Possible Ways to Produce the S Stars in the Galactic Centre

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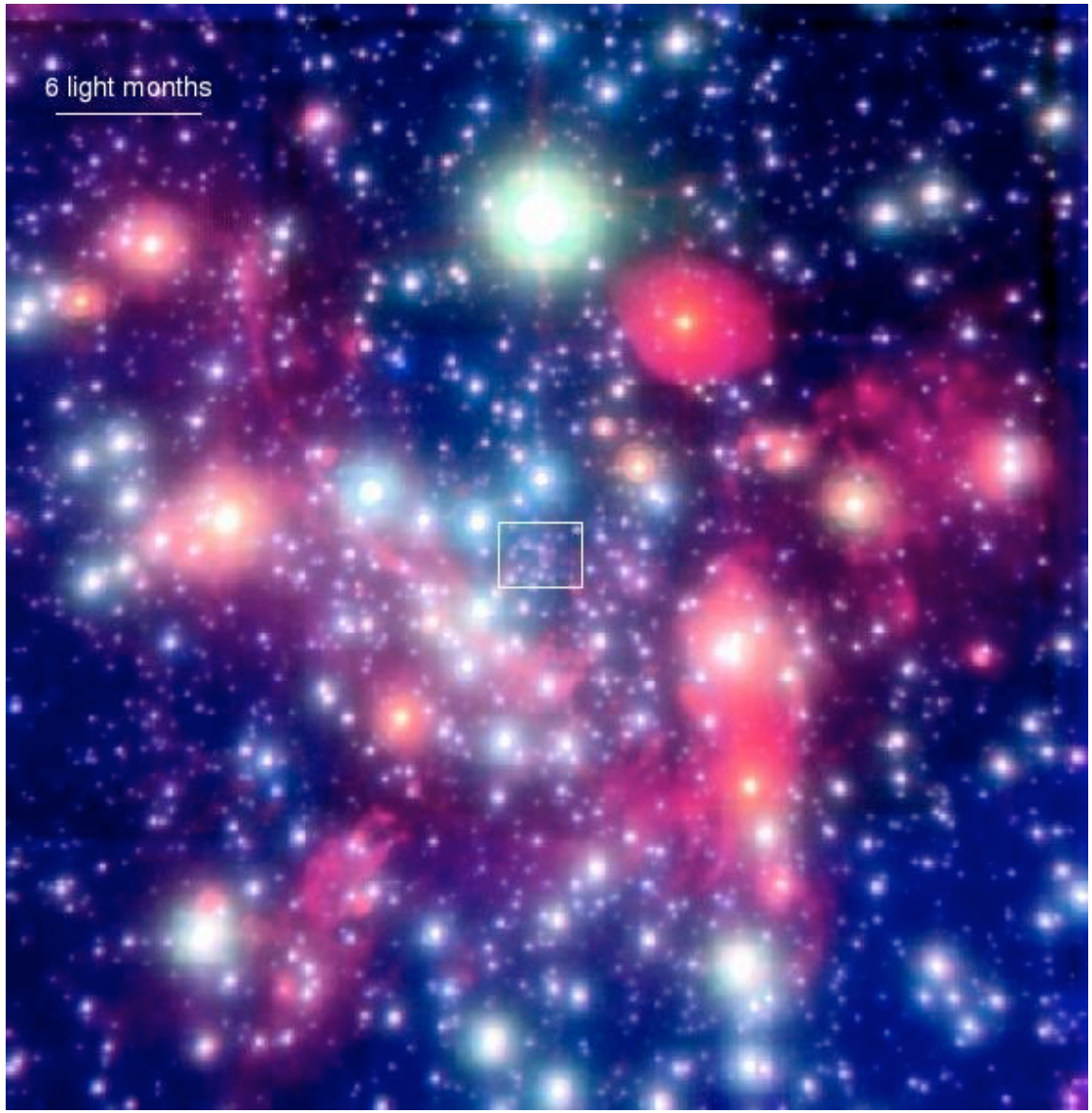
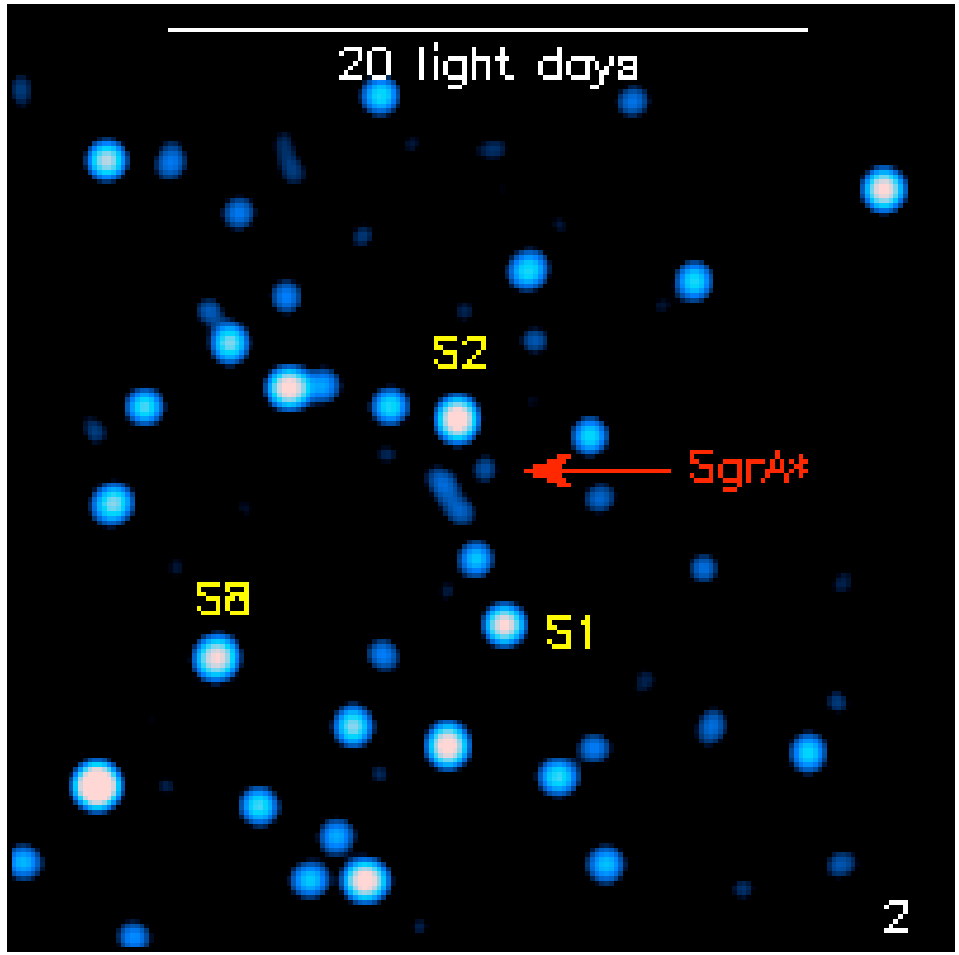


