

Astro 8501 – 6944

Binary Stars

Thursdays 9am
AlfA 0.008

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http://www.astro.uni-bonn.de/~izzard/binary_stars.html

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Kepler's Laws

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

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

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

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Elliptical Motion

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Stellar Evolution

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Tidal System

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Tides Overview

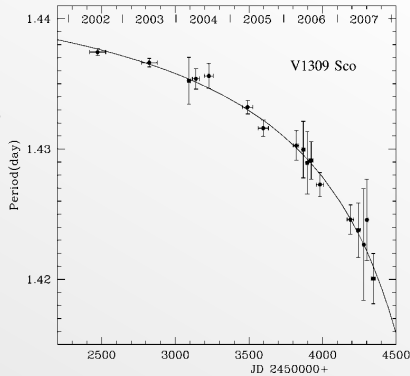
- Tides synchronise, then circularise
- Rate $\sim (R/a)^{6,8}$
- Close binaries should be sync. and circular
- Assuming $\Omega = \omega$ and $e = 0$
we continue our analysis by moving to close, circular binaries and interaction by exchange of *angular momentum and mass*
- Some assumptions ~~problem~~ is tractable

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Darwin Instability Seen!

- V1309 Sco
- Tylenda et al.
2011 A&A 528,114



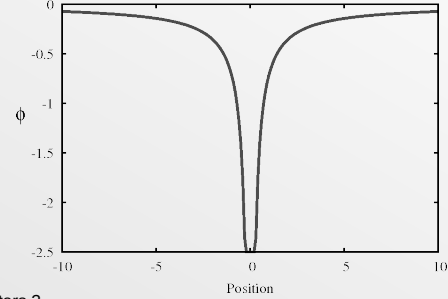
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Potential

$$\phi = -\frac{GM}{r}$$

- Potential due to a point mass (star~point!)



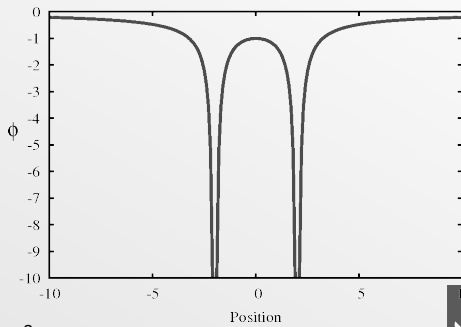
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Potential

$$\phi = -\frac{GM_1}{r_1} - \frac{GM_2}{r_2}$$

- Potential due to two point masses



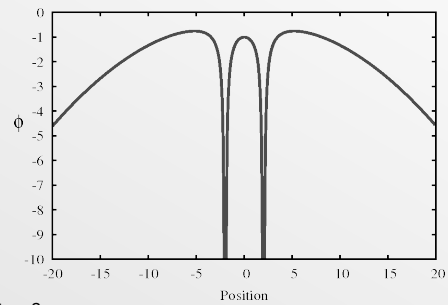
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Potential

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

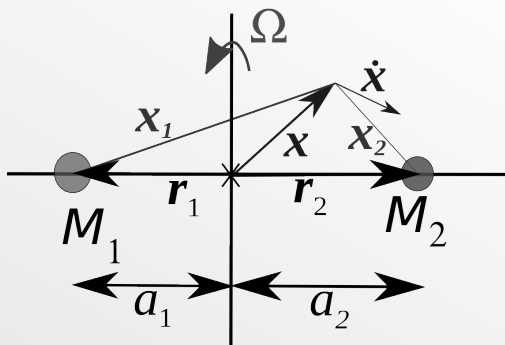
- Potential due to two point masses in *corotating frame*



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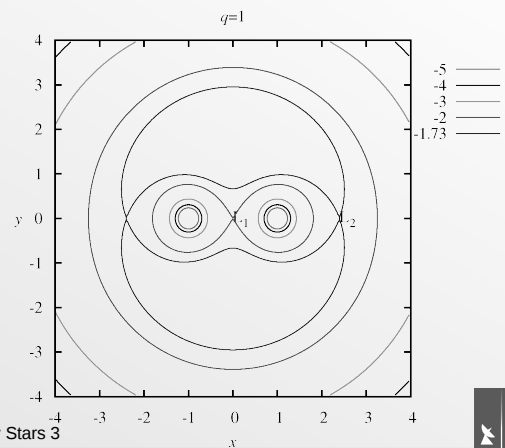
Roche potential



