White Dwarf Mergers

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Outline

- Inspiral
- Dynamical Stability
- Merger
- Unresolved Questions
- Outcomes

Inspiral

Gravitational Radiation

$$\tau_{inspiral} = \frac{1}{8}\tau_{GR} \equiv |J/\dot{J}|$$

$$\approx 98\ \mathrm{yr}\,(M_{chirp}/M_{Ch})^{-5/3}(P/\mathrm{min})^{8/3}$$

where

$$M_{chirp} \equiv \left(\frac{M_1^3 M_2^3}{M_1 + M_2}\right)^{1/5}$$

Orbital period at contact

$$P \approx 43\,\mathrm{sec}\,(M/M_{Ch})^{-1}\left[1-(M/M_{Ch})^{4/3}\right]^{3/4}$$

Preheating?

Rotation energy if synchronous:

$$E_{rot} \sim 0.01 GM^2 / R \sim 10^{48.5} \text{erg}$$

- High dissipation rate, concentrated in outer envelope
- Insufficient energy to lift bulk degeneracy of core.

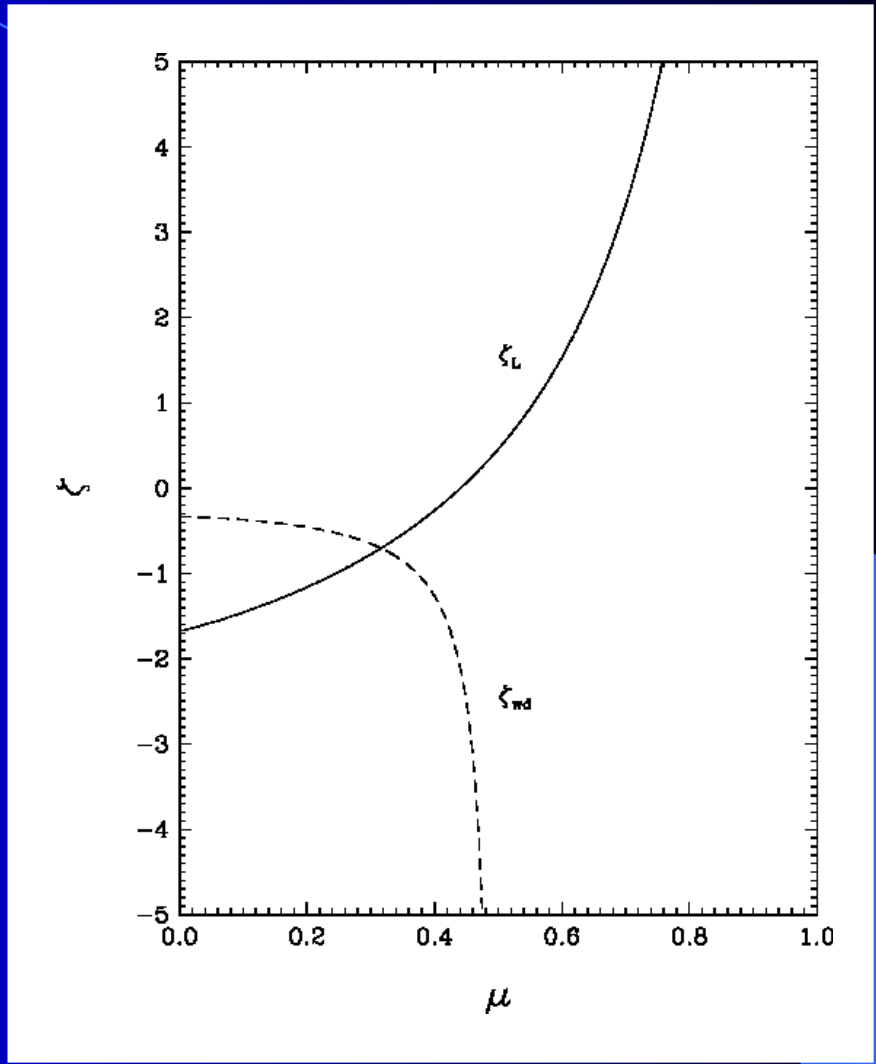
Stability

$\zeta_{wd} \geq \zeta_L$

=> dynamically stable

$\zeta_L > \zeta_{wd}$

=> dynamically unstable



Mass Transfer Rates

Fully degenerate donor star (1) (envelope μ_e', core μ_e):

