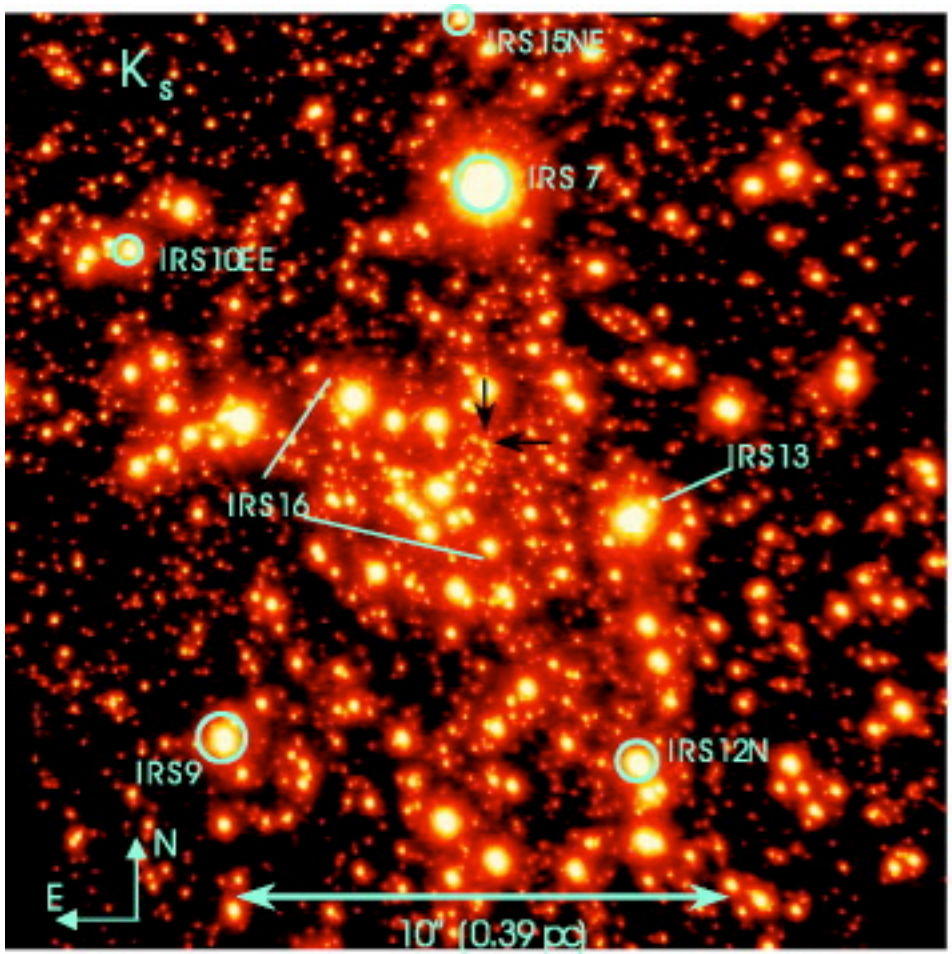
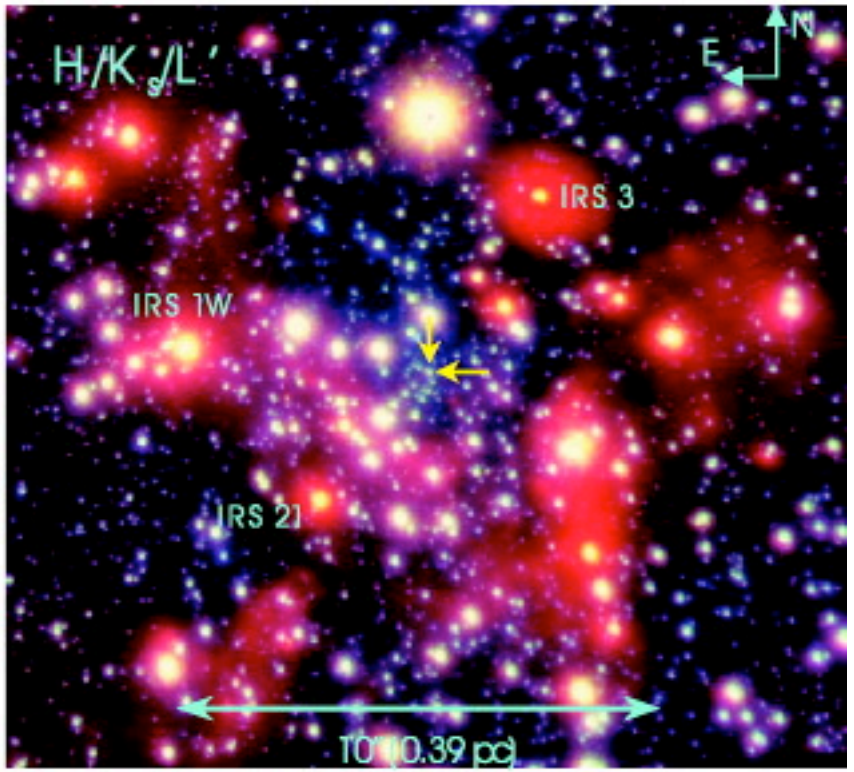
The Effects of Stellar Encounters in the Galactic Centre

