

1. **Supermassive black holes in UCDs**
2. How erosion of GCs has affected their specific frequencies
3. Is omega Centauri a star cluster after all?

Steffen Mieske
ESO Chile

MODEST 14
June 6, 2014

Supermassive black holes in UCDs as relics of their progenitors



Seth



Strader



v.d. Bosch



Neumayer



Luetzgendorf



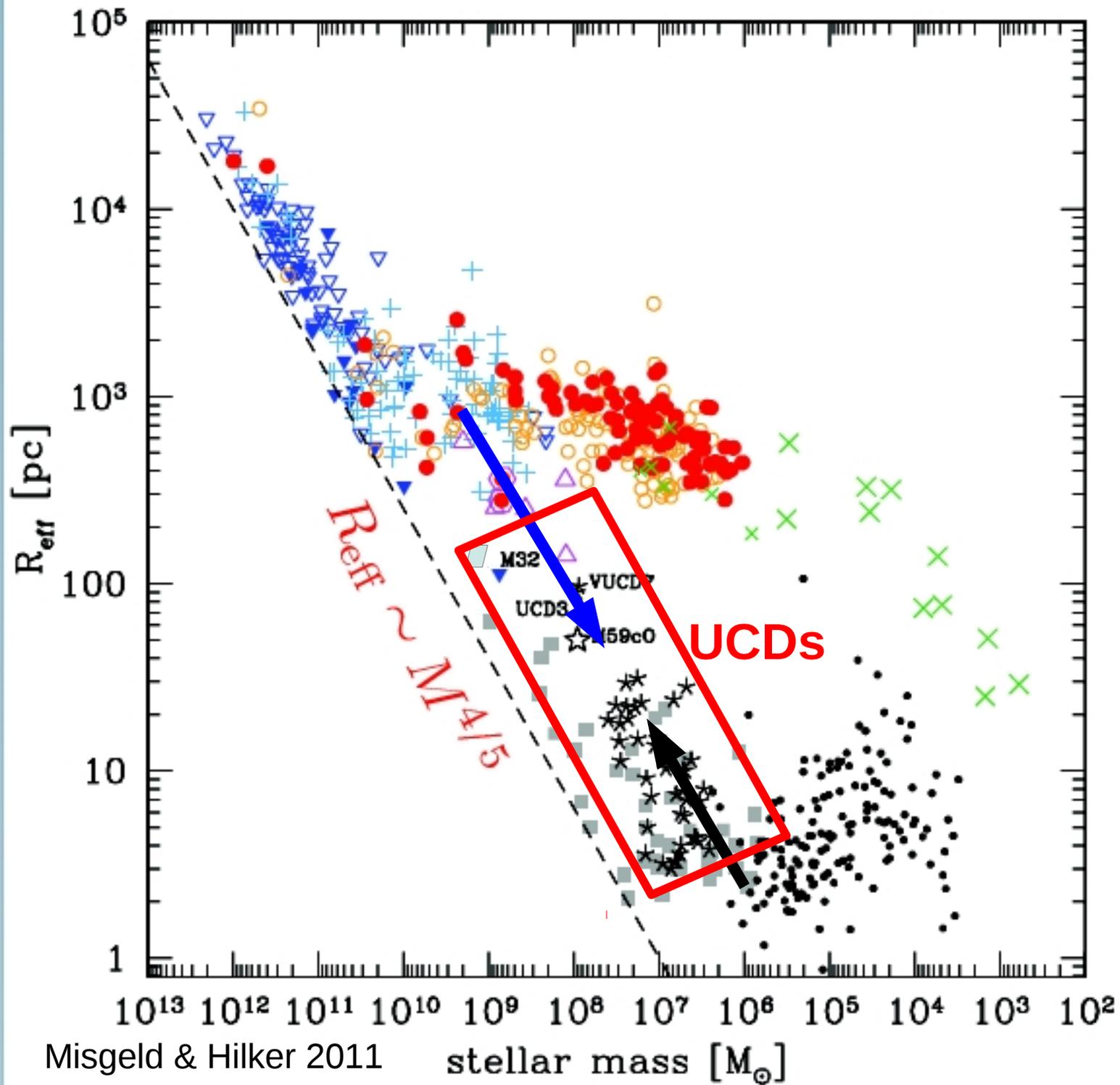
Baumgardt

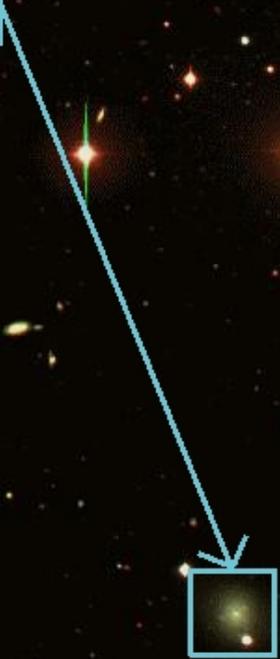
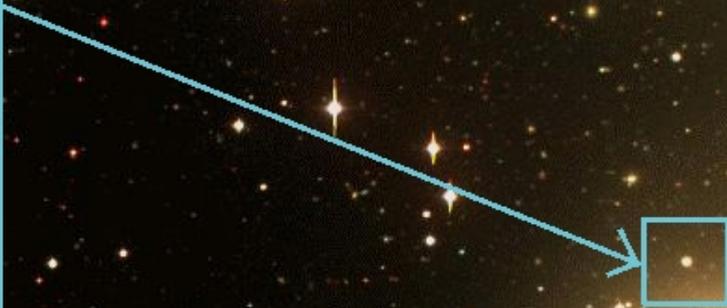
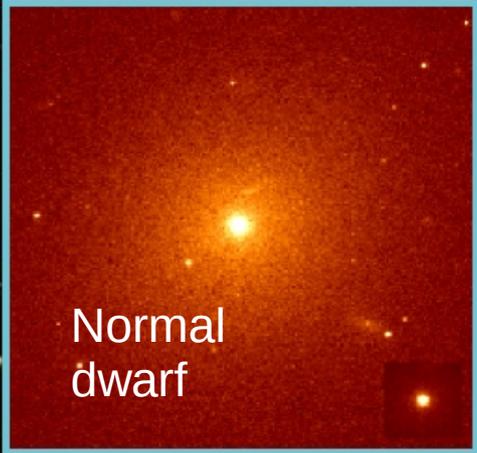
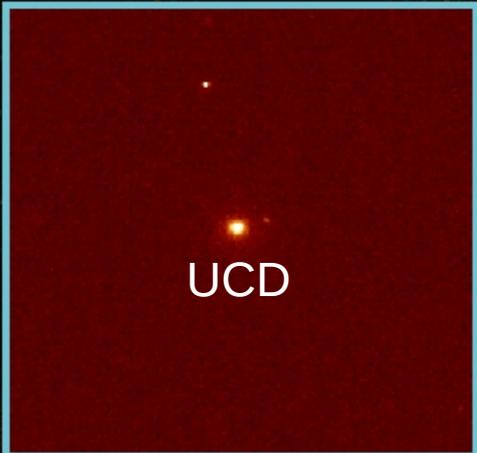