JHK Composite image (MPE)



So-called S stars in the very central region

There are two ideas in this talk.

I will also suggest that

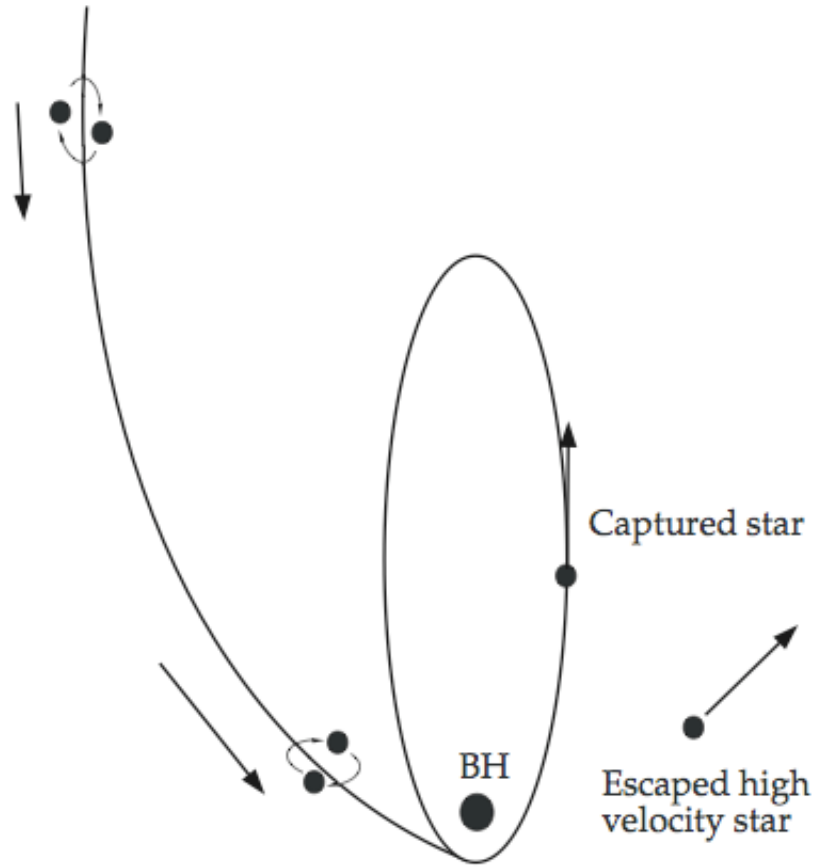
$1 + 2 < 2.35$

The first idea

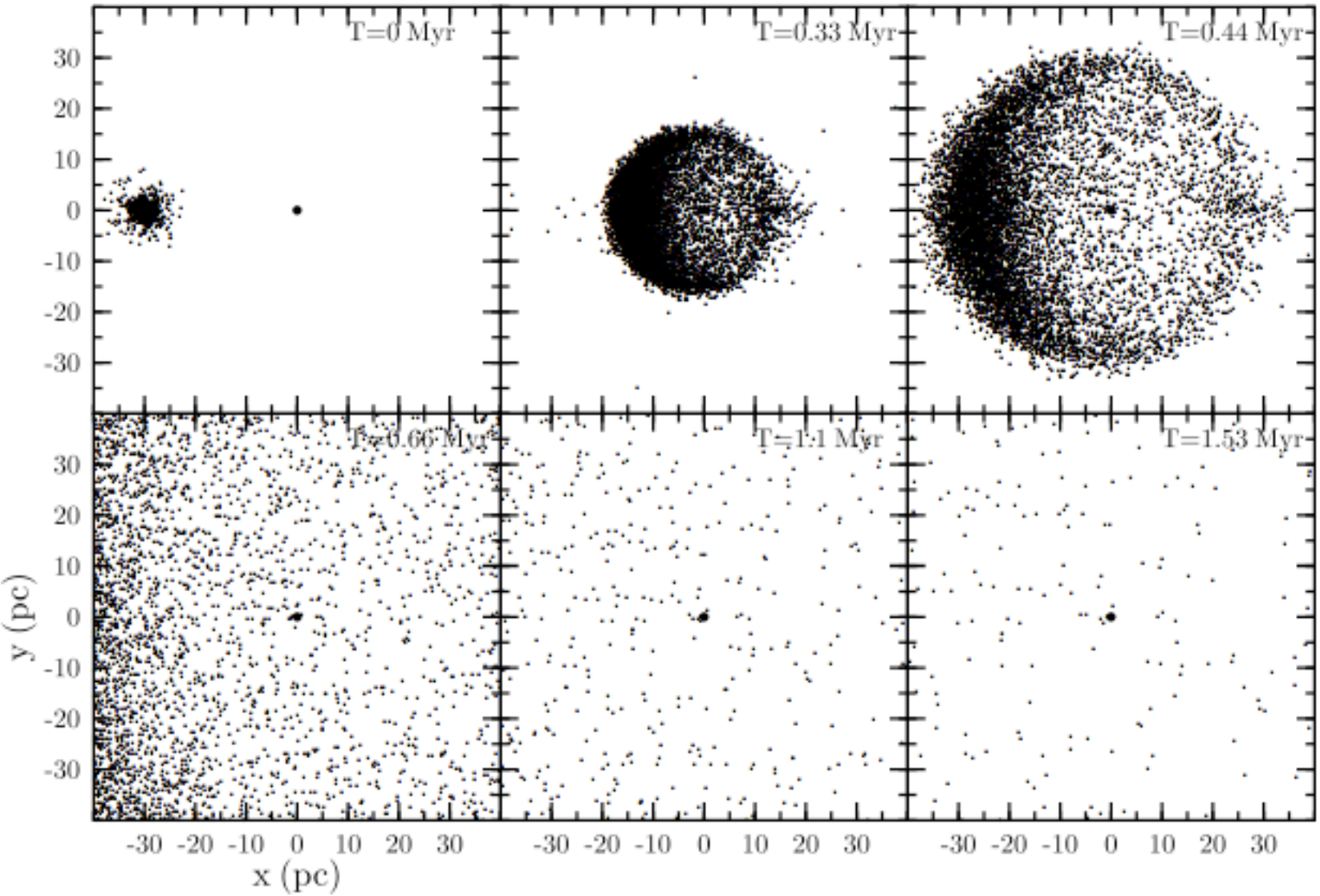
- Several binaries may be thrown at the black hole in a single event if the binaries are all contained inside a stellar cluster.
- Can (possibly) produce cluster on radial orbit via cloud-anticloud collision.
- Binaries in the cluster core will pass close enough to the black hole to be broken up leaving some stars on very tight orbits.
- ARE THESE THE S STARS?