$$\dot{M}_1 = -F(M_1/M_2)E(M_1/M_{Ch})\left(\frac{\mu_e'}{\mu_e}\right)^{5/2}\left(\frac{M_1}{P}\right)\left(\frac{\Delta R_1}{R_1}\right)^3$$

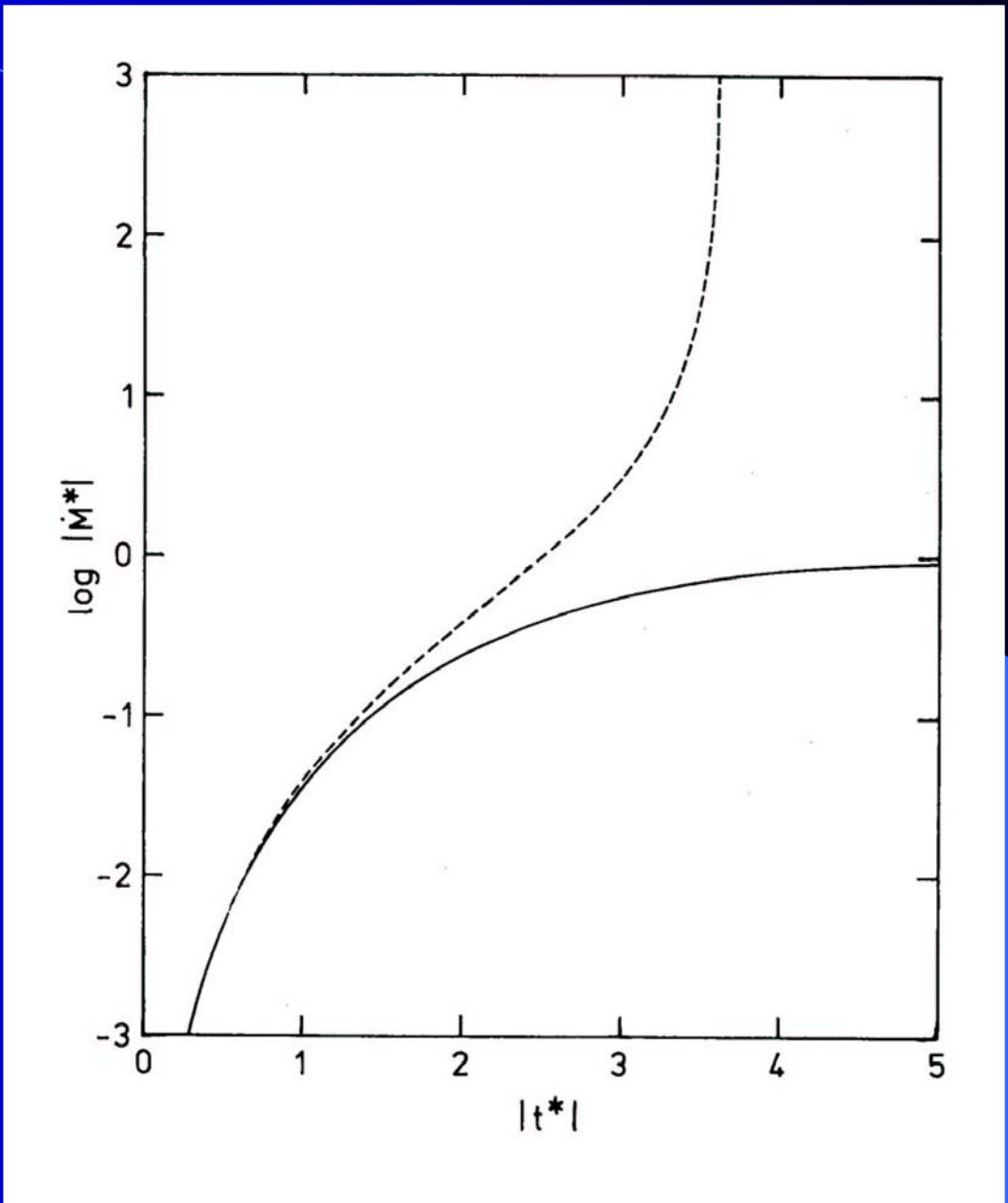
$$\approx 0.15\, M_{\odot}\,\mathrm{sec}^{-1}\left(\frac{\mu_e'}{\mu_e}\right)^{5/2}\left(\frac{M_1}{M_{Ch}}\right)^2\left(\frac{\Delta R_1}{R_1}\right)^3$$

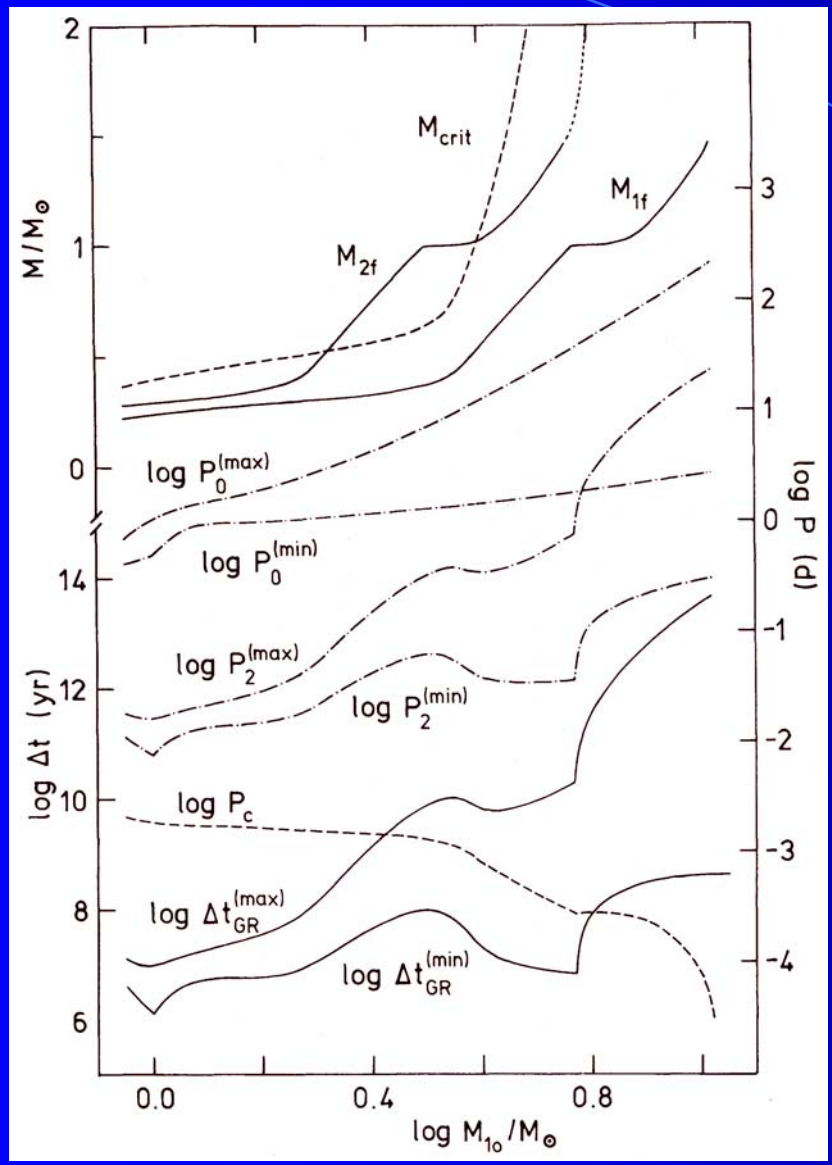
$\dot{M}^*$ in units of

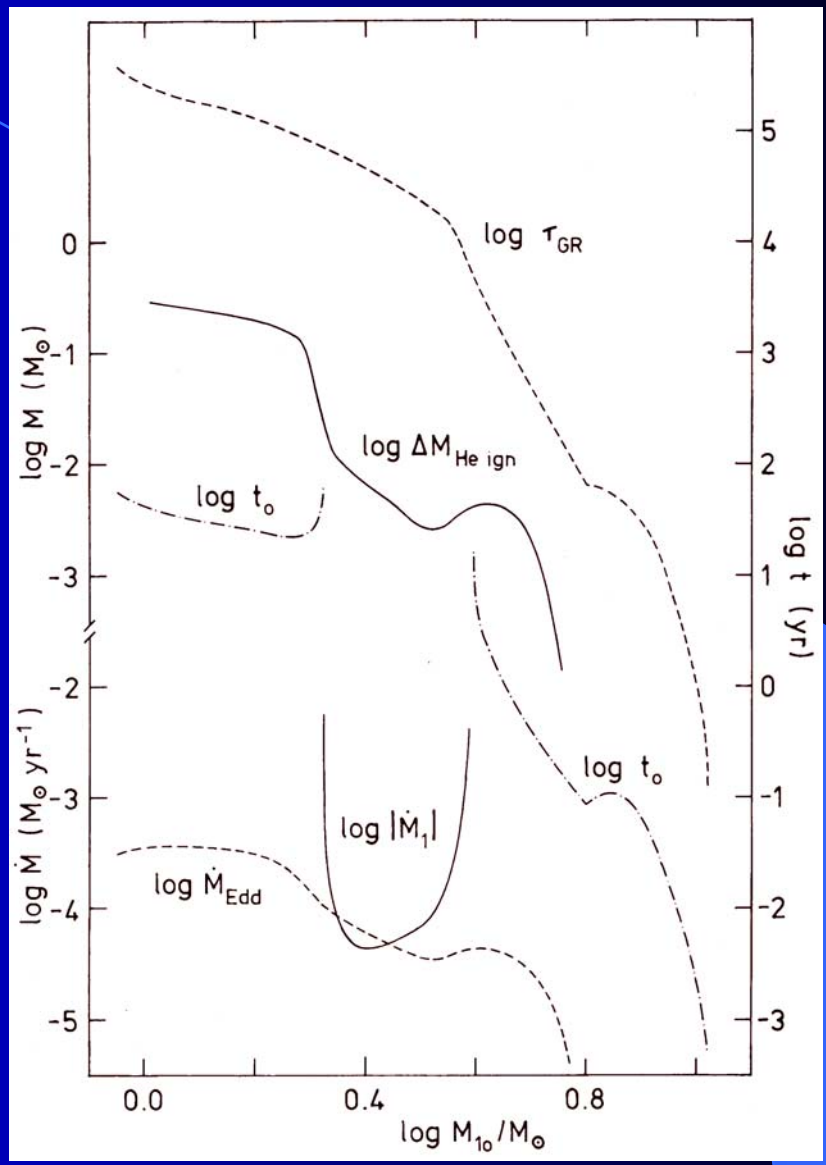
$$\frac{2}{\tau_{GR}} M_1 \left|\zeta_1 - \zeta_L\right|^{-1}$$

t^* in units of

$$\frac{1}{3}\left(\frac{\tau_{GR}^2 P}{4FE\left|\zeta_1 - \zeta_L\right|}\right)^{1/3}$$

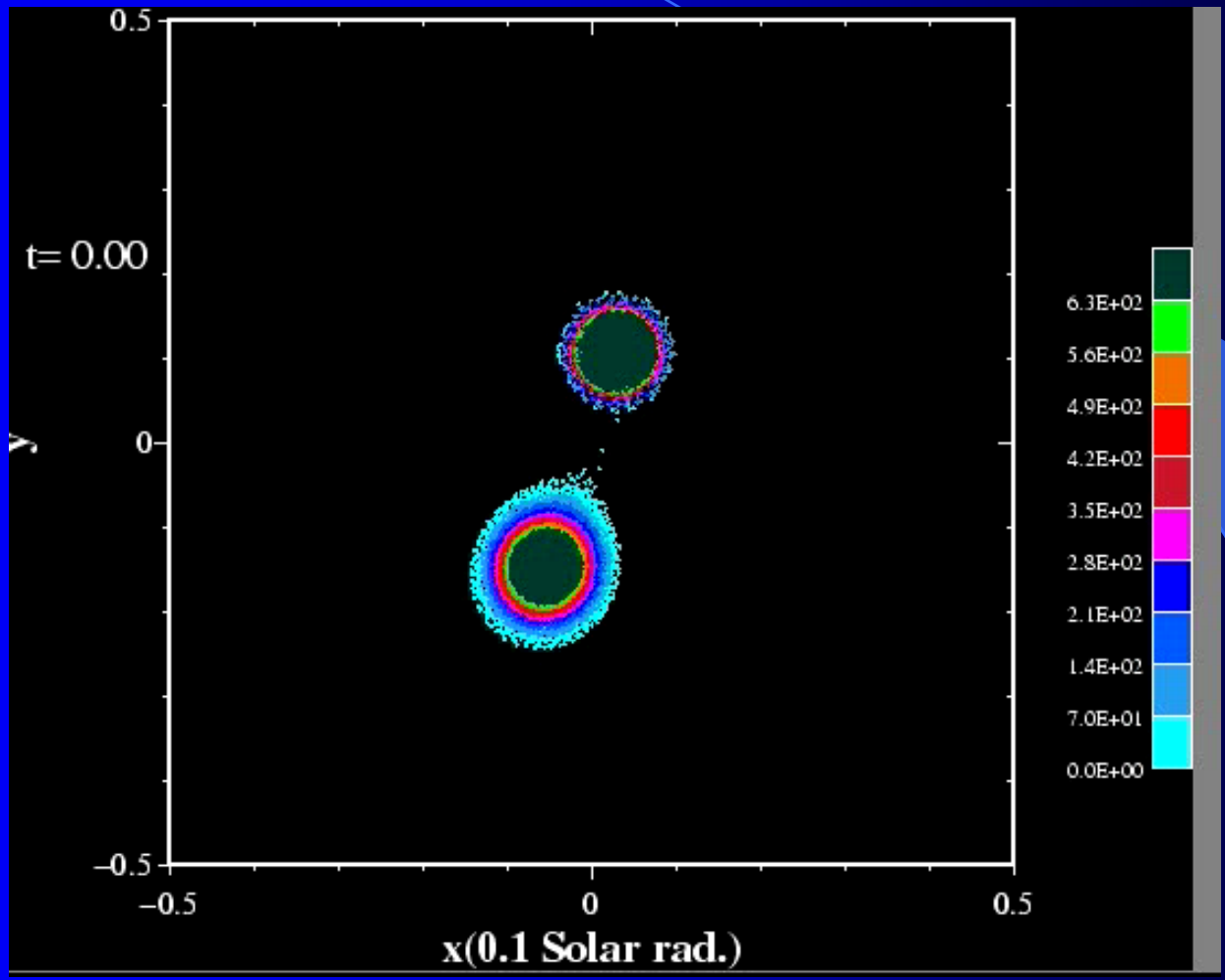






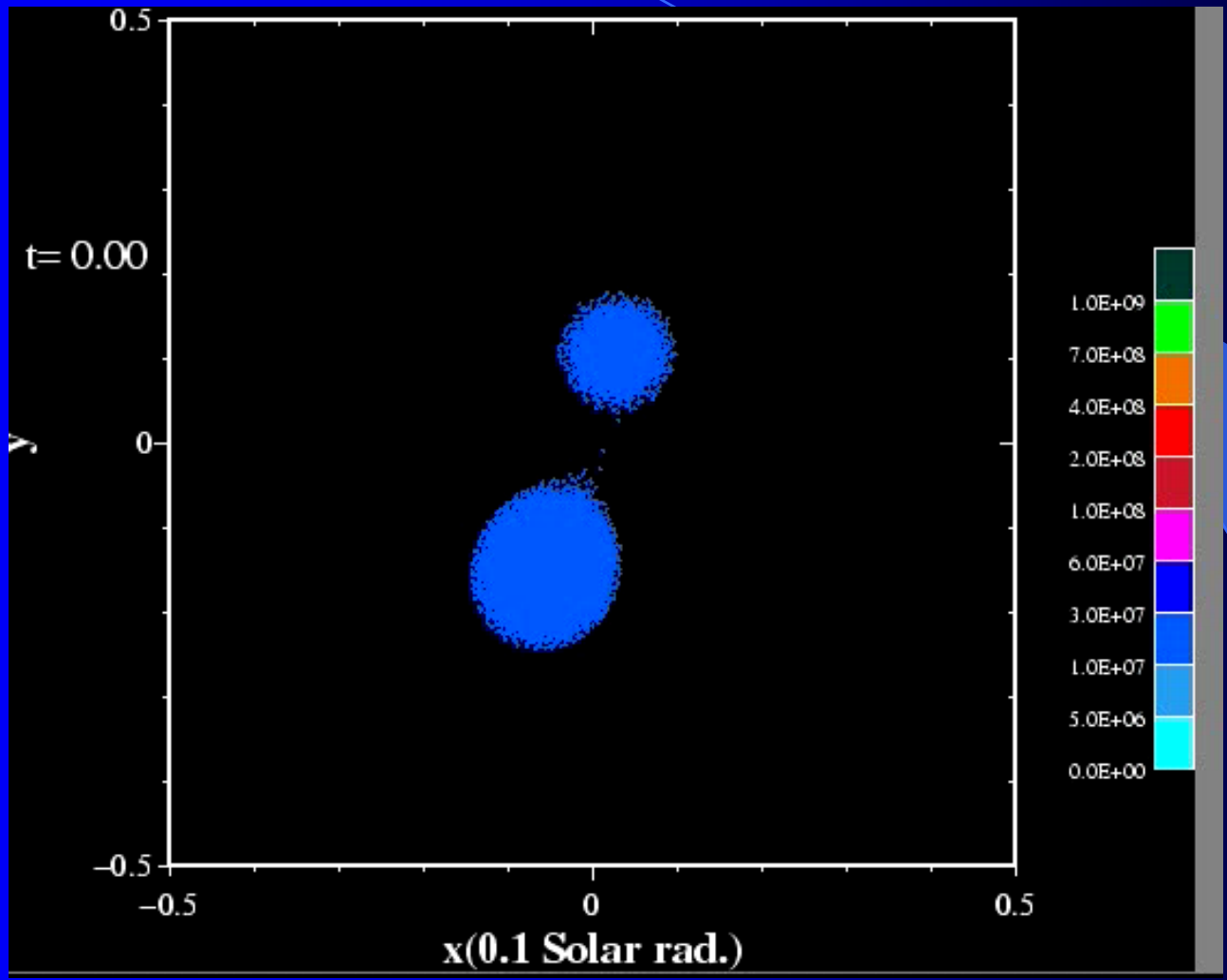
Webbink 1984

Merger!



0.8+1.0 M_O (Guerrero, Garcia-Berro & Isern (2004 A&A 413, 257)

Heating/Ignition



0.8+1.0 M_O (Guerrero, Garcia-Berro & Isern (2004 A&A 413, 257)

Unresolved Questions

- What fraction of the orbital angular momentum of the binary is lost in the dynamical merger? (Dynamical mass loss is minimal - 0.5-2%)
- Over what fraction of the donor is electron degeneracy lifted?
- What physical process removes angular momentum from the heavy disk remnant of the donor? (And on what time scale?)
- Can observable counterparts to heavy disk systems be identified?