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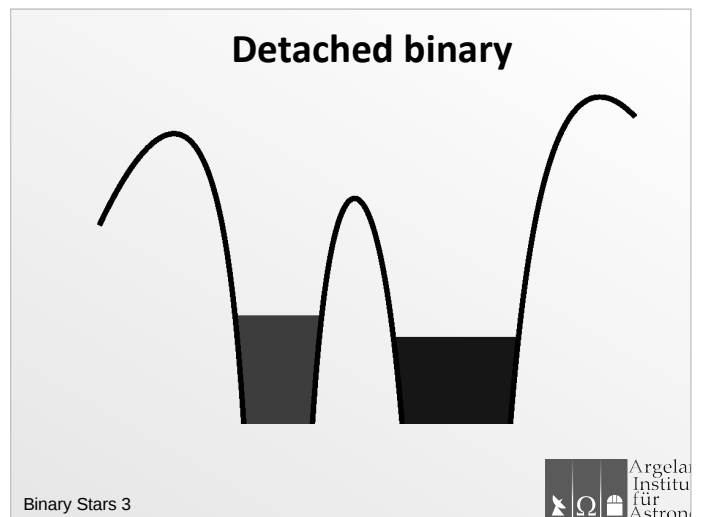
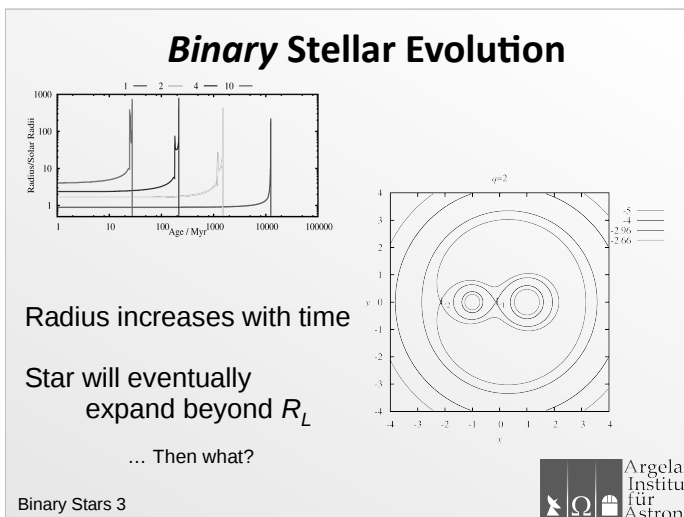
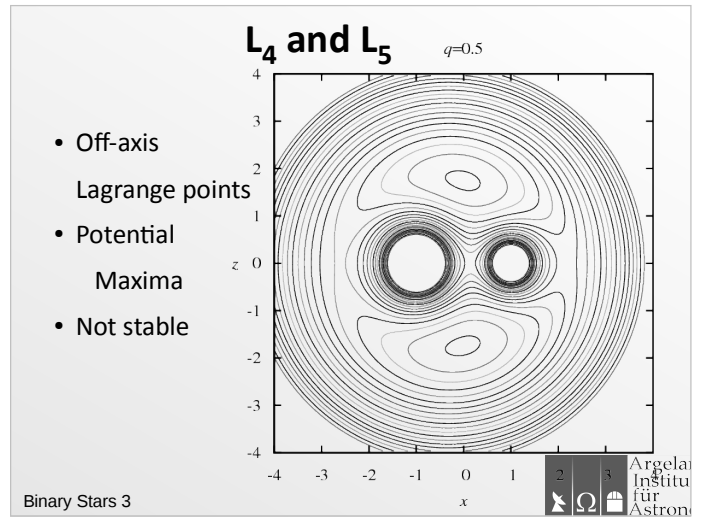
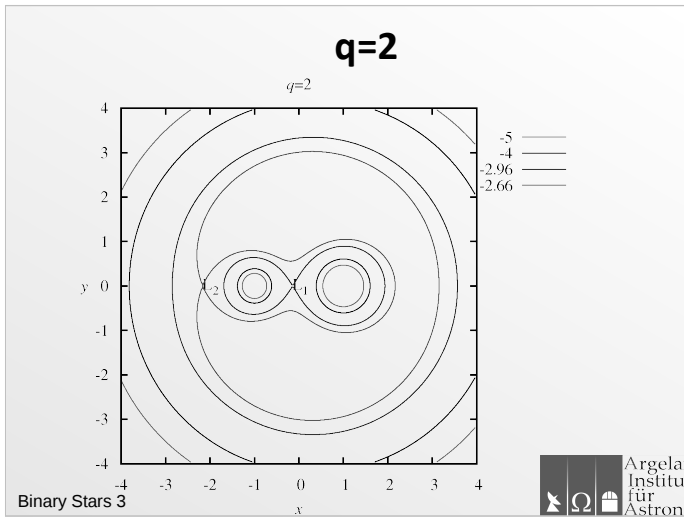
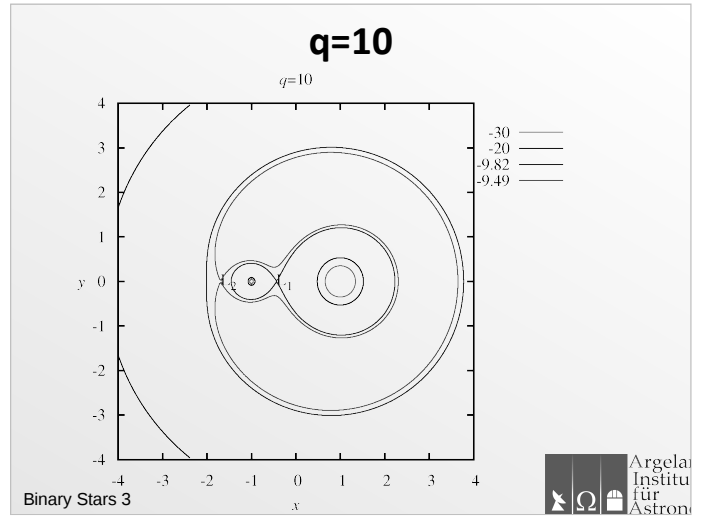
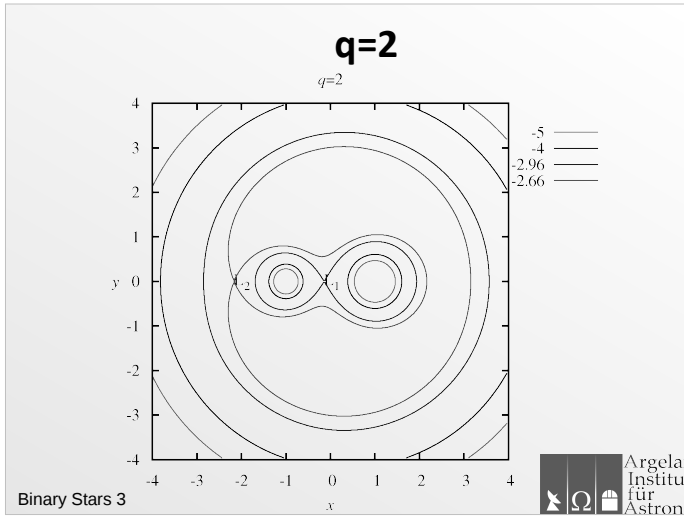


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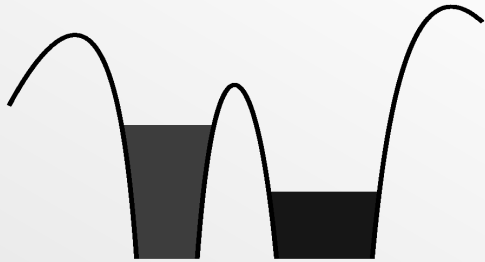


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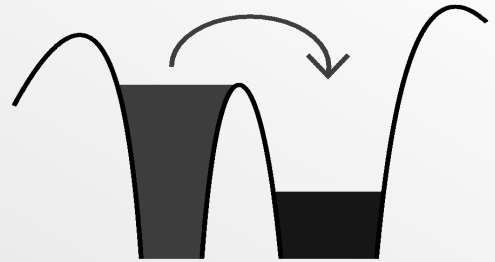
Evolved Detached binary



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Semi-detached Binary

Roche Lobe Overflow



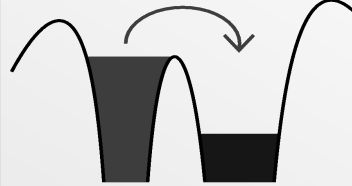
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Contact Binary



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Roche Lobe Overflow



- Primary expands

$$R > R_L$$

- Mass "overflow"
- Questions:
 - Conservative?
 - Non-Conservative?
 - Donor response
 - Accretor response
- Final Fate...?

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