Melvyn B. Davies
Lund Observatory

Ross Church, Serge Nzoke, James Dale, Daniel Malmberg, Marc Freitag

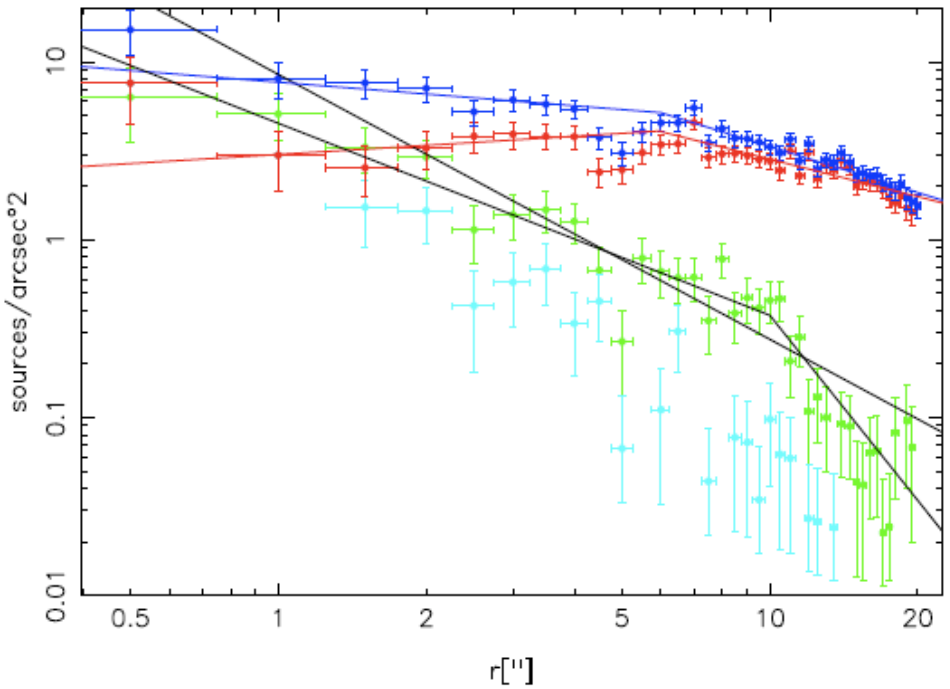
The Galactic Centre



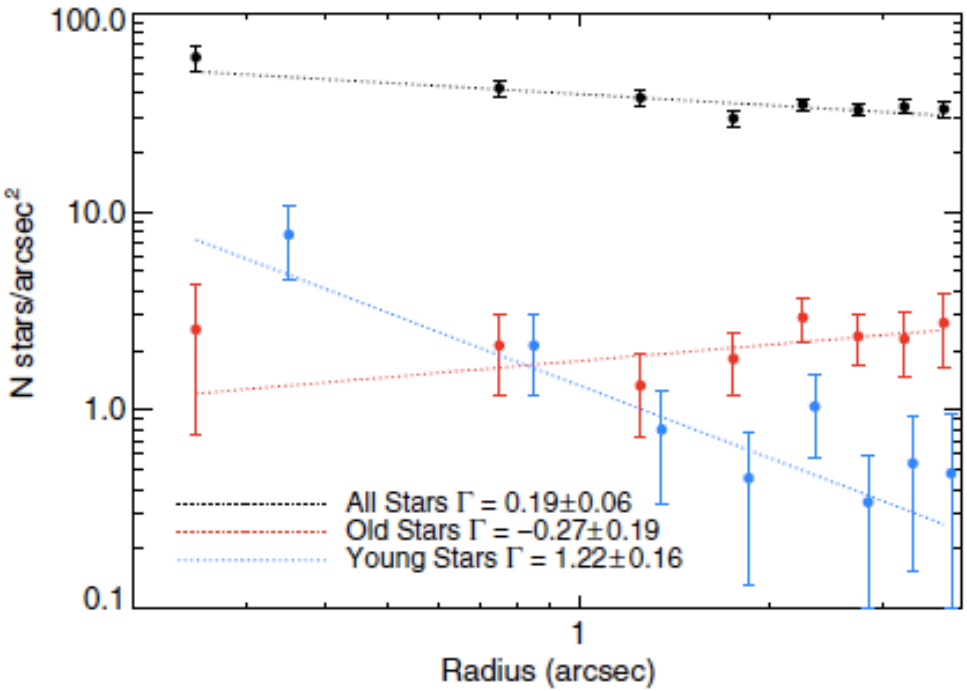


(Genzel et al 2003)