(Dischler, Davies, Mackey, and Wilkinson 2006)

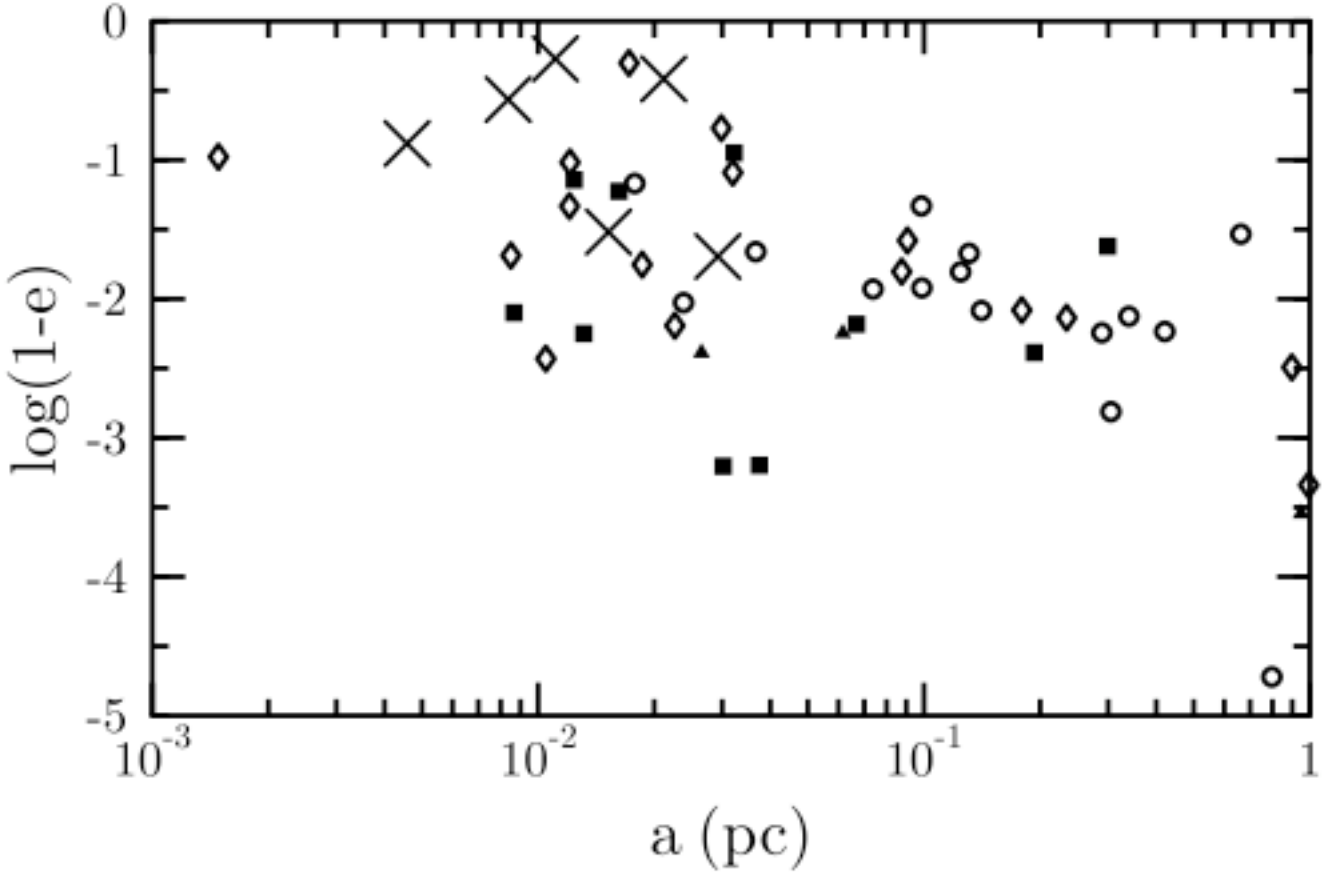
A binary encountering the central BH



Snapshots of Cluster-BH Encounter



Orbital properties of captured stars



Summary 1

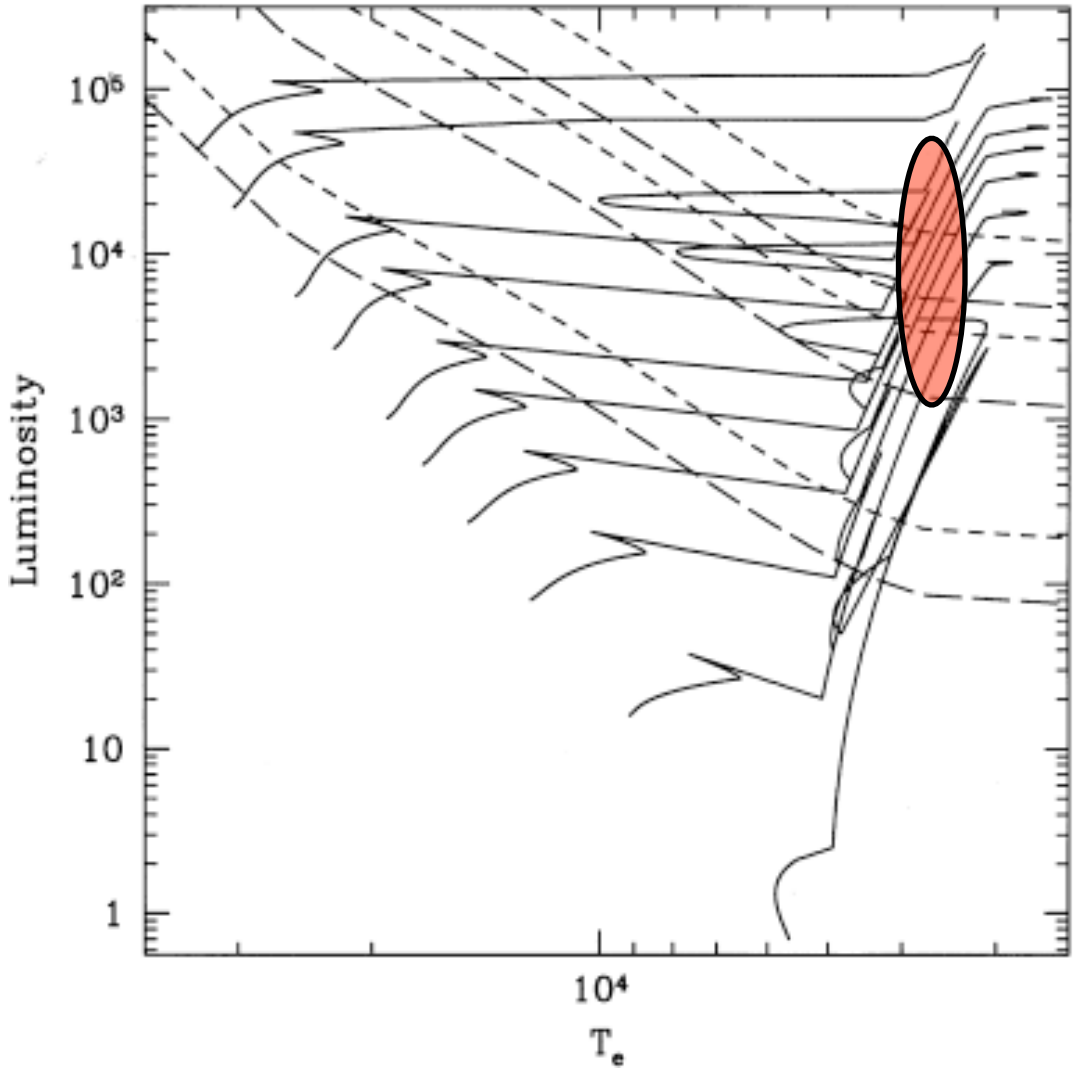
- A cluster thrown in towards BH will leave several stars on very tight orbits.
- Many have moderate-high masses.
- Chance that a cluster was thrown in within the last 10 million years may be about 0.0few or could be higher.

The second idea

- Red giants are scattered in towards black hole and are tidally shredded
- A red giant with most of its envelope removed will appear blue
- Cores of red giants will thus be left on tight orbits around the black hole
- ARE THESE THE S STARS?