Frank



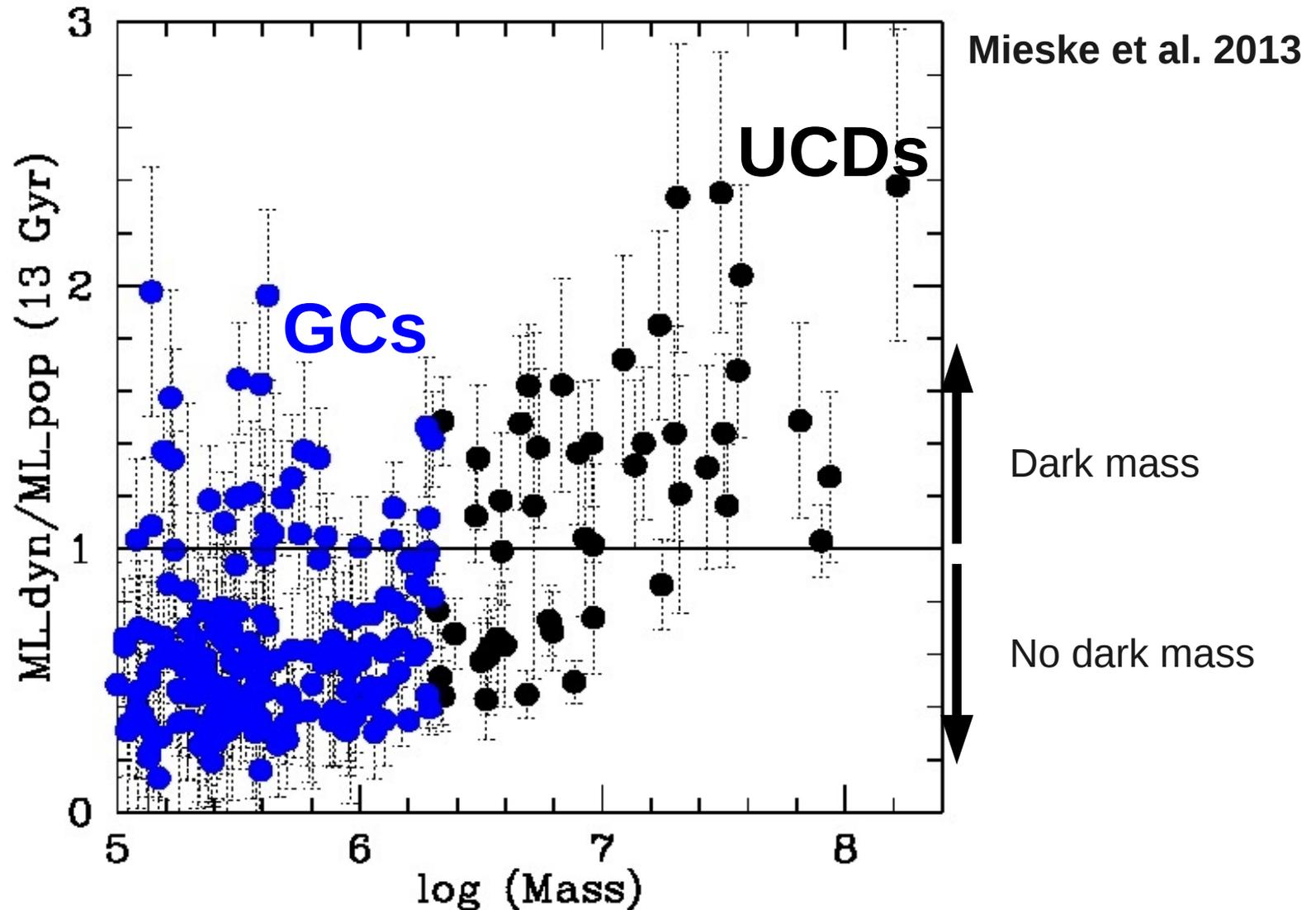
Hilker





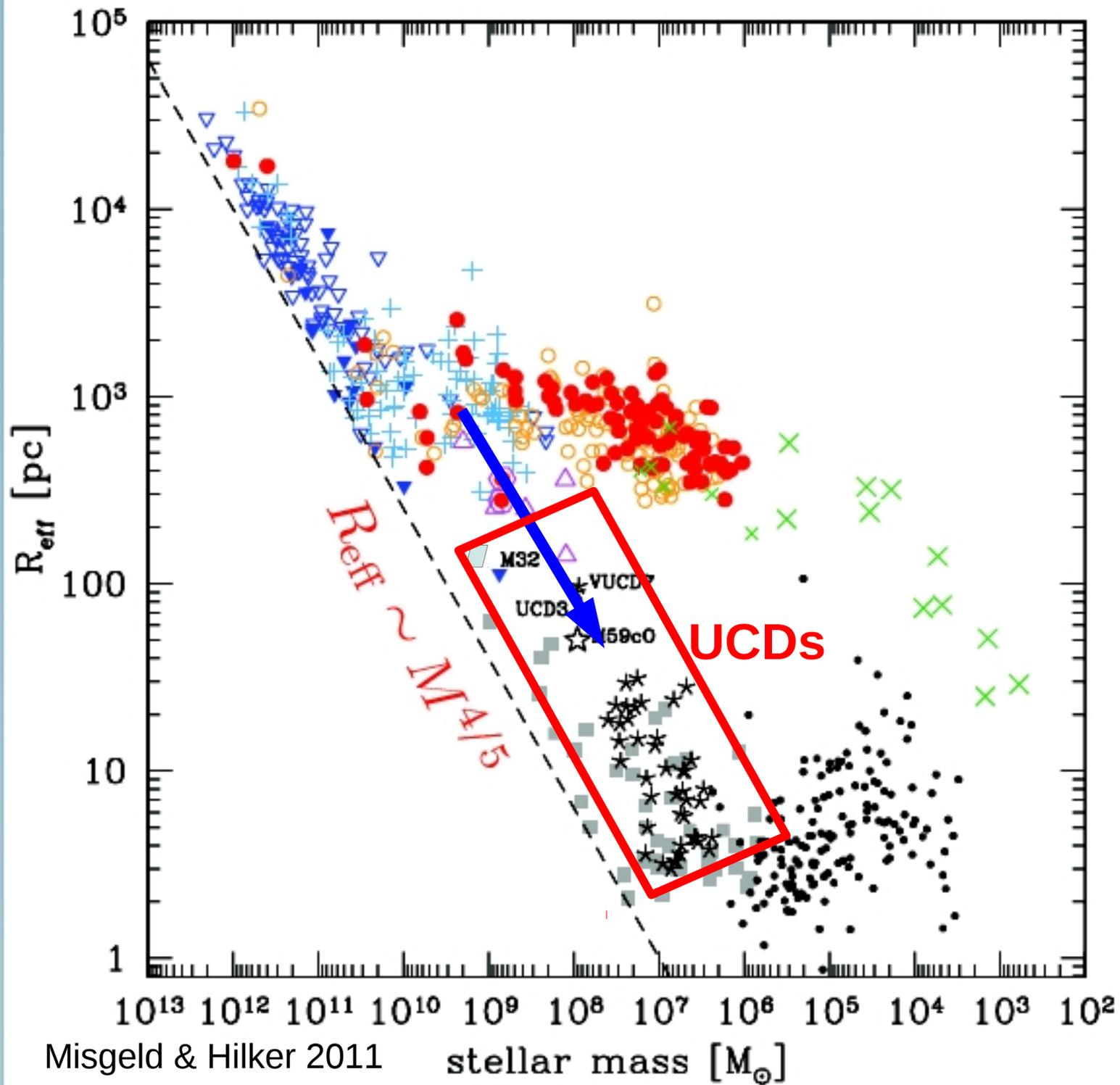
Minniti et al. 1998
Hilker et al. 1999
Drinkwater et al. 2000
Phillipps et al. 2001