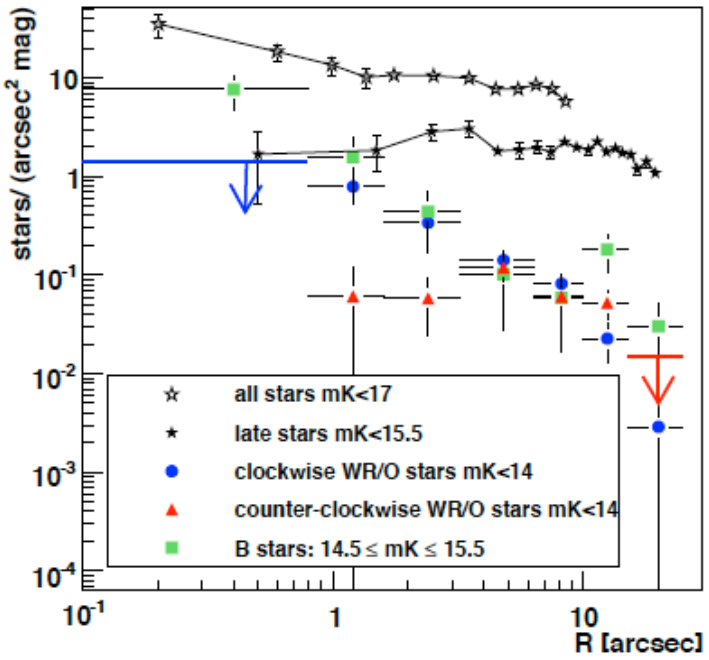
Observations: early vs late-type stars



(Buchholz et al 2009)

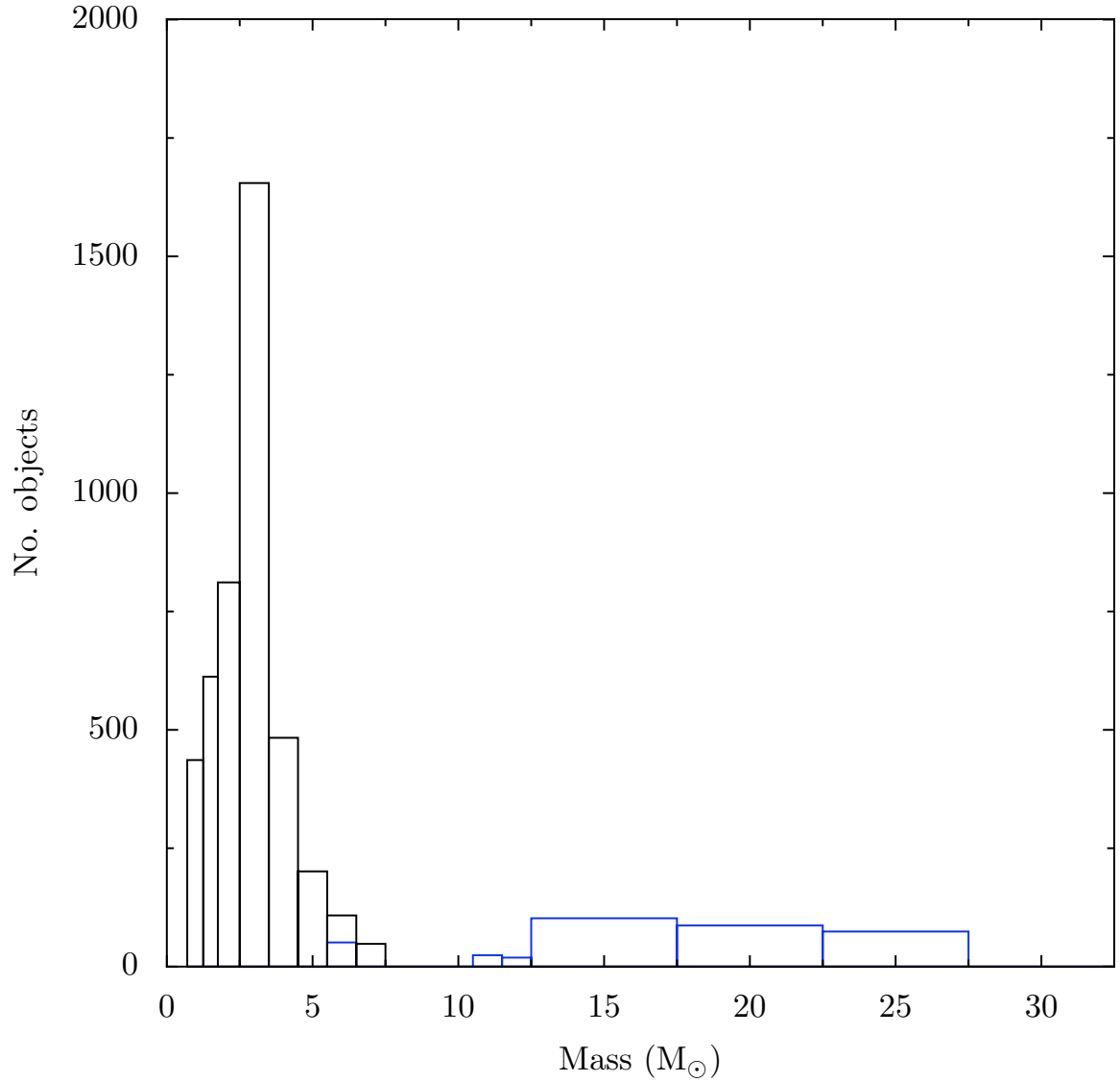


(Do et al 2009)



