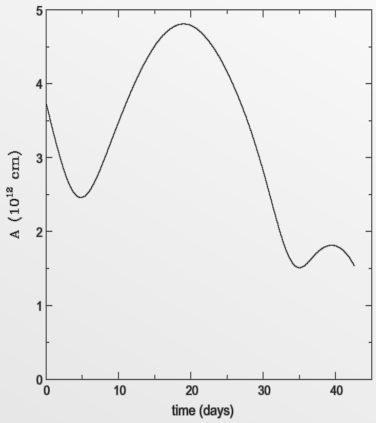

$M_1 = 1\mathrm{M}_\odot$
$M_2 = 0.7\mathrm{M}_\odot$
$P = 1\,\mathrm{month}$

Sandquist et al. 2000
Ricker and Taam 2010

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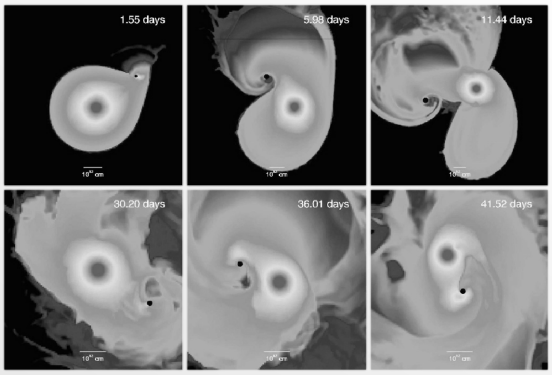
3D Simulations



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Sandquist et al. 2000
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