Elevated dynamical M/L of UCDs: Black holes or IMF [Dabringhausen]



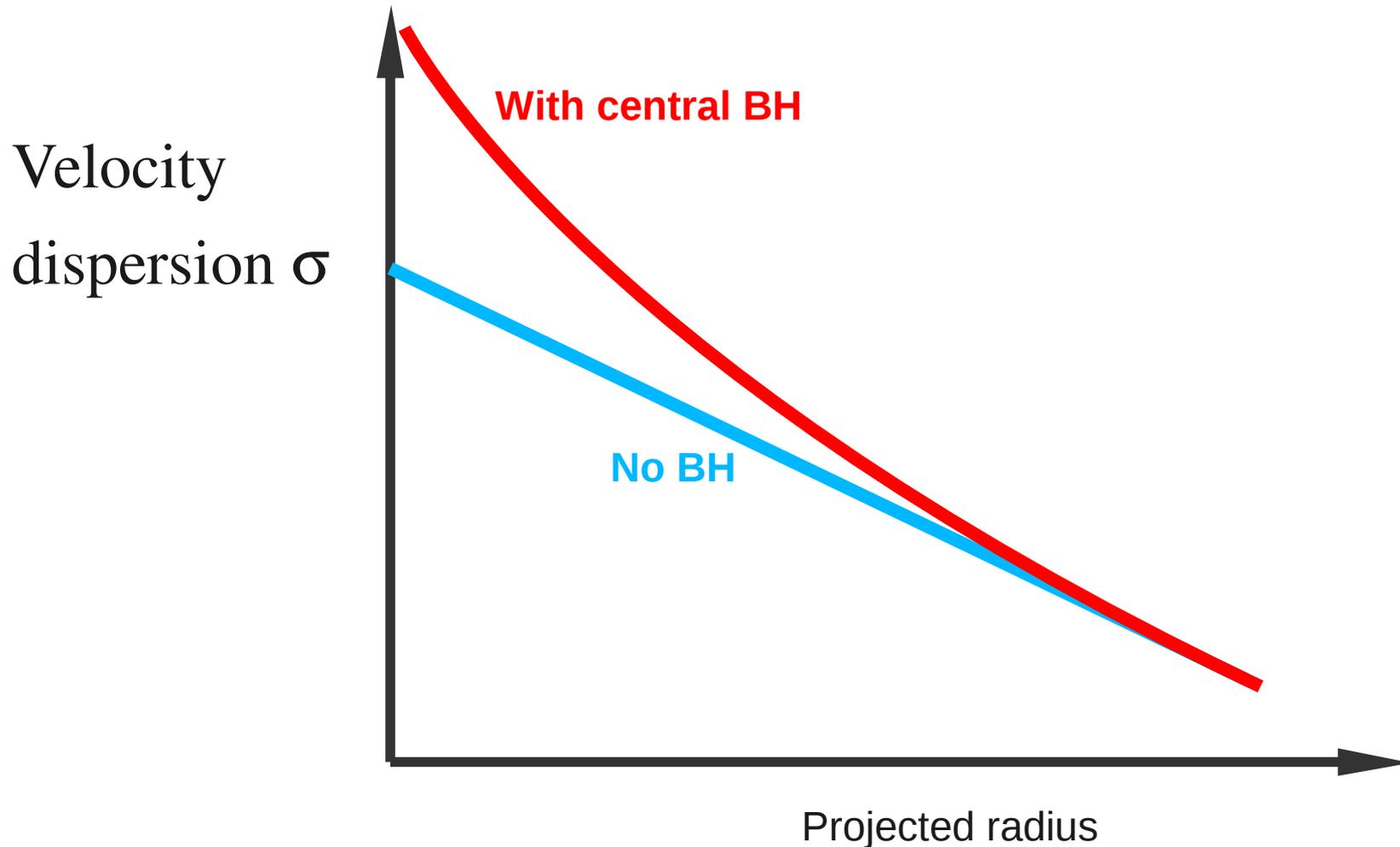
Literature:

McLaughlin et al. 2005, Hasegan et al. 2005, Evstigneeva et al. 2007, Hilker et al. 2007, Mieske et al. 2008 & 2013, Chilingarian & Mamon 2008, Taylor et al. 2010, Chilingarian et al. 2011