(Davies & King 2005)

HR diagram for galactic center



HR diagram for galactic center

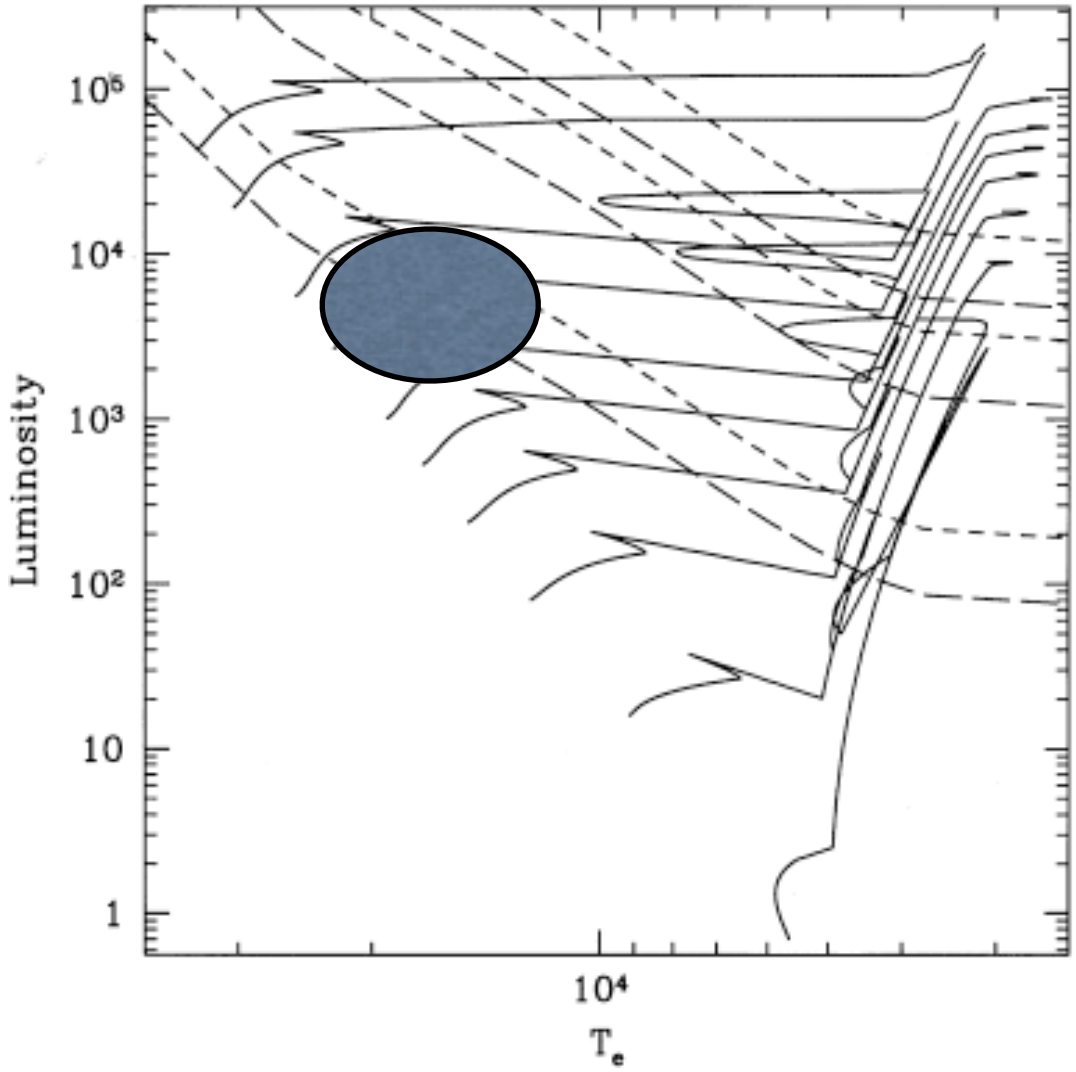


TABLE 1

TIDAL RADII FOR MEASURED ORBITS

Name (1)	p (mpc) (2)	e (3)	R_T ($R_\odot$) (4)	p (mpc) (5)	e (6)	R_T ($R_\odot$) (7)
S2	0.6	0.87	114	0.6	0.88	111
S12	2.2	0.73	424	1.1	0.90	206
S14	0.4	0.97	75	0.5	0.94	101
S1	8.0	0.62	1541	10.1	0.36	1941
S8	0.6	0.98	116	0.9	0.93	176
S13	6.0	0.47	1156	5.0	0.40	963

NOTES.—Cols. (2)–(4) are from the orbital fits of Schödel et al. (2003), while cols. (5)–(7) columns are from the fits of Eisenhauer et al. (2005). Note that the orbits for S14, S1, S8, and S13 were all poorly constrained in Schödel et al.

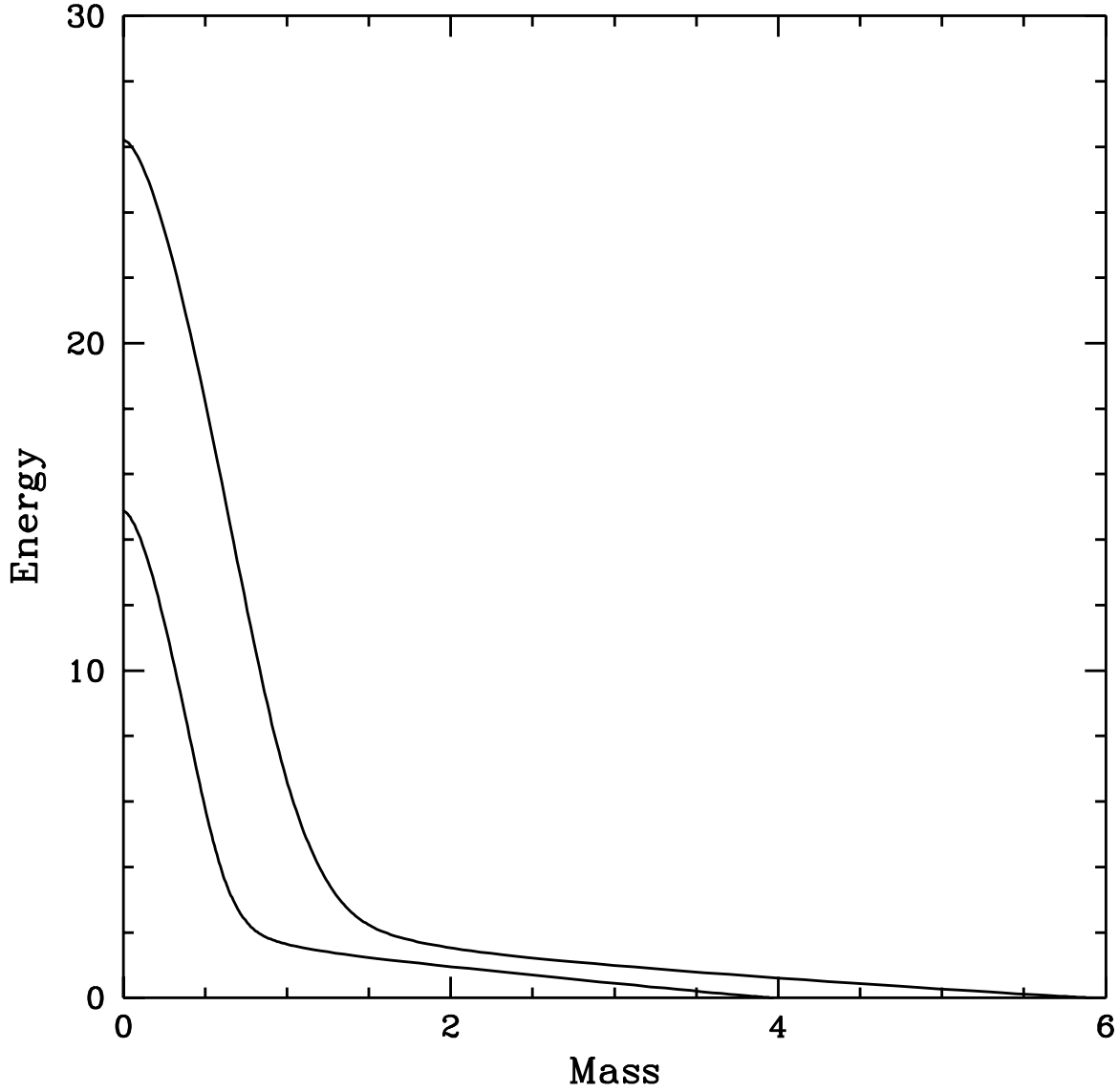
(Davies & King 2005)

Do we dissipate enough energy?

$$E_{orb} = \frac{GM_{BH}M_c}{2a}$$

For S stars, orbital energy is about 10^{49} ergs

Energy as function of mass for RG models



(mass in solar units, energy in units 10^{48} ergs)

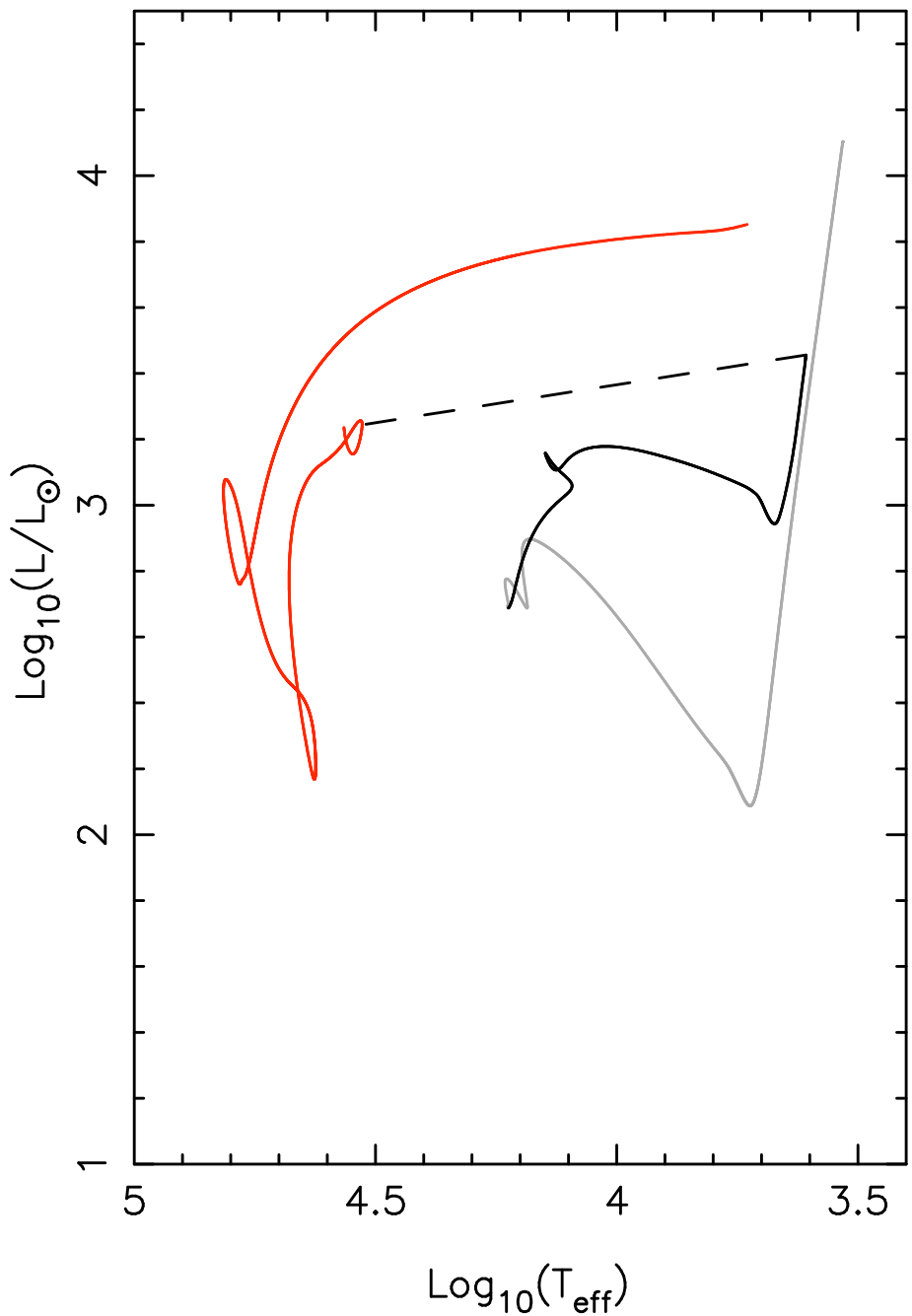
What is lifetime of stars after shredding?

How do they evolve?

Post-shredding evolution has been studied using STARS code.

(Dray, King, and Davies 2006)

Example track for 4 solar mass star with 99% loss



Summary 2

- Large RGs scattered in towards BH will be shredded
- They will lose almost all their envelope and may appear blue
- These shredded RGs may be the blue S stars travelling on tight orbits around the central BH

Finally, back to...

$1 + 2 < 2.35$