(Bartko et al 2010)

Early-type are massive, late-types are lower mass



(Davies et al 2010)

Missing giants in the Galactic Centre

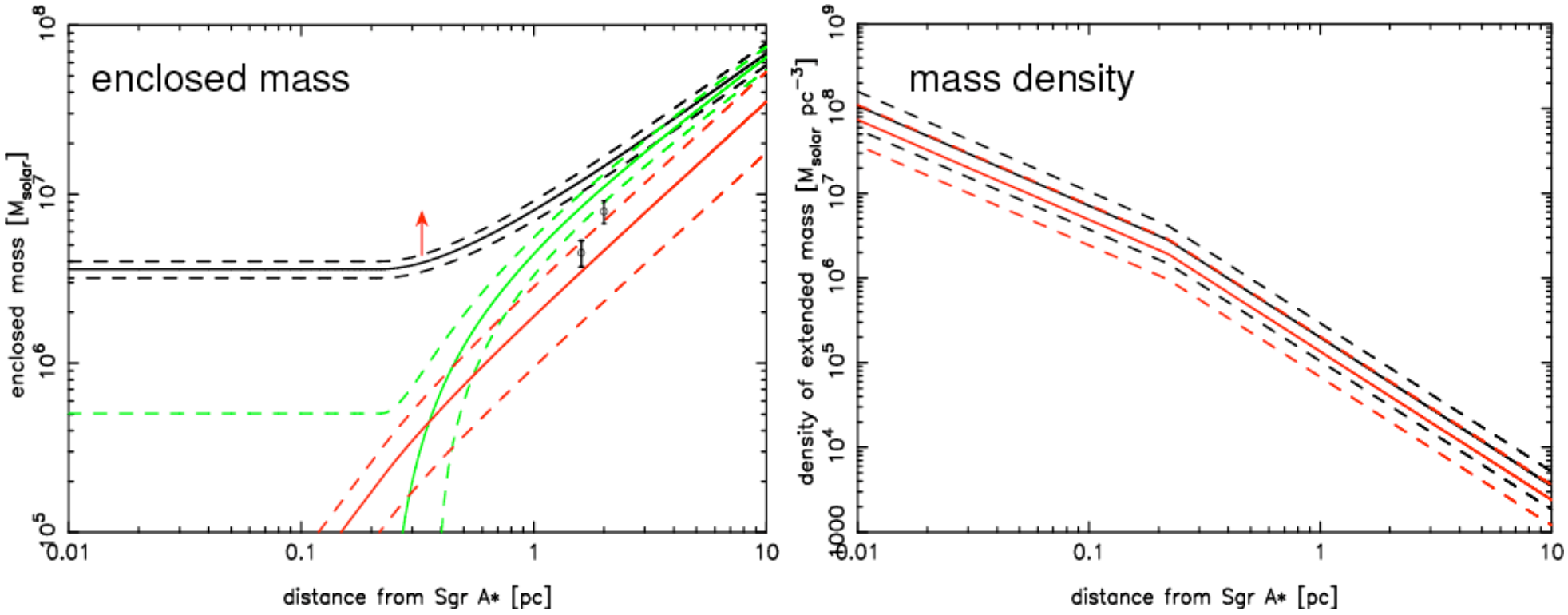
The Galactic Centre cluster is a very dense system

Stellar collisions certainly occur there

Collisions may be able to explain the missing giants

Can use this to study stellar population including objects we cannot see (eg black holes)

Galactic Centre is a dense environment



Plots from Schoedel et al 2007 of dynamical enclosed mass estimates

Clearly have a large number of stars packed into a small volume, $n \sim 10^7 pc^{-3}$ (like a globular cluster...)

Stellar collisions

If, in a given volume of space, the number density of stars is n, the mean velocity is v, and the cross section for collisions is σ, the collision rate per star is nσv

In the region dominated by the SMBH, v is approximately Keplerian

$$v = 400 \left(\frac{r}{0.1\mathrm{pc}} \right)^{-\frac{1}{2}} km/s$$

Collision timescale given by

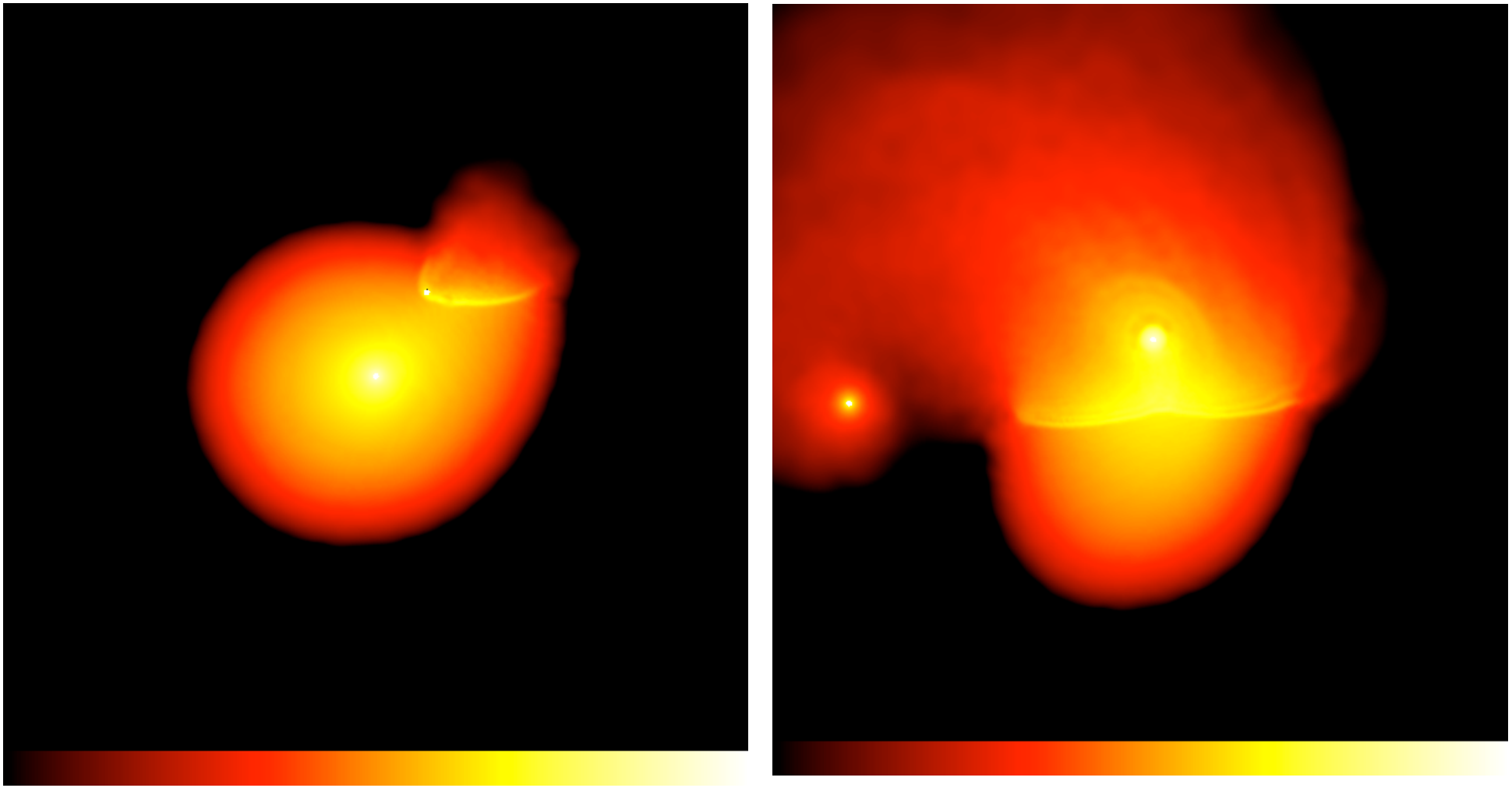
$$t_{coll,unfocussed} \sim 7 \times 10^{10}\mathrm{yr} \left(\frac{n}{10^{7}\mathrm{pc}^{-3}} \right)^{-1} \left(\frac{\mathrm{v}}{10^{3}\mathrm{kms}^{-1}} \right)^{-1} \left(\frac{R_*}{R_\odot} \right)^{-2}$$

Three ways to remove red-giant population:

- RG-BH (clobber giant)
- MS-MS (change range of stellar masses)
- MS-CO (destroy stars)

RG-BH collisions

RG-BH collision with v_∞=800kms^{-1},R_{min}=10$R_\odot$, 1$M_\odot$ giant, 10$M_\odot$ BH



(Dale et al 2009)

What is n(r) in the Galactic Centre?

What do we assume about the star formation in the Galactic Centre?

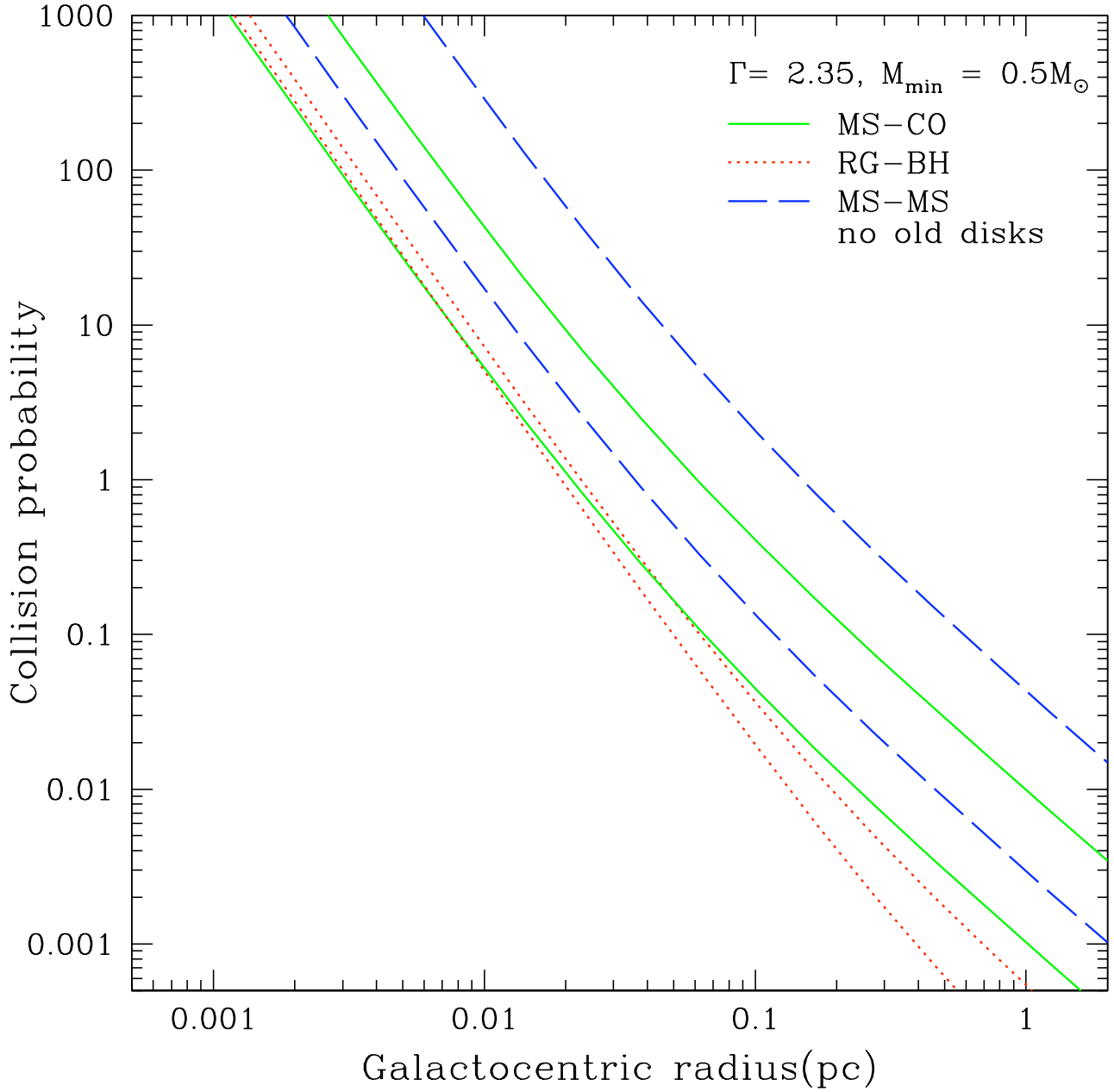
1) IMF slope (eg Miller-Scalo vs flat)

2) Range of stellar masses (eg higher low-mass end)

3) Star formation history (eg more old stars)

Can build up Galactic Centre with a stack of discs

Collision rates for a regular IMF



(Nzoke et al in prep)

Summary for regular IMF

RG-BH collisions can remove some RGs in the very centre of the galaxy (within 0.04 pc)

(Dale et al 2009)

MS-BH collisions can destroy stars but too infrequent

(Dale et al in prep)

MS-MS mergers do not necessarily help: ones become twos but halves become ones (unless there are no halves)

(Nzoke et al in prep)

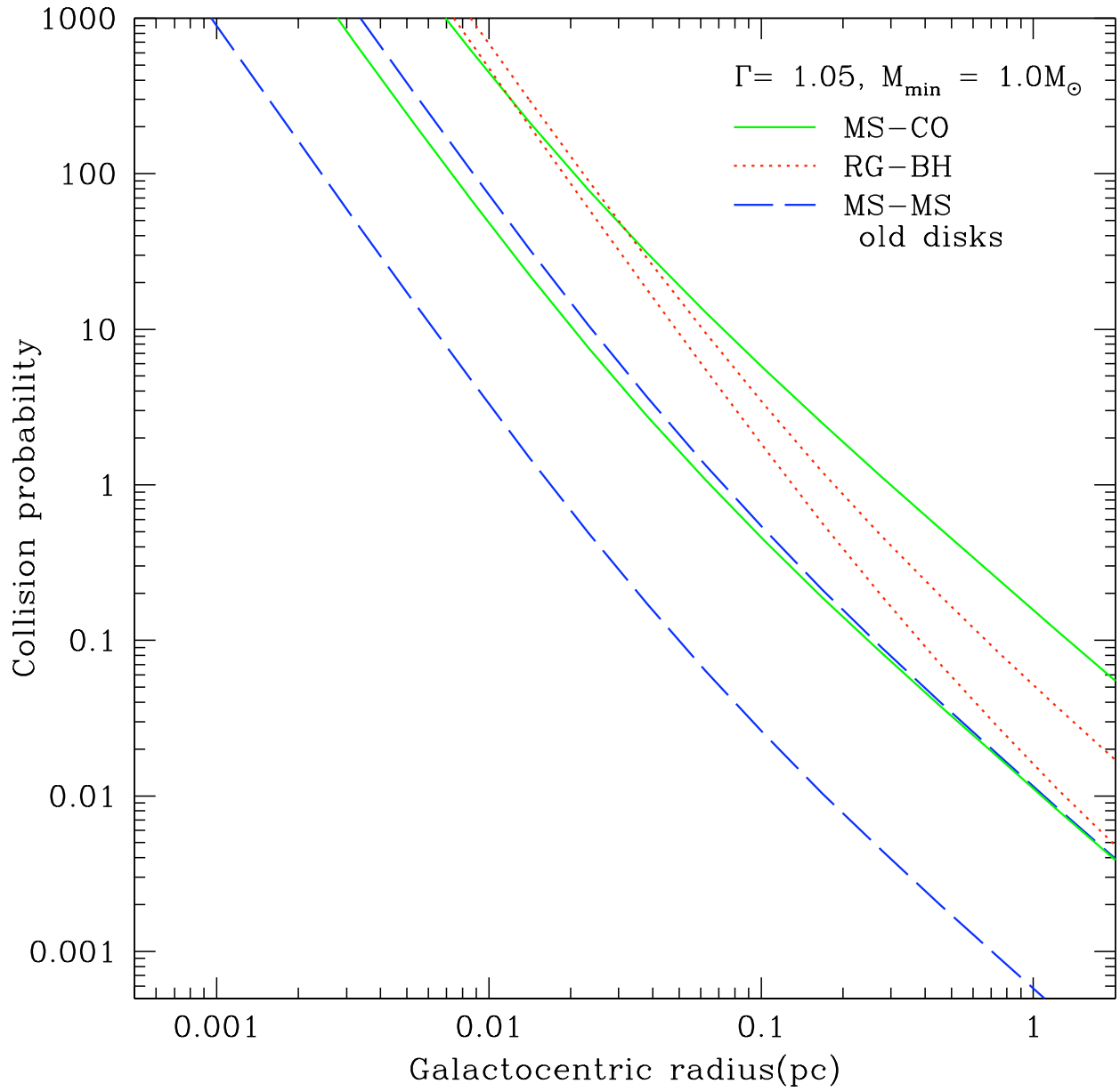
Will now consider the effects of a flatter IMF

There are fewer low-mass stars

Most stars have evolved to become BHs, NSs, or WDs

The dominant collision rate for MS stars involve compact remnants (ie BHs, NSs, or WDs)

Collision rates for a flat IMF



(Nzoke et al in prep)

Summary for flatter IMF

WDs, NSs and BHs dominate population

MS-CO collisions dominate and can destroy stars

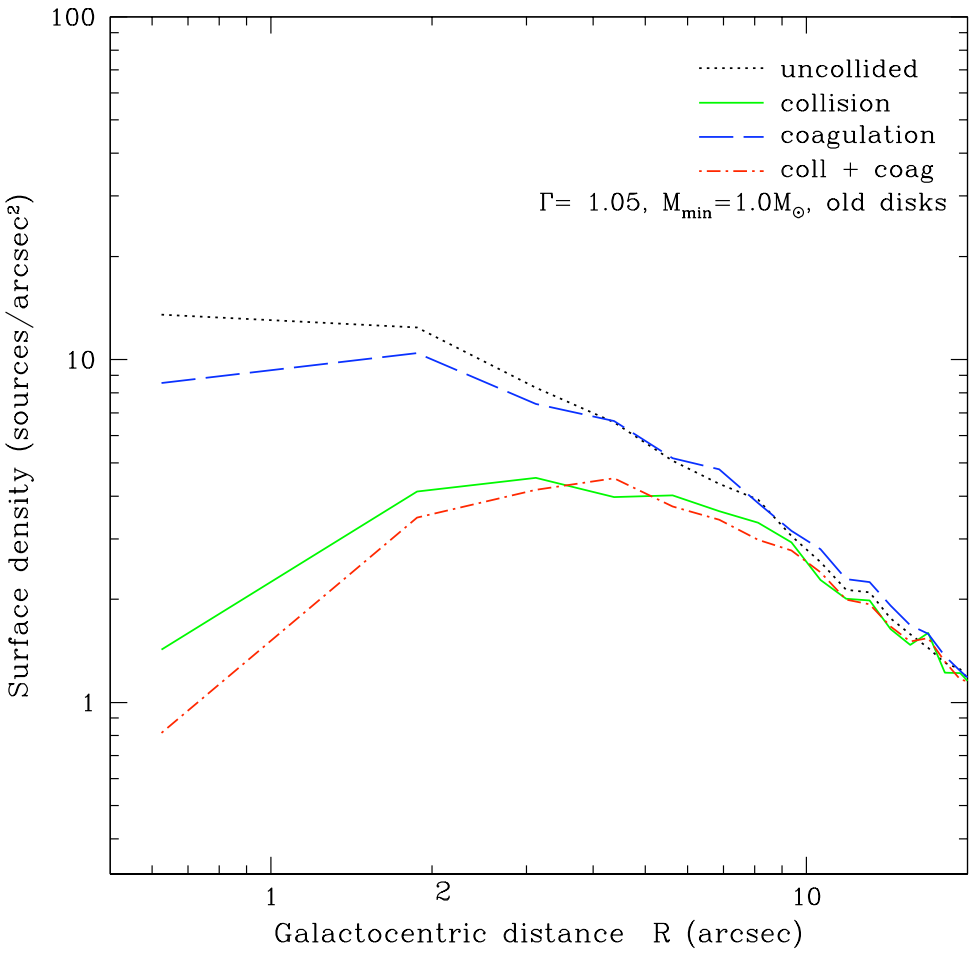
Could frequency be high enough to flatten surface density of late-type stars?

Total mass could be a problem: but BHs may feed SMBH

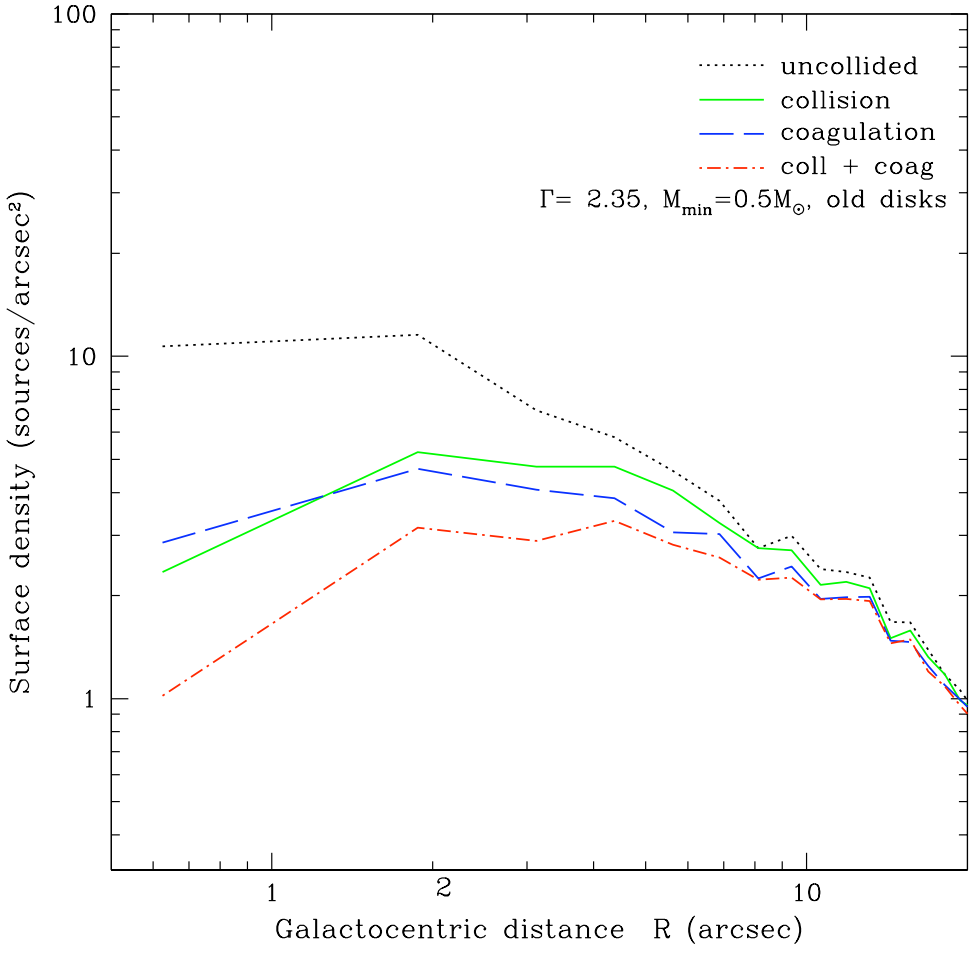
Need to look at dynamical effects (eg mass segregation)

Would have a *GREY CLUSTER* at the galactic centre

Flat IMF



Regular IMF (+old stars)



(Nzoke et al in prep)