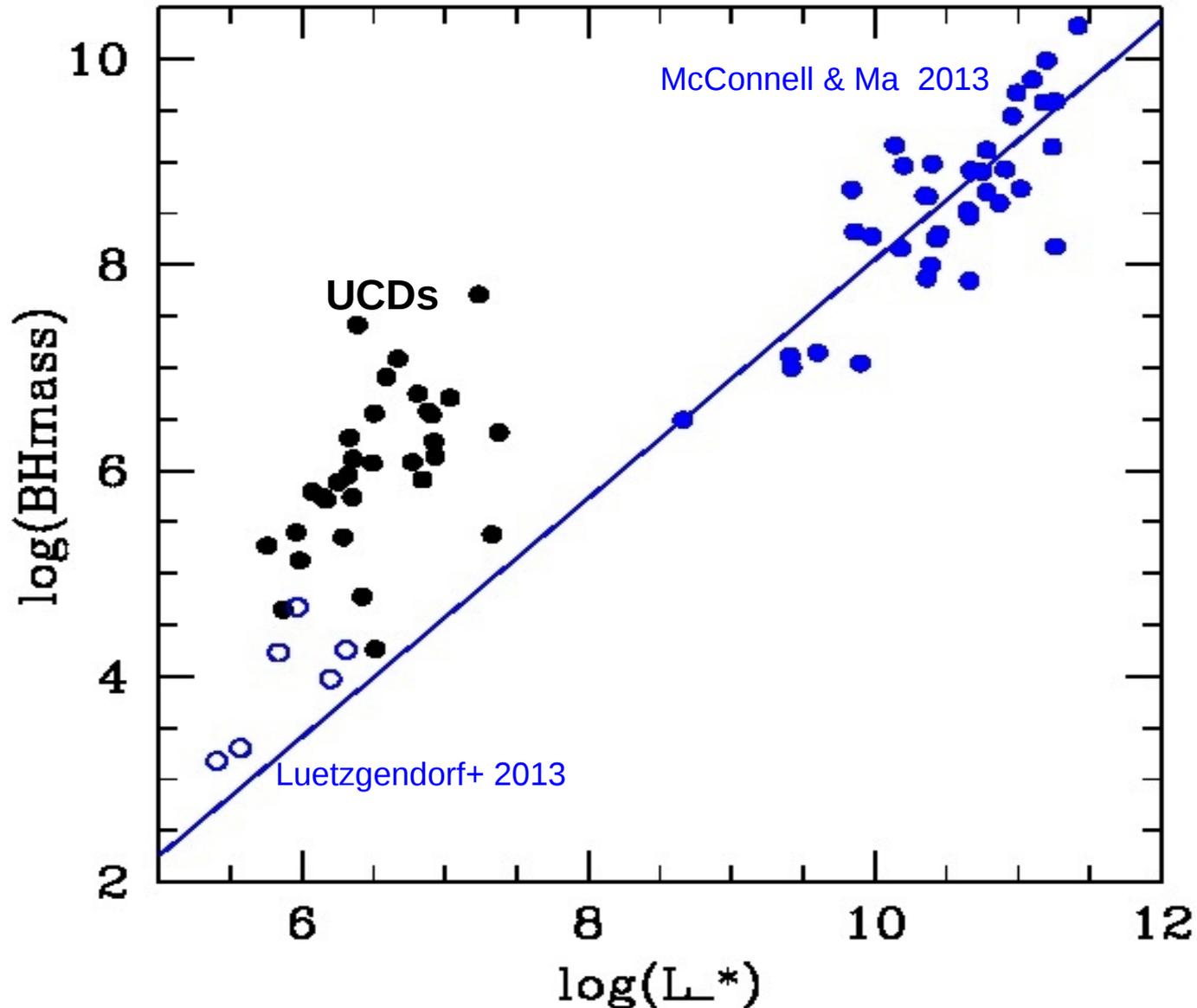
Mieske et al. (2013): calculate central BH masses in UCDs needed to elevate M/L

(Mieske, Frank, Baumgardt, Luetzgendorf, Neumayer, Hilker, A&A 2013, 558, 14)



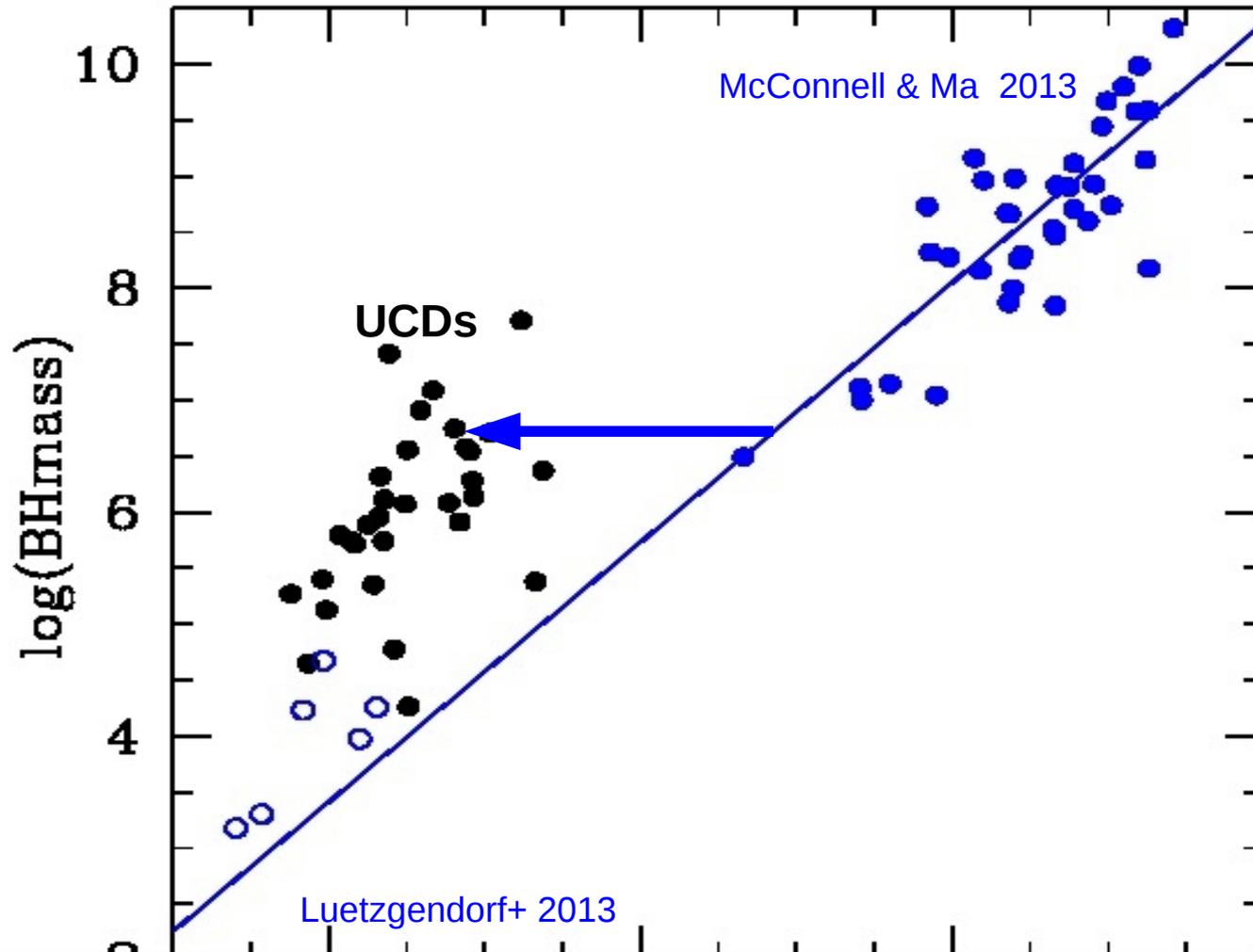
Result: (Mieske+ 2013)

UCDs need $\sim 10\%$ relative BH masses to explain their elevated M/L --> **Progenitor masses $\sim 10^9 M_*$**



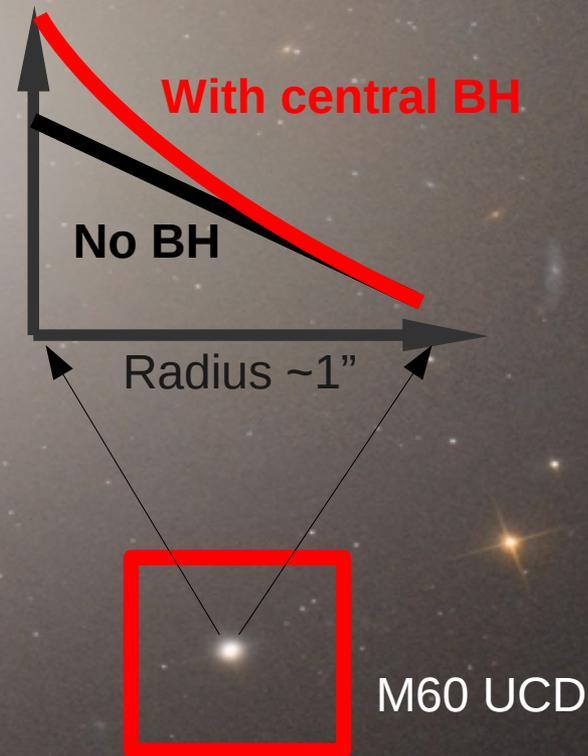
Result: (Mieske+ 2013)

UCDs need $\sim 10\%$ relative BH masses to explain their elevated M/L --> **Progenitor masses $\sim 10^9 M_*$**



Massive BHs in UCDs would thus be relics of massive progenitors.
(Bekki et al. 2003, Pfeffer & Baumgardt 2013)

How to actually detect a SMBH in a UCD



Strader et al. (2013):
"The densest galaxy"

**To resolve the kinematical signature
of an SMBH in UCDs,
one needs AO assisted spectroscopy**

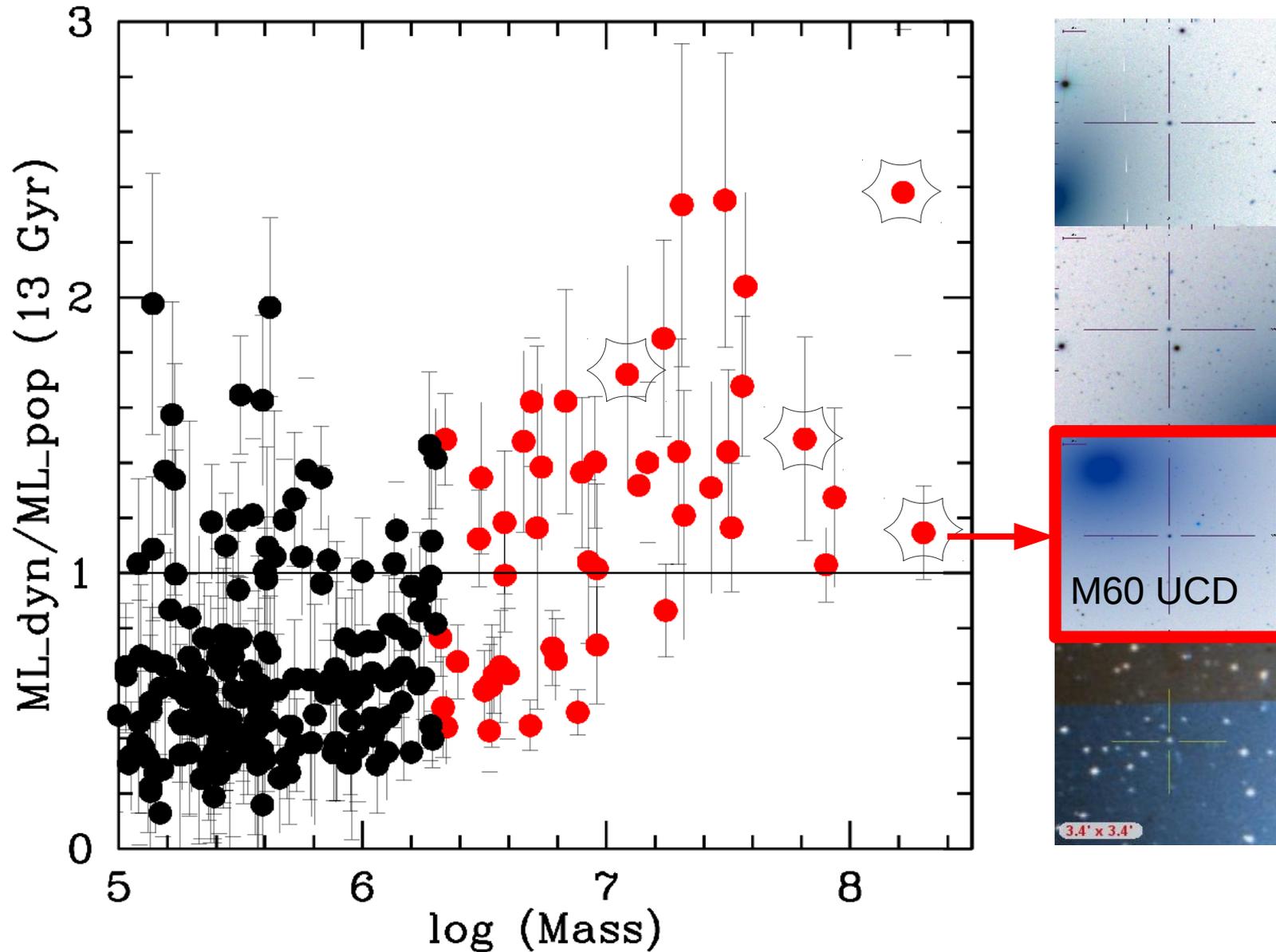
How to actually detect a SMBH in a UCD



**To resolve the kinematical signature
of an SMBH in UCDs,
one needs AO assisted spectroscopy**

Three ongoing LGS programs to resolve UCD dynamics: Gemini, Keck, VLT

[PIs Seth, Brodie, Mieske]



Preliminary results for M60UCD, the most massive UCD (Seth et al. in preparation)

Reconstructed image of M60 UCD1 from
Gemini NIFS observations Feb+May 2014

$r_h \sim 0.30''$ [24 pc]
HWHM of AO PSF $\sim 0.08''$ [6-7 pc]

M60 UCD



Preliminary results for M60UCD, the most massive UCD (Seth et al. in preparation)

Redacted, not for public use yet

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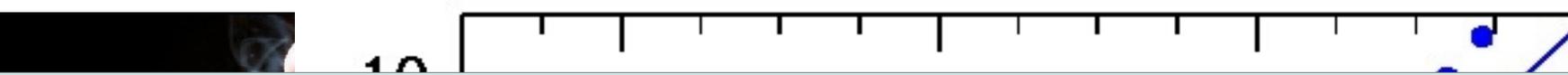
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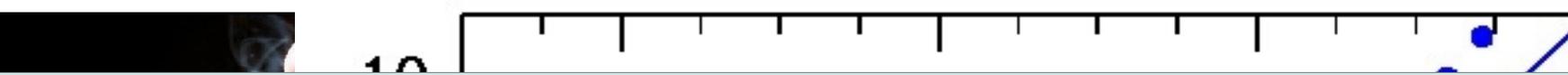
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M60 UCD black hole in context



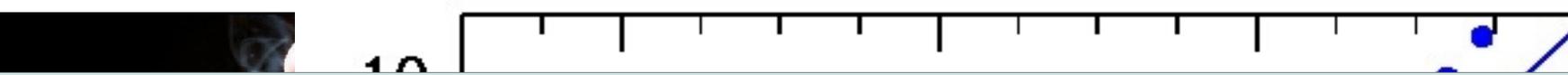
Redacted, not for public use yet

M60 UCD black hole in context



Redacted, not for public use yet

M60 UCD black hole in context



Redacted, not for public use yet

Summary

1. Evidence for a $10^7 M_*$ black hole in $10^8 M_*$ M60UCD

Offset from L-BH relation is consistent with tidal stripping.
How do UCDs contribute to BH demographics?

2. Erosion of GCs creates a u-relation between S_N and M_V

Need to consider GC erosion when discussing primordial formation efficiencies of star clusters

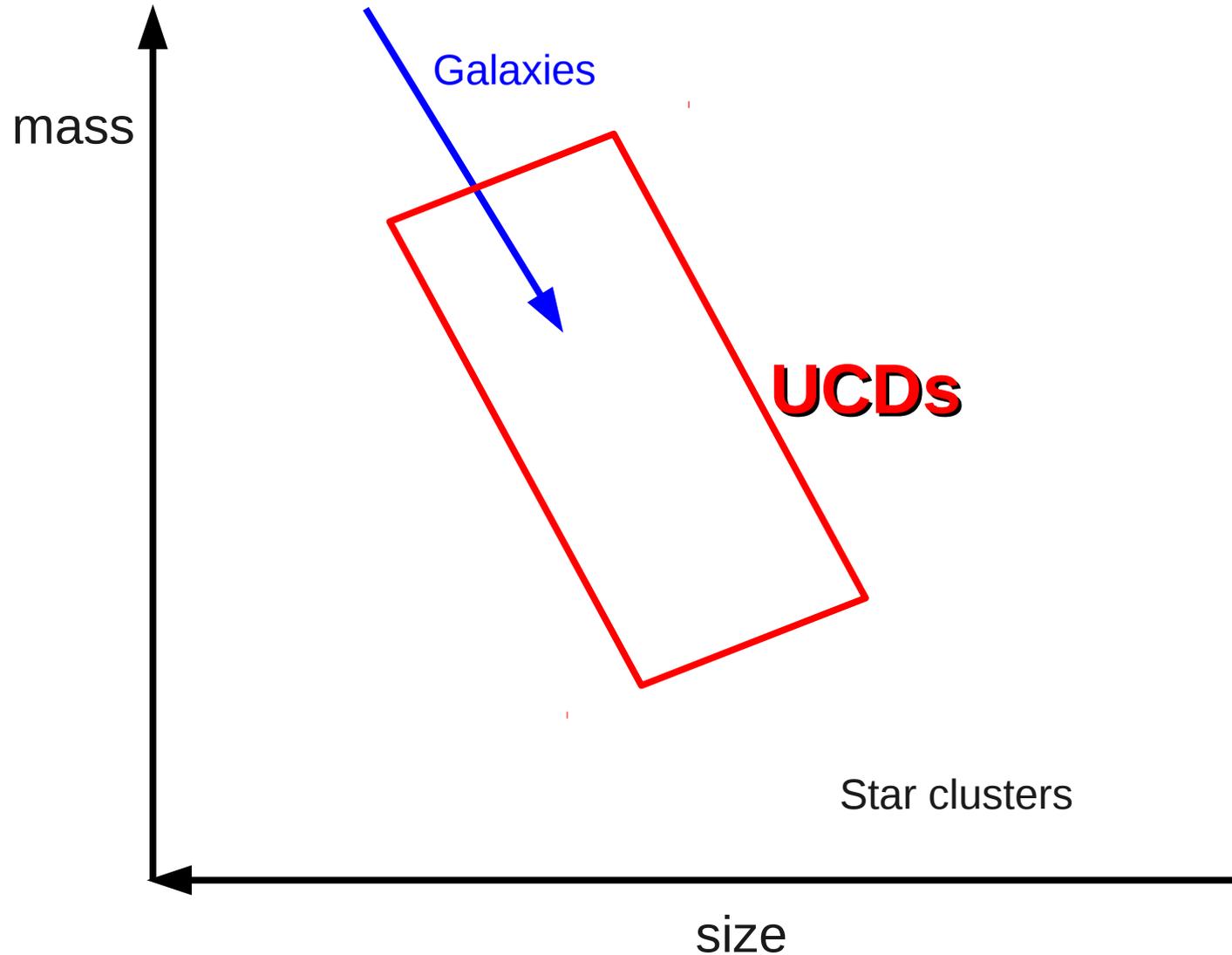
3. Metