Barium Stars Revisited

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and

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and

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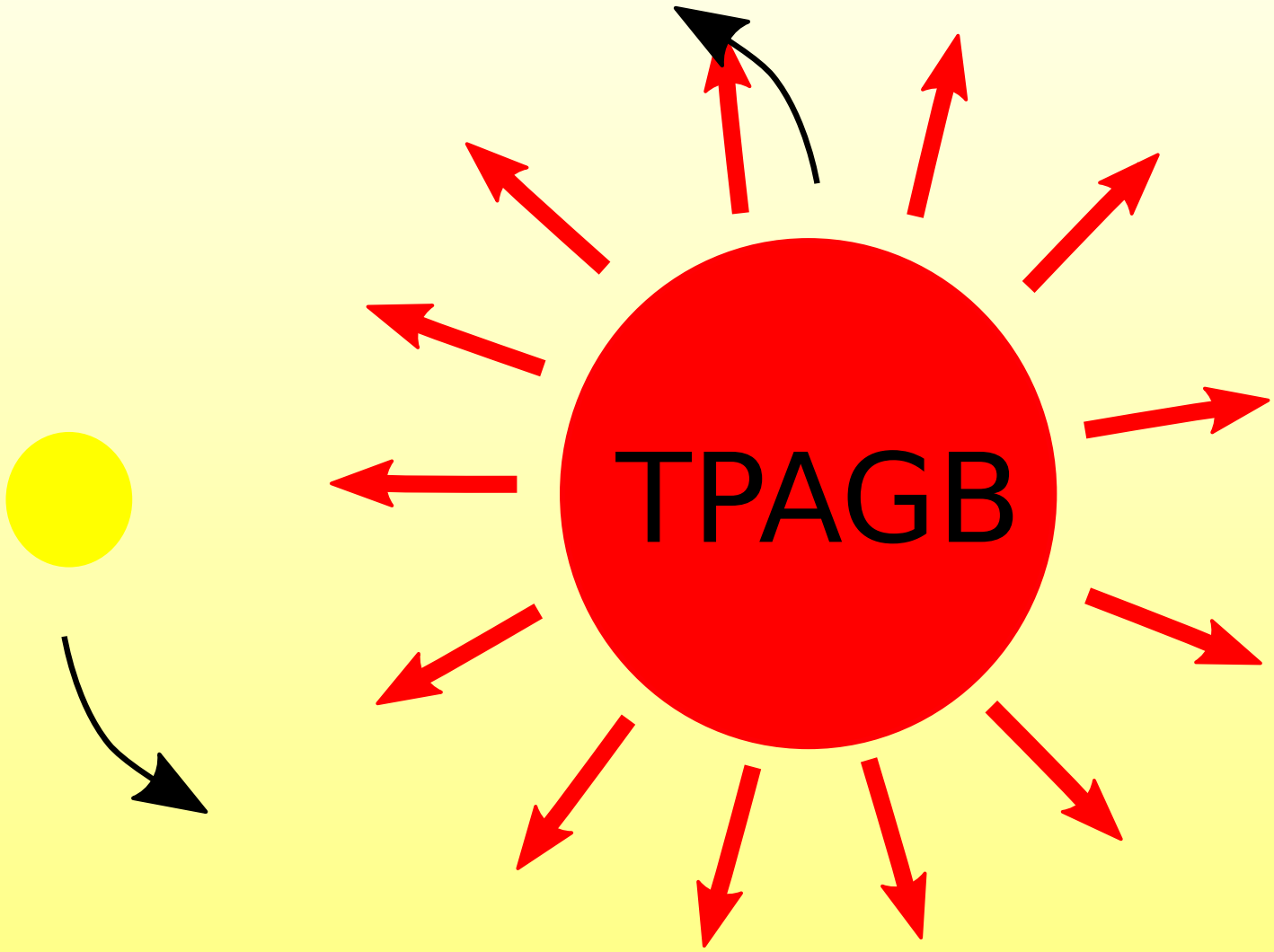
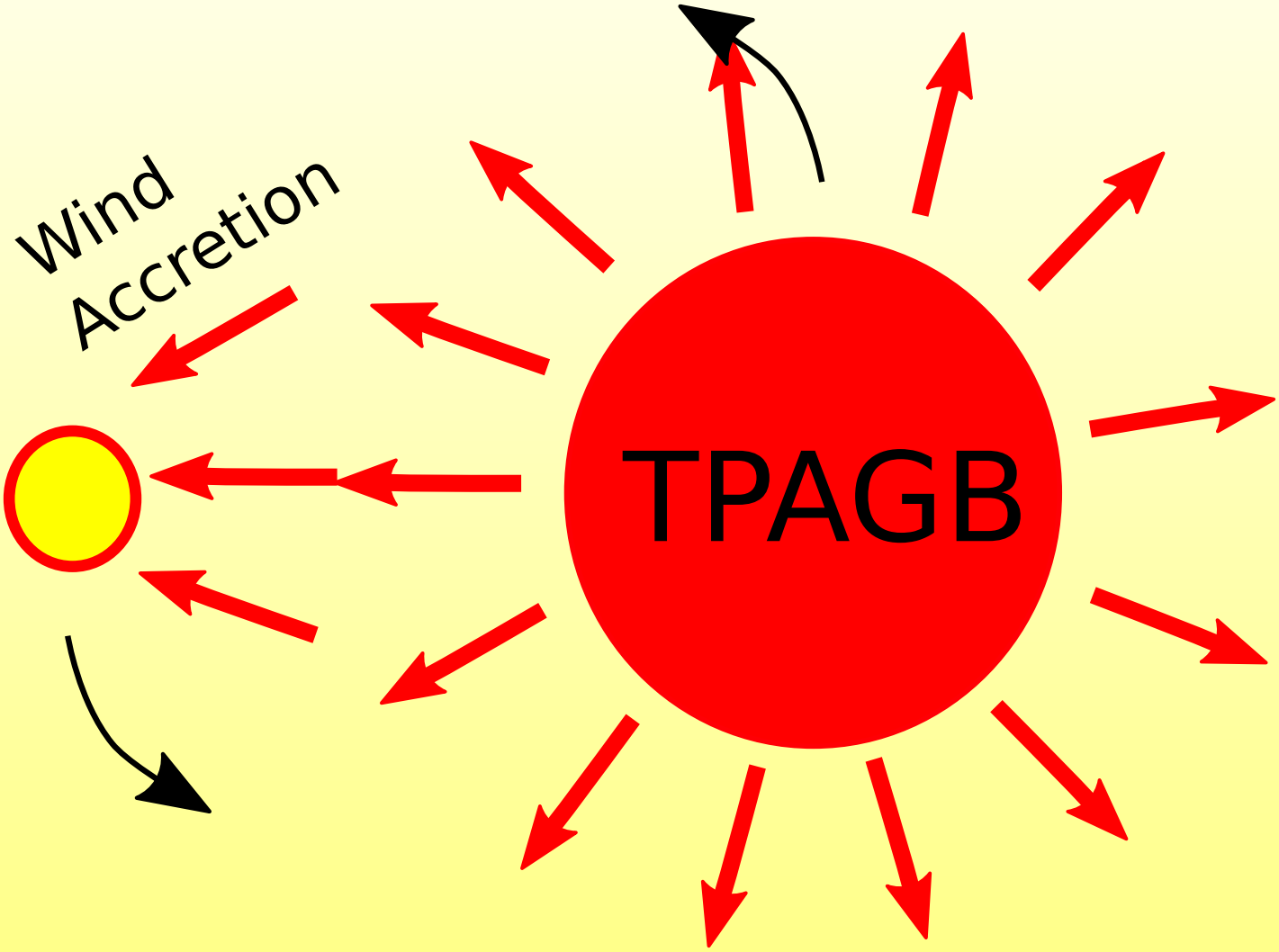
Lund Observatory

What is a barium star?

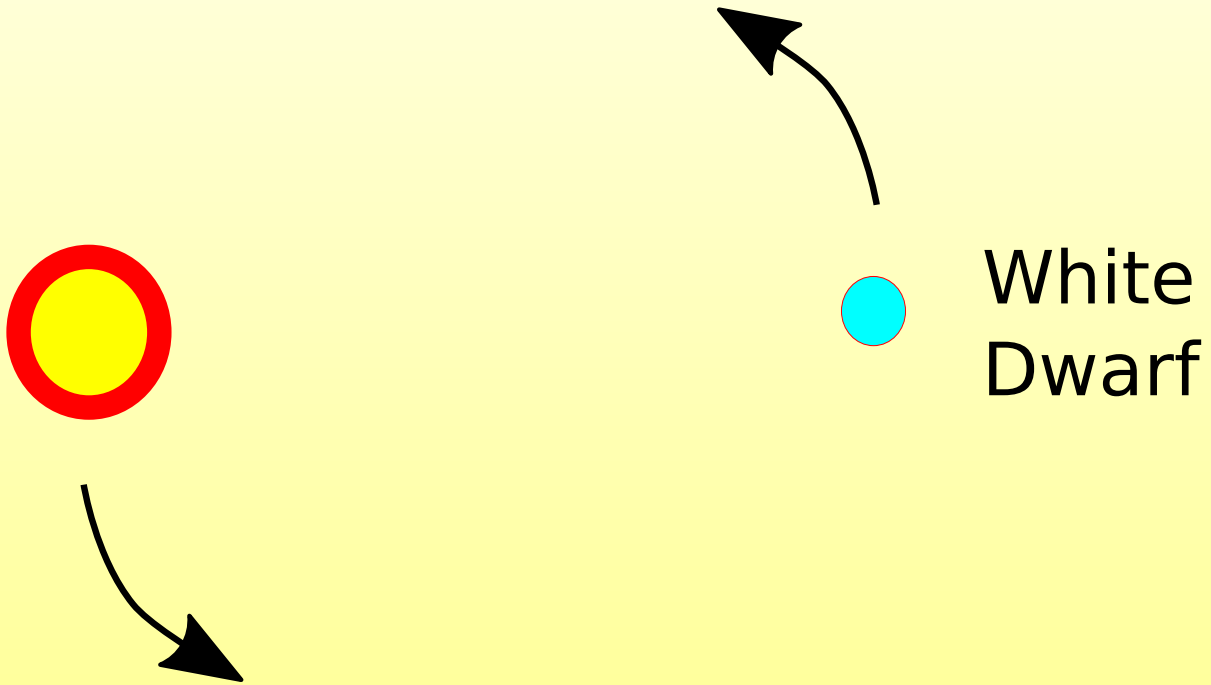
How to make a Ba star? A long time ago...



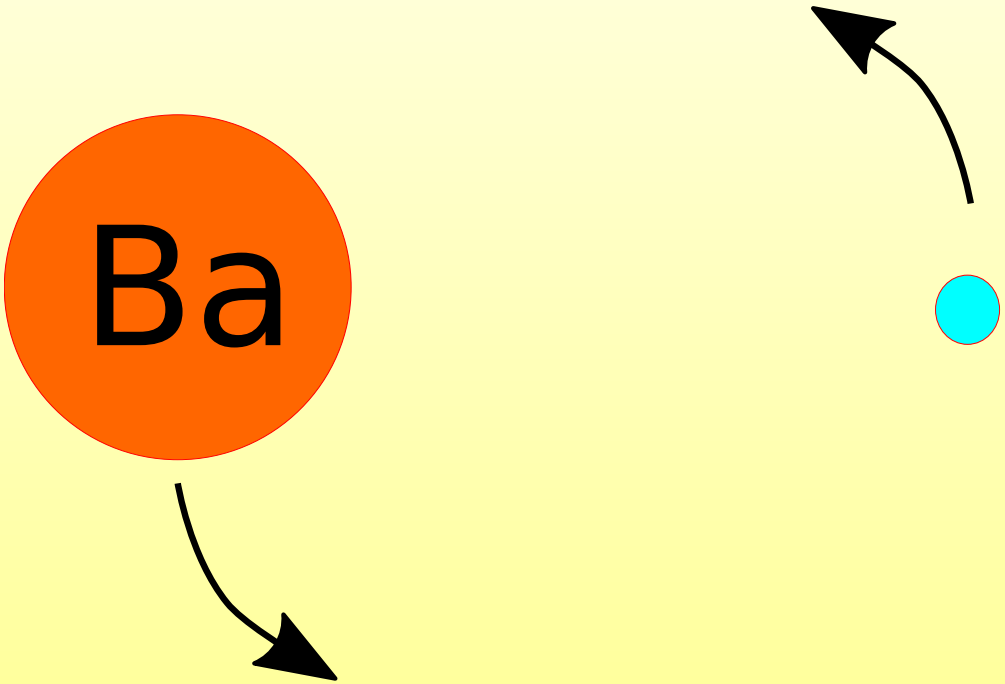
How to make a Ba star? A long time ago...



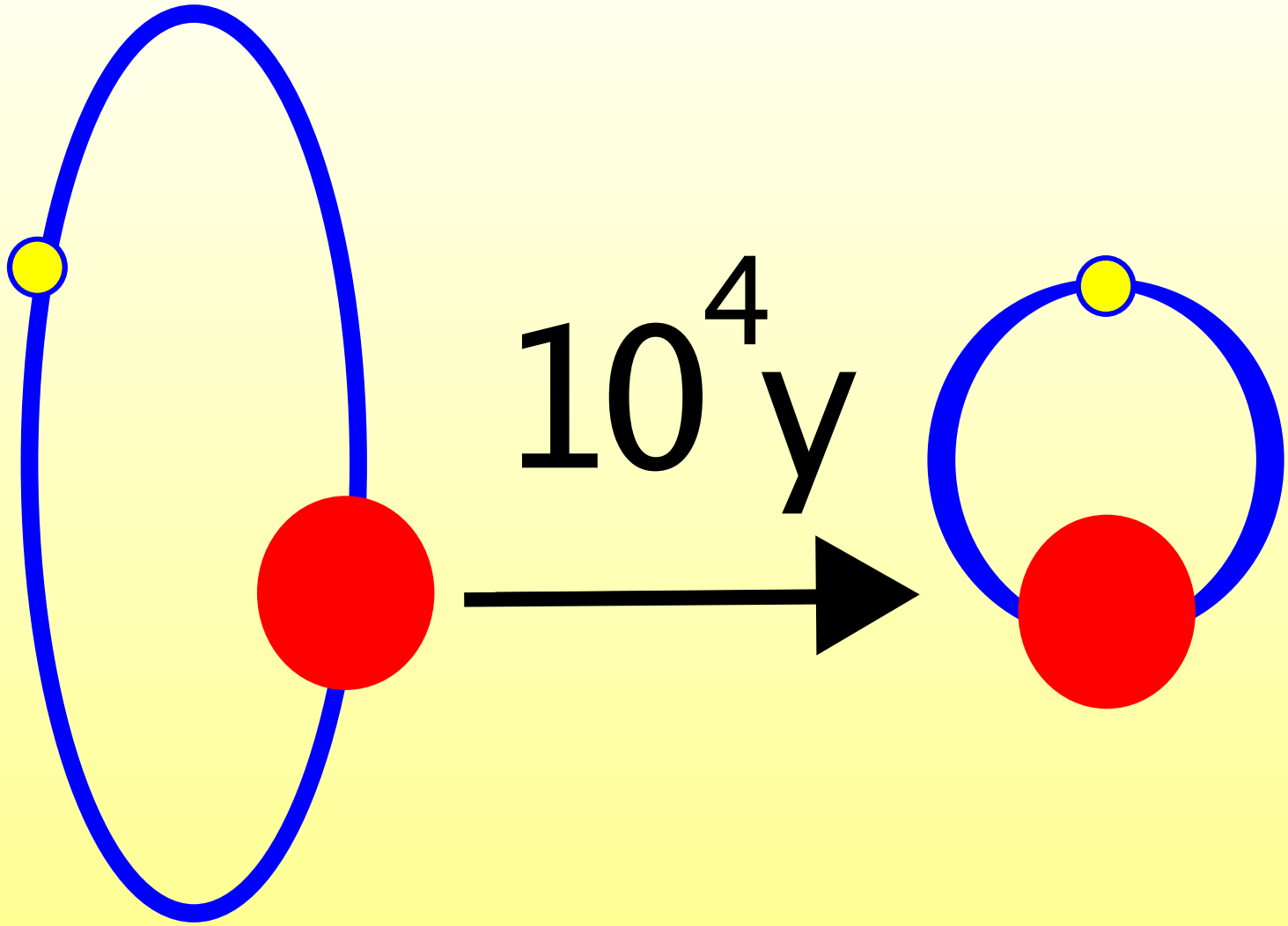
How to make a Ba star? A long time ago...



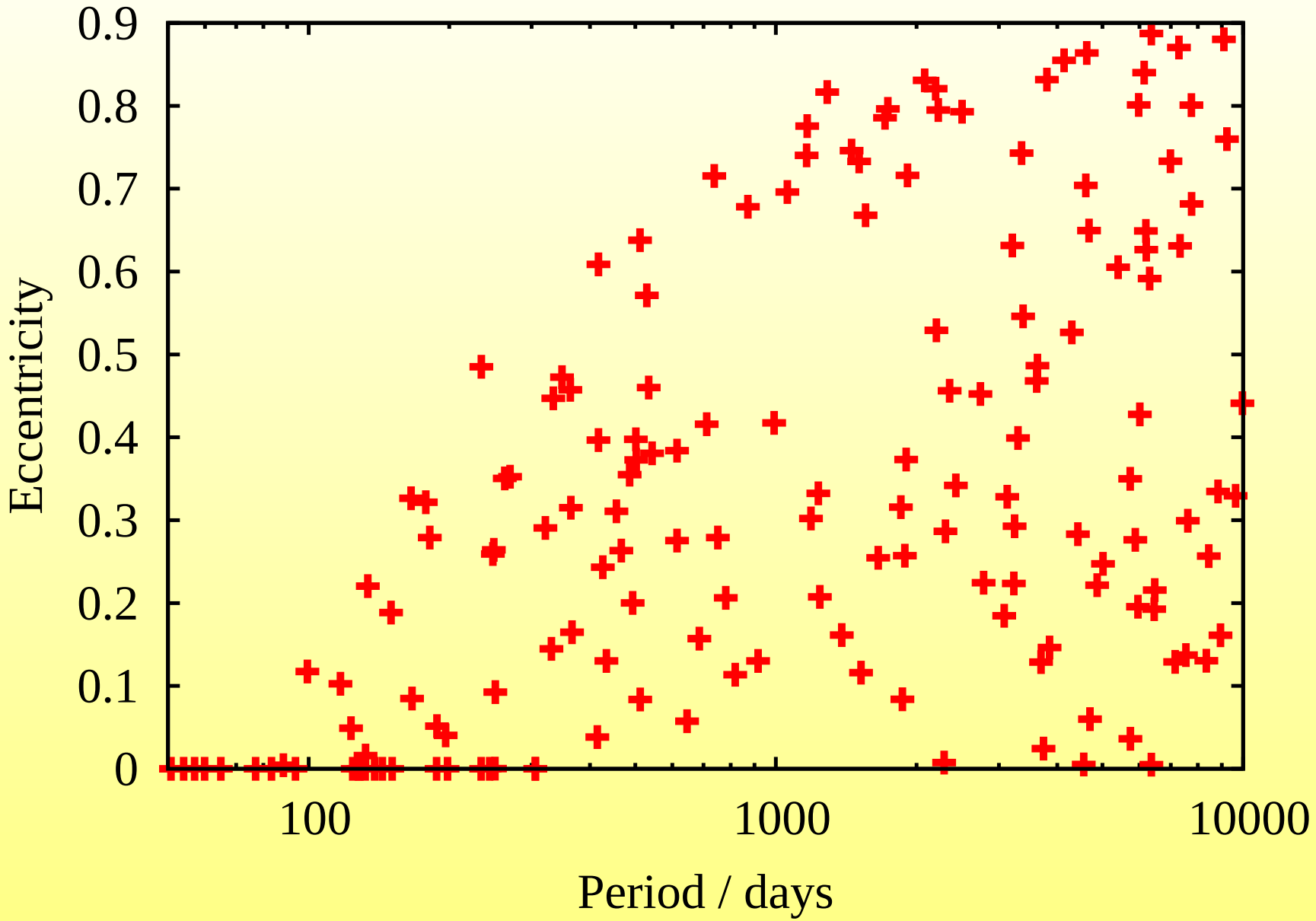
The barium star now



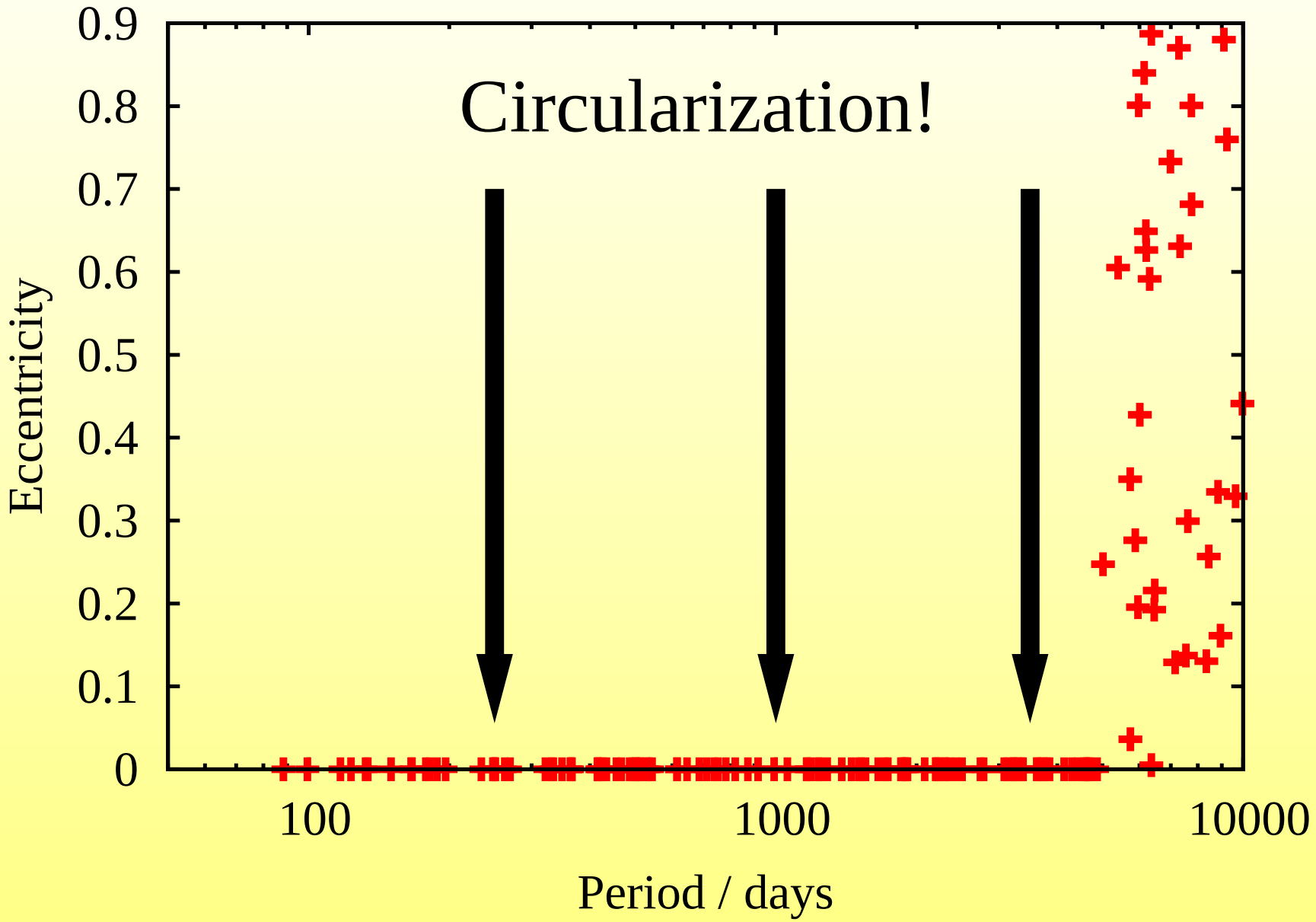
Tidal Circulari[sz]ation $\tau \sim (a/R)^8$



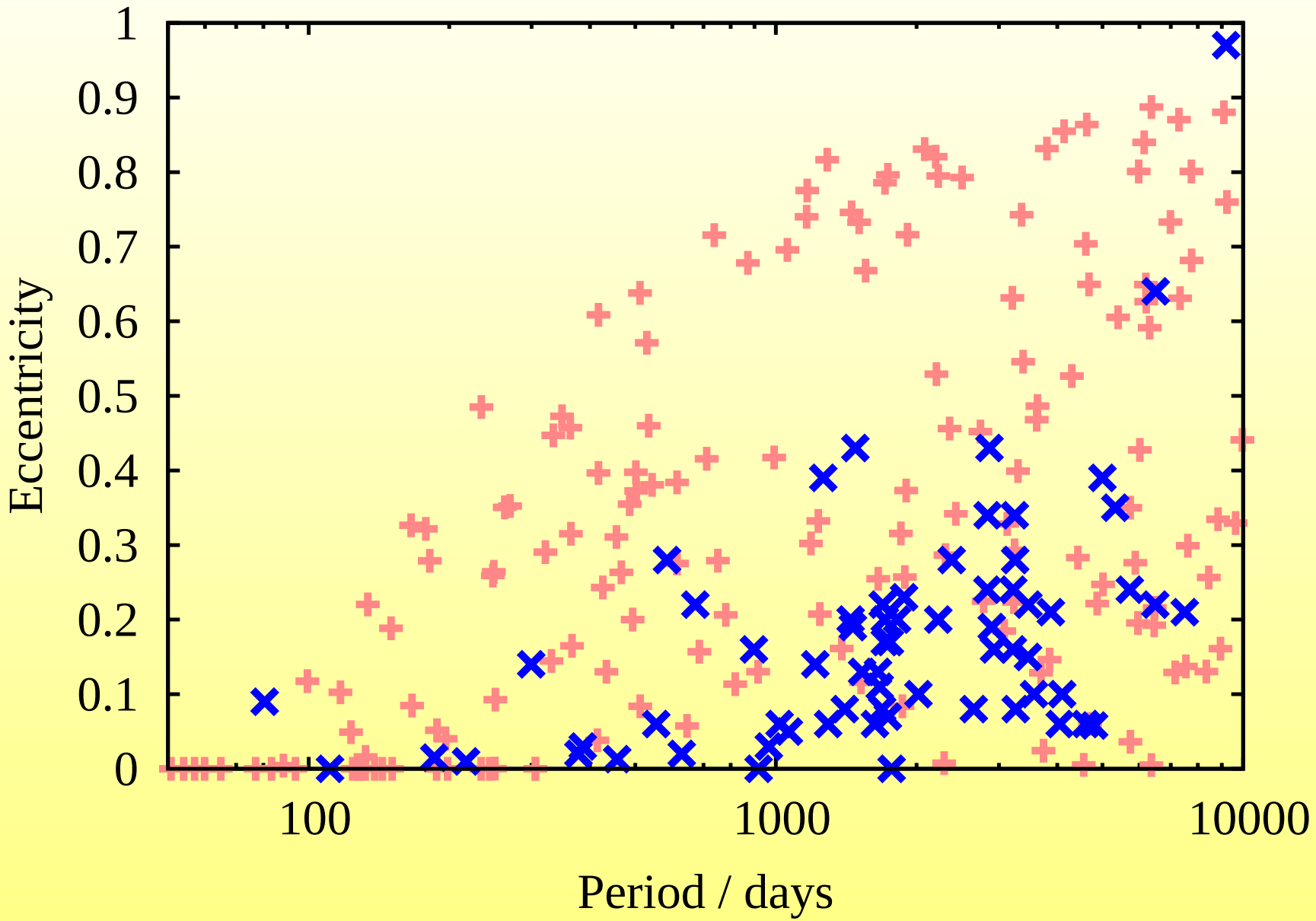
Observations: GK giants (Jorissen data)



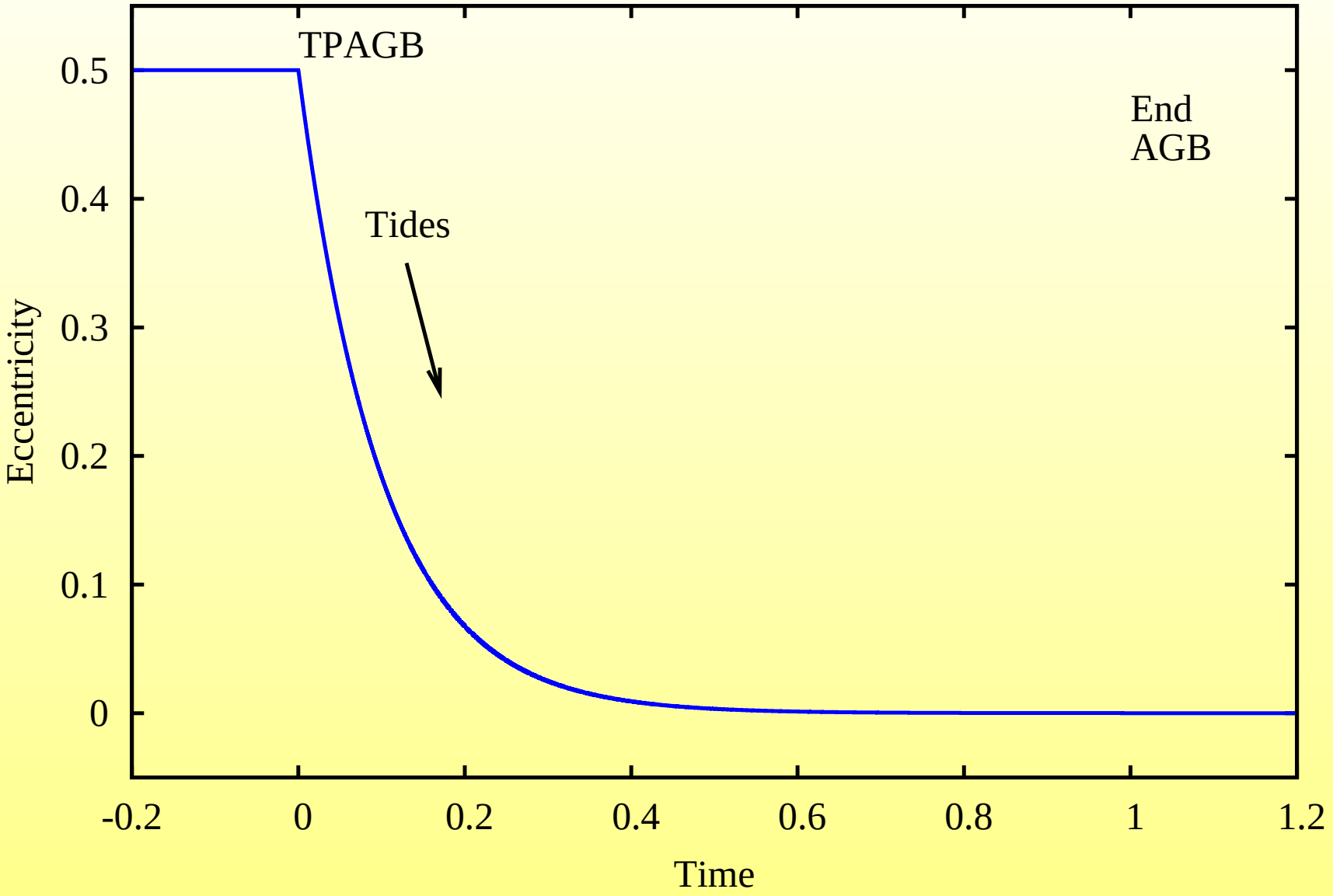
Expected result for Ba stars



But it doesn't/mayn't happen!



What is happening?



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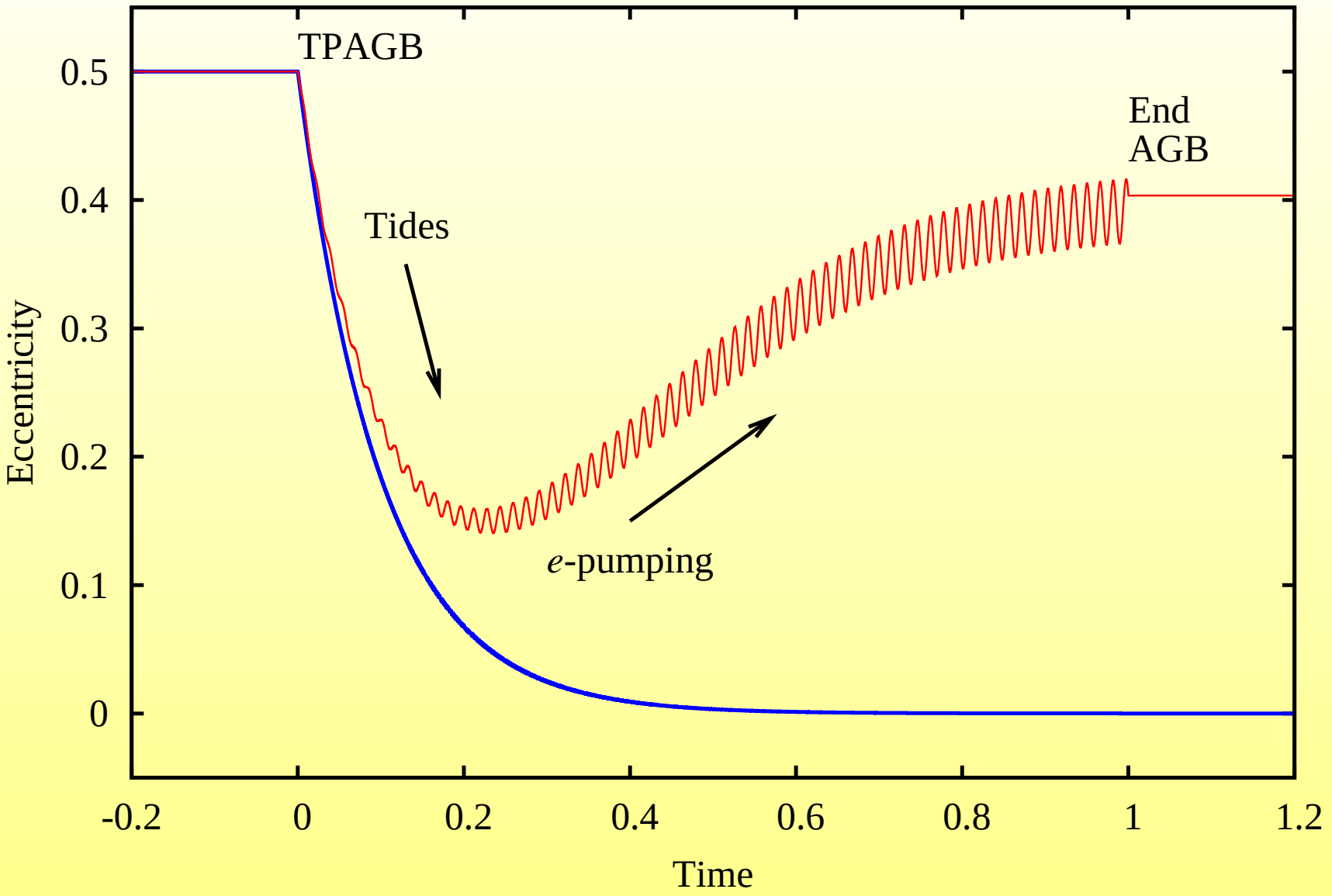

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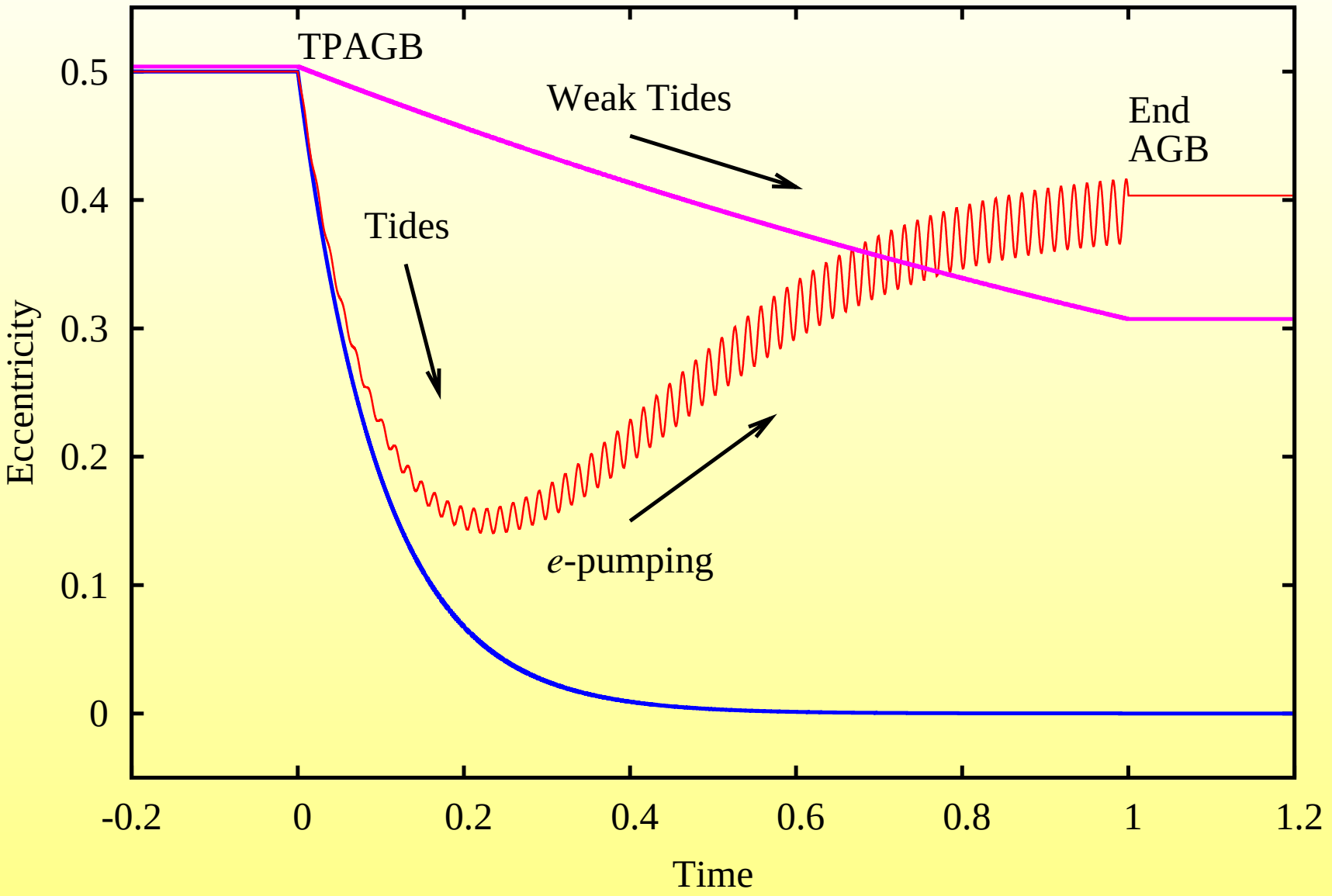

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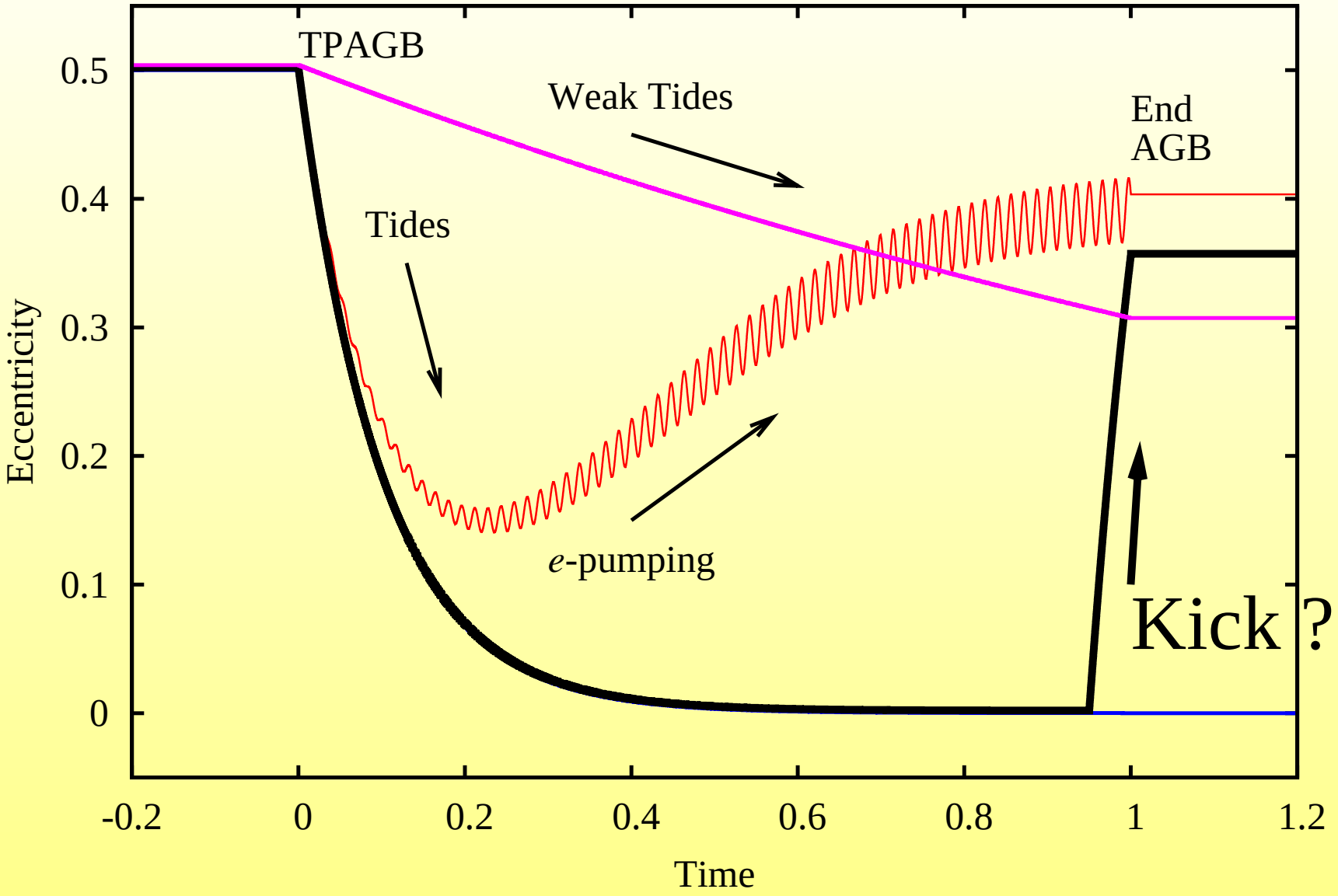
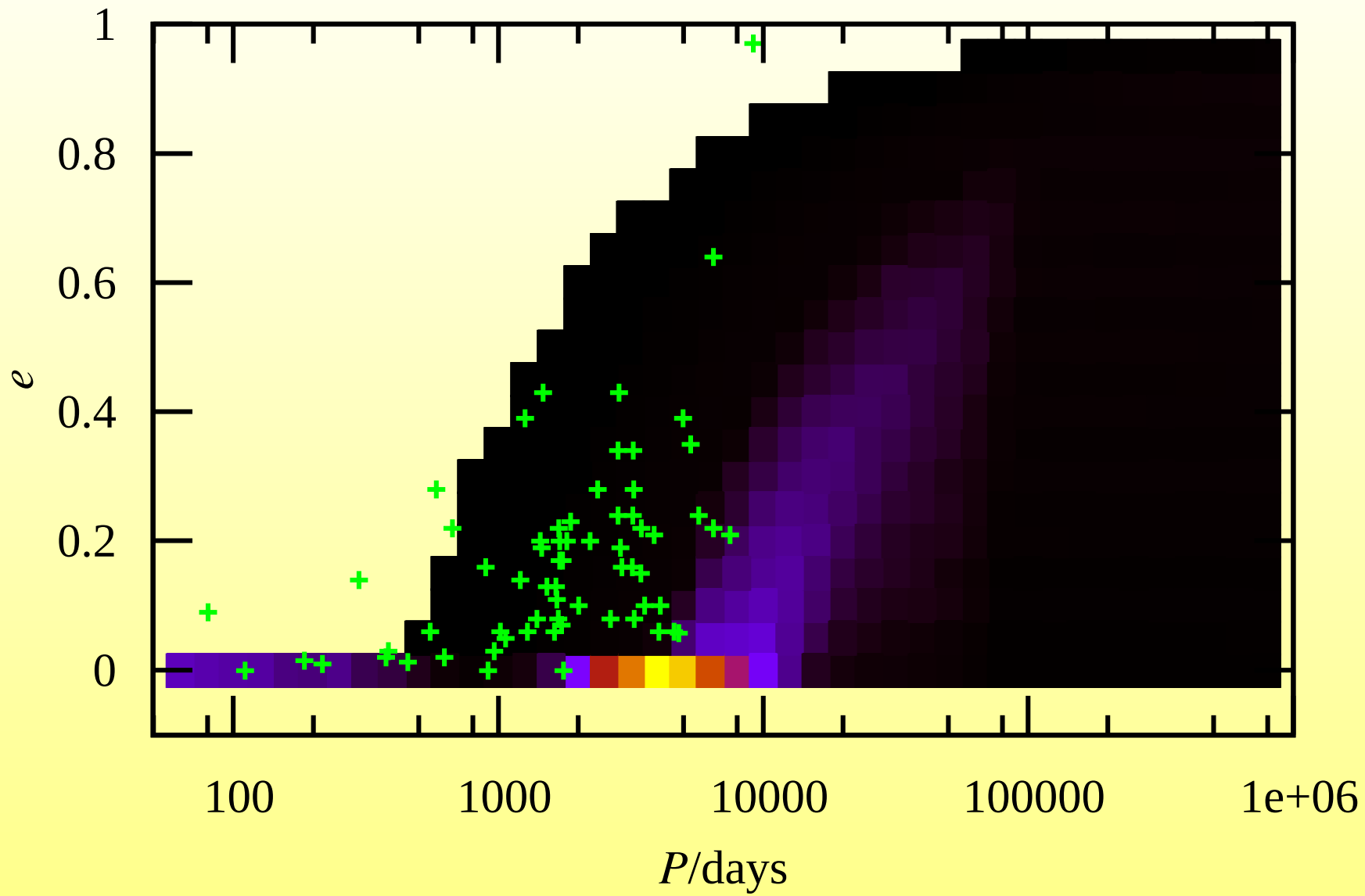
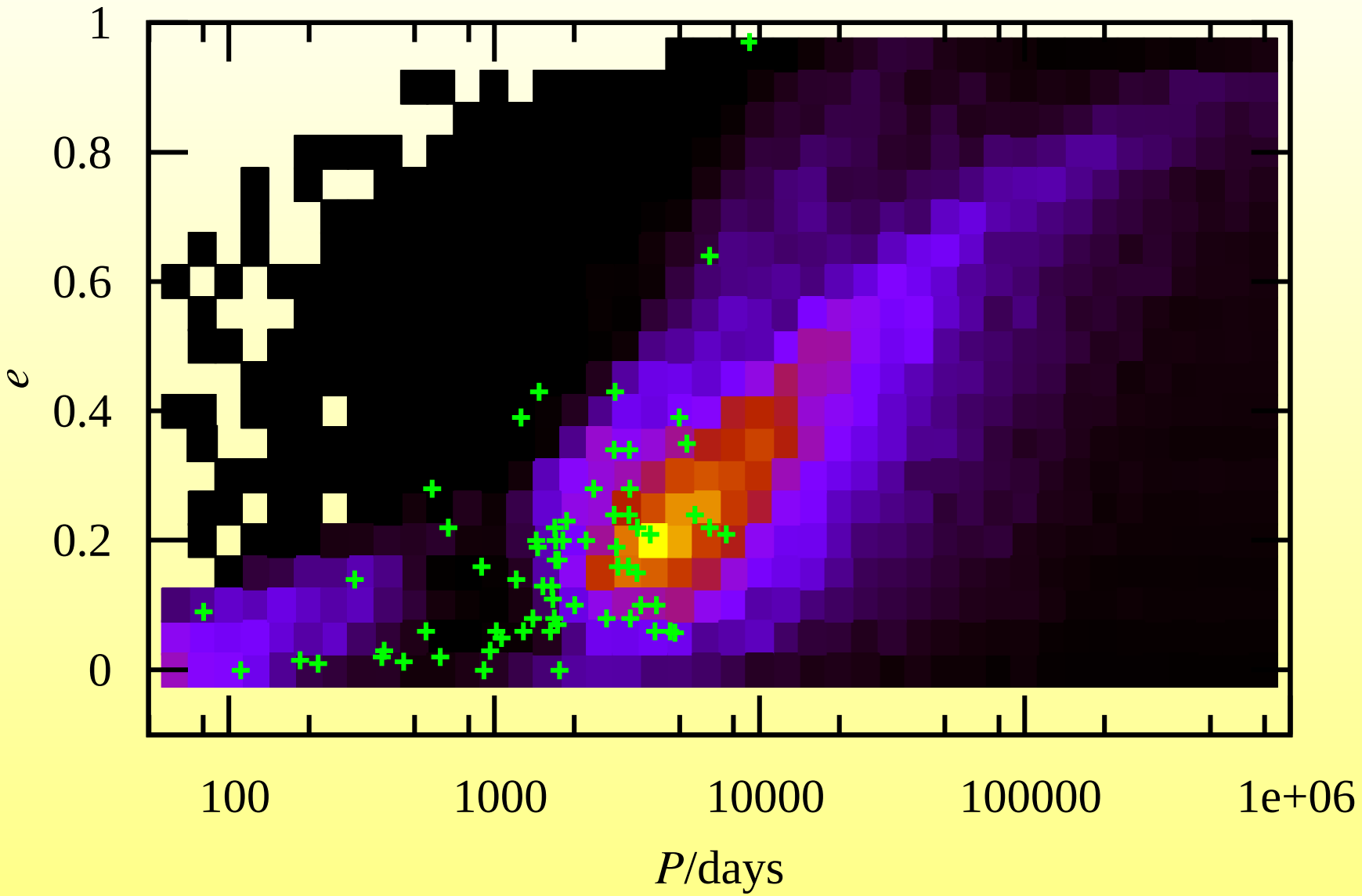


Canonical result

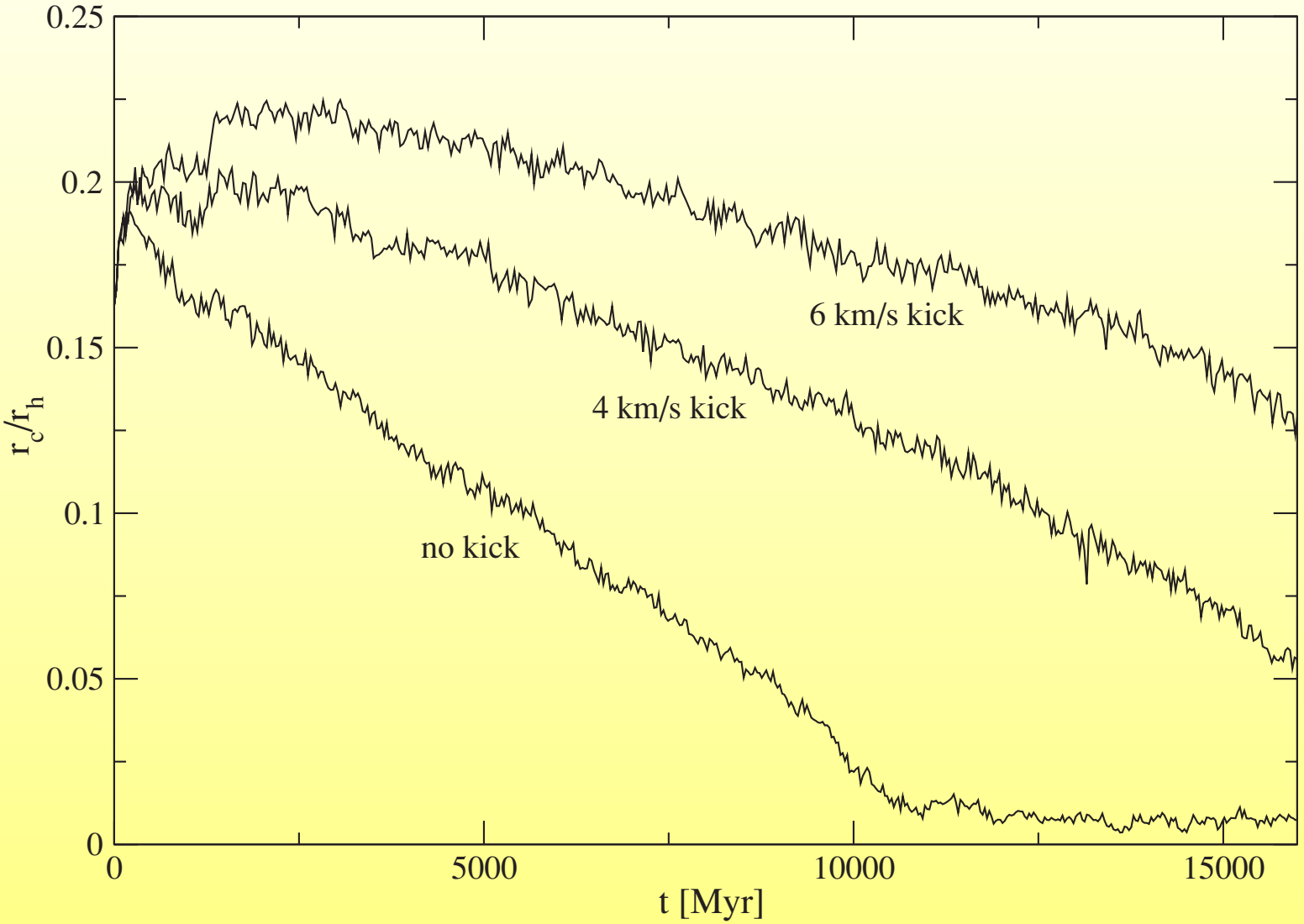


4km/s kick

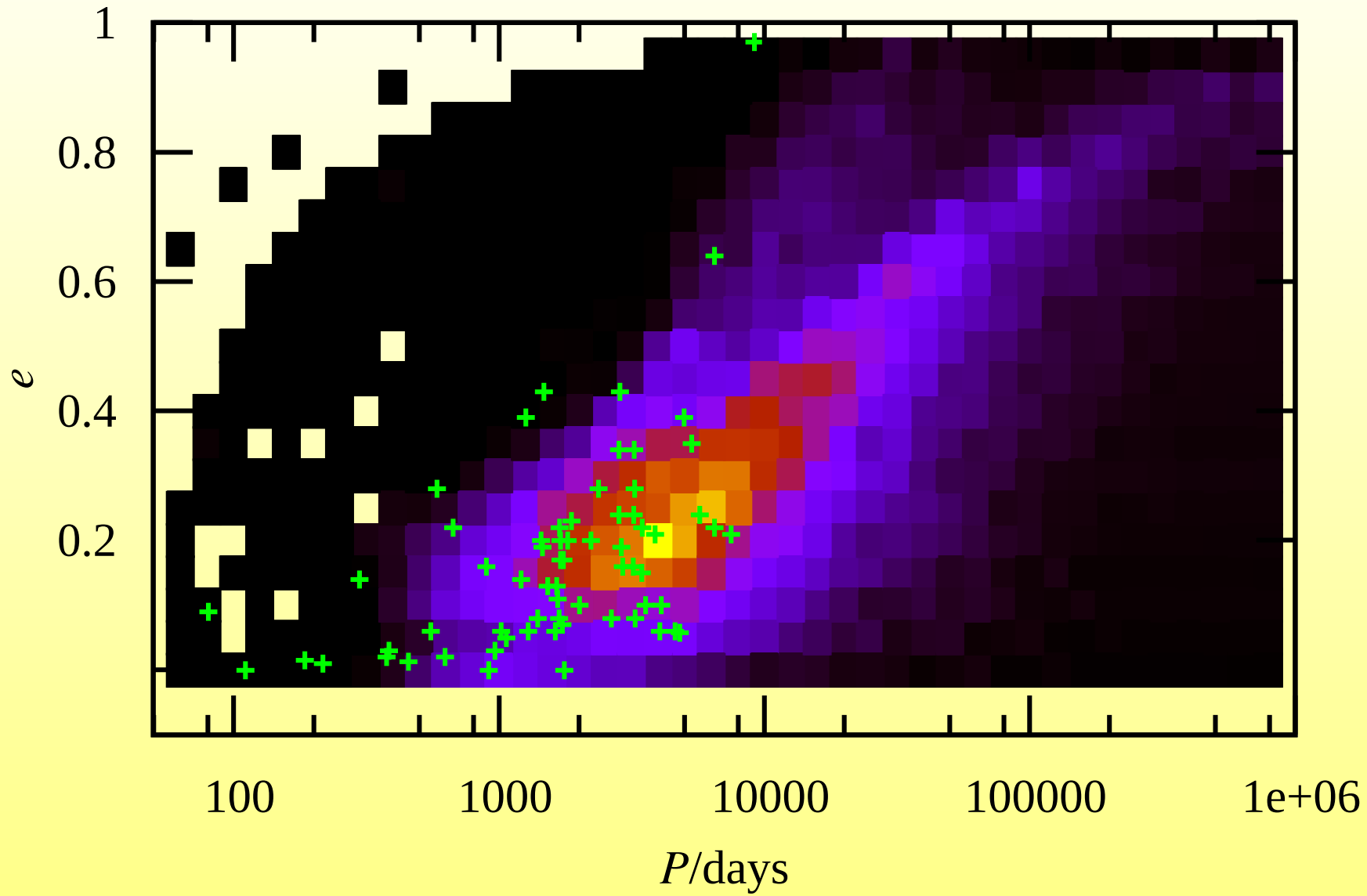


Independent evidence from GCs

Fregeau, Heyl etc.



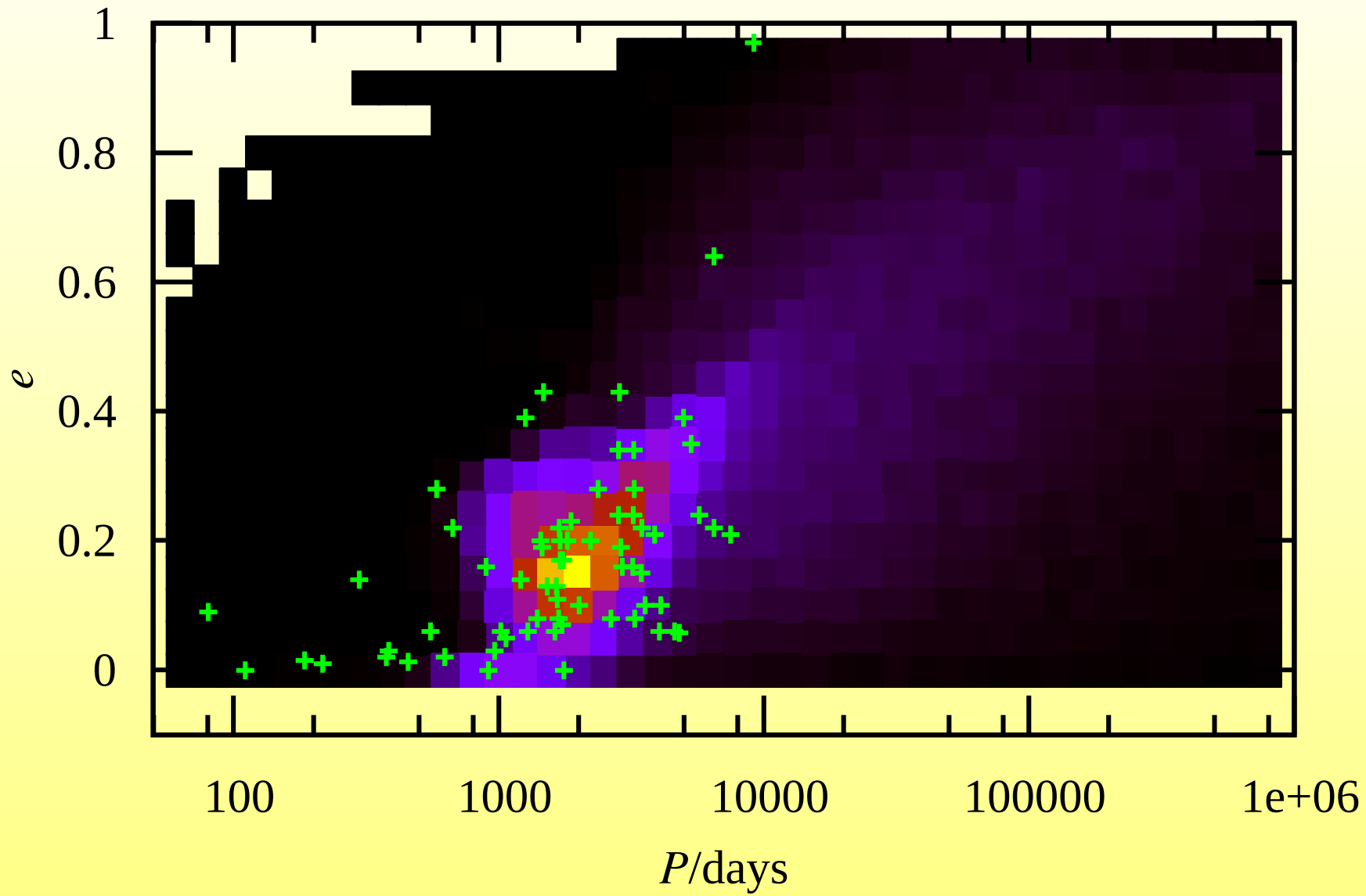
4km/s kick+efficient CE



Efficient common envelope ejection?

- *As if we have a clue?!*
- Envelope weakly bound
- Even with $\alpha = 1$ only a few % of envelope's recombination energy is required
- Nelemans/Tout γ prescription $\rightarrow$similar!
- Only for $\mathrm{P} \lesssim 2000\,\mathrm{days}$

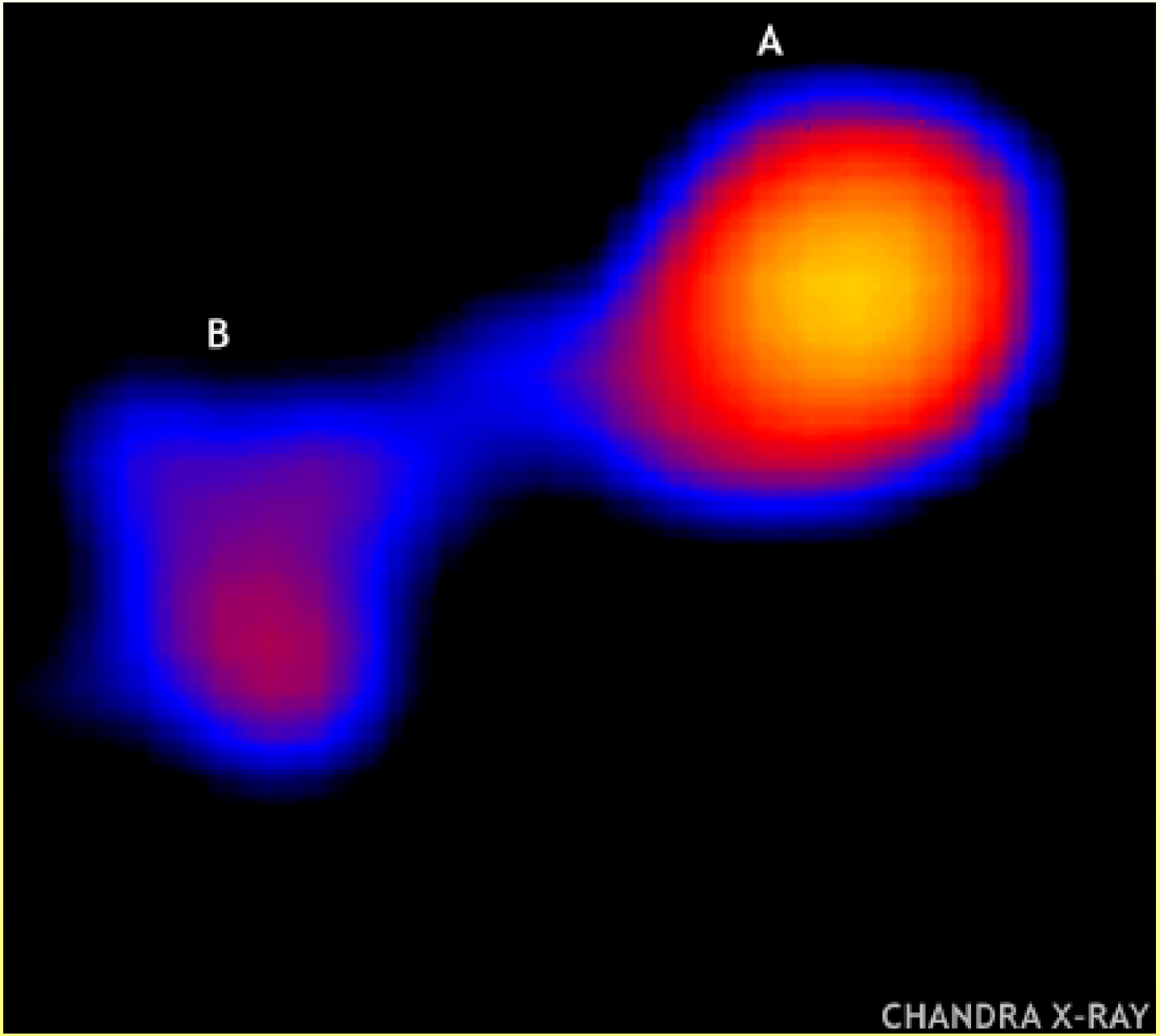
4km/s kick + efficient CE and $\dot{M}_{acc} \rightarrow \dot{J}$



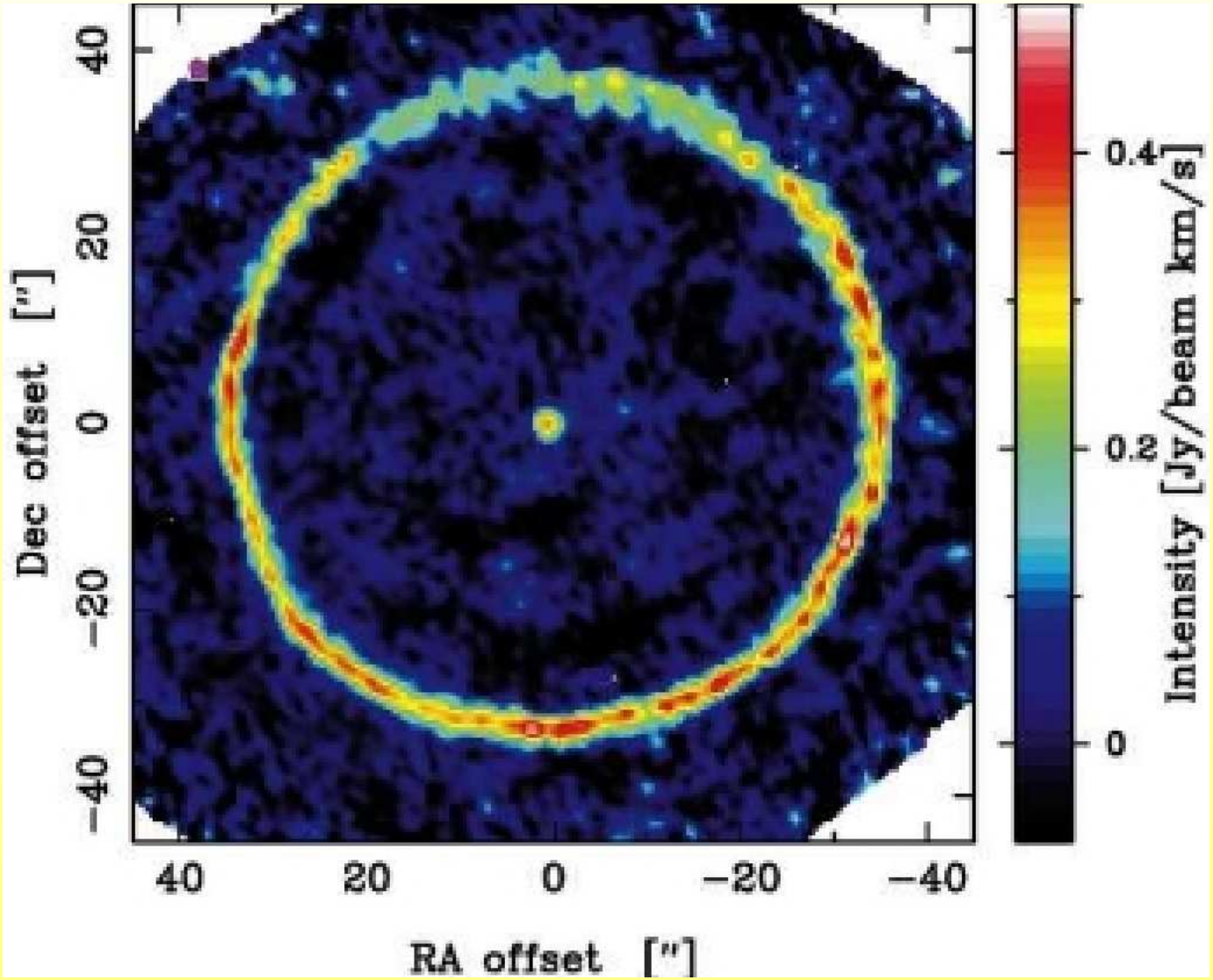
Angular momentum?

- Huang 1956:
  - *when the lost mass is collected by the secondary component, the major axis will decrease*
- $$\dot{J}_{orbit} \propto \left(- |\dot{M}_{lost}| - \frac{M_2}{M_1} |\dot{M}_{acc}| \right)$$
- Second term **large** for efficient accretion!
- Only for wide systems $P \gtrsim 5000$ days
- Alternatively:
  - magnetic braking
  - disc mass loss?

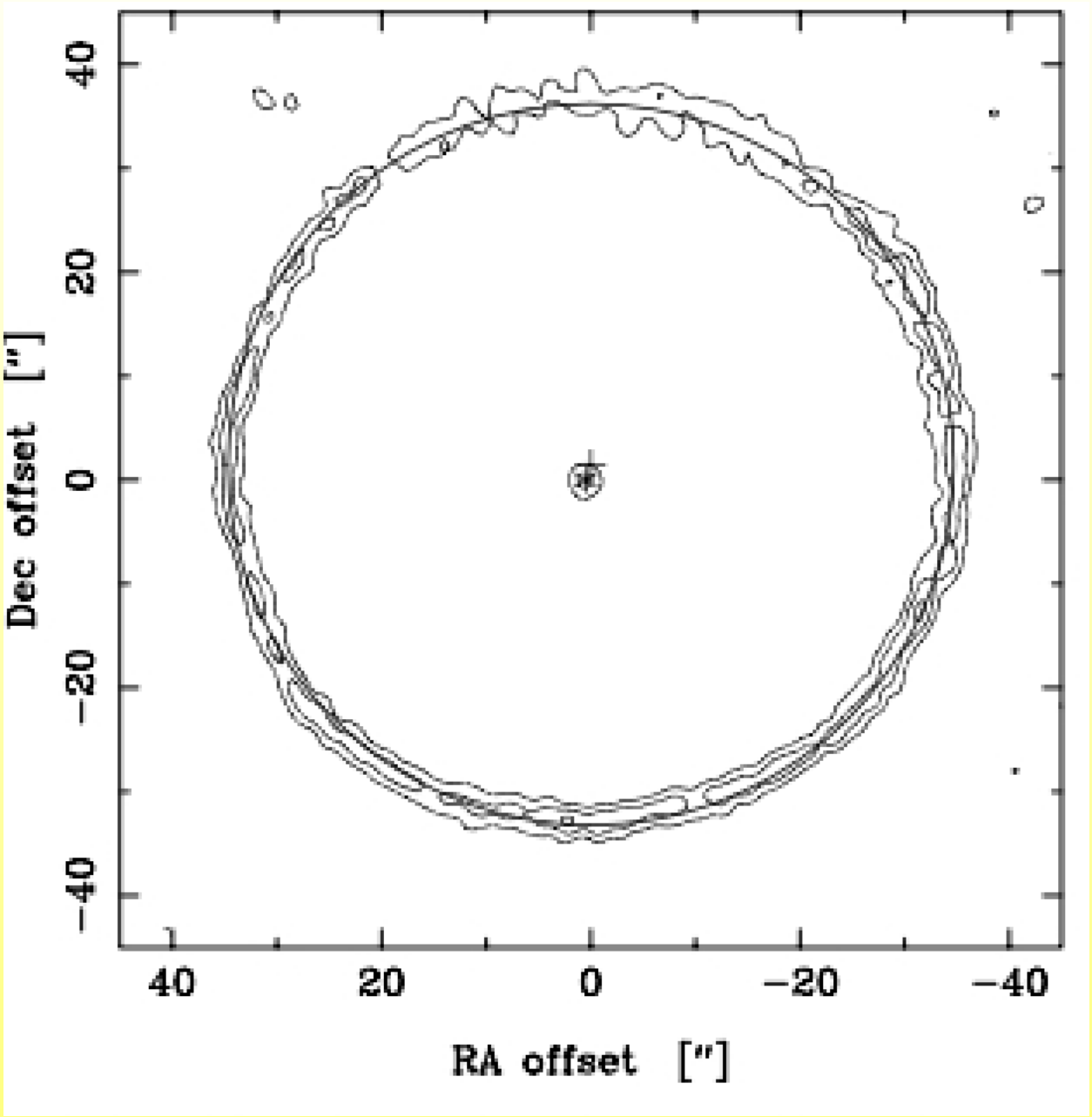
Efficient accretion: Mira



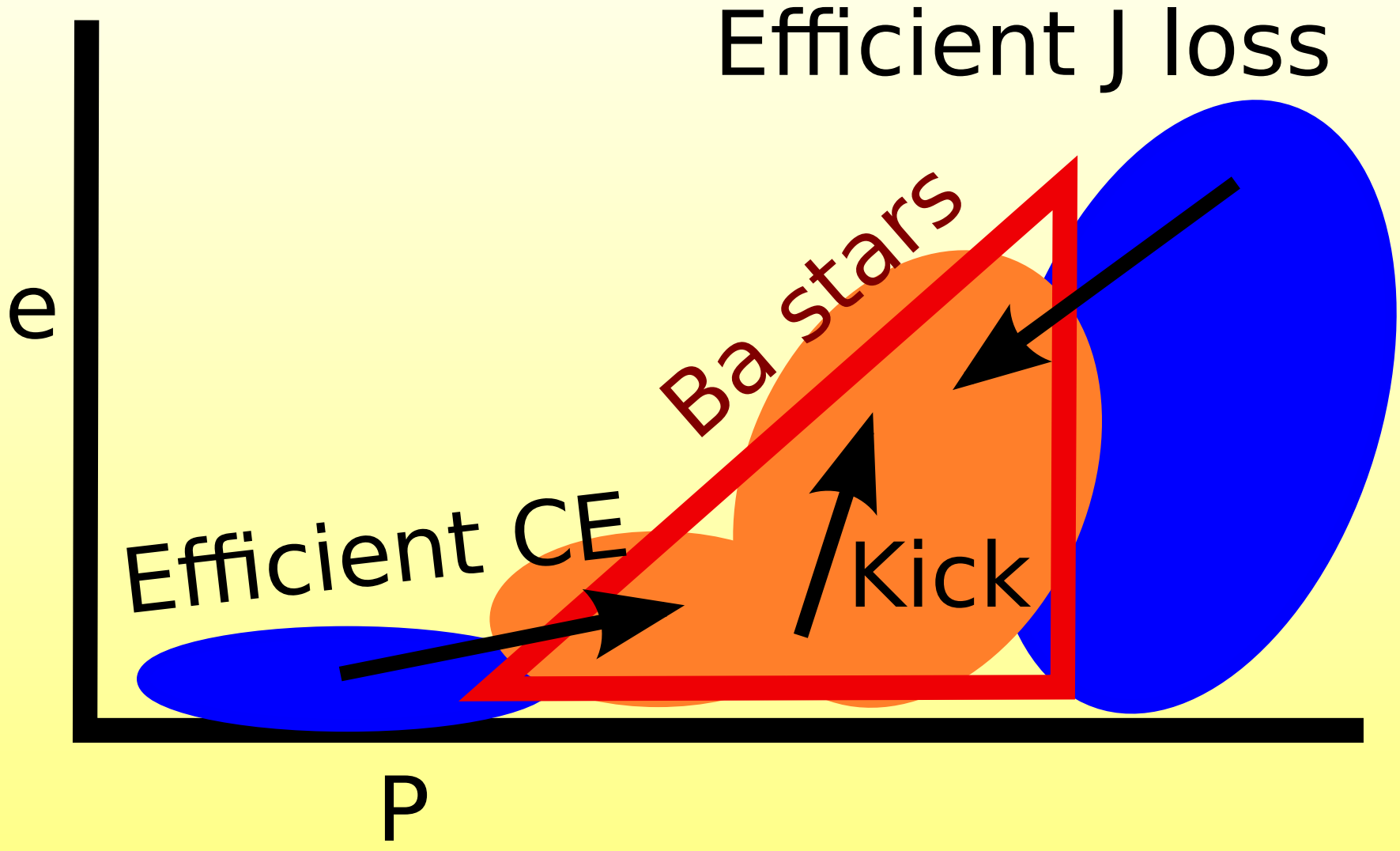
Kick Implications: PNe (TT Cygni in CO)



Kick Implications: PNe (TT Cygni in CO $v \sim 0.6\,\mathrm{km\,s^{-1}}$)



Conclusion: How To Make Ba Stars. . . ?



Big Brains→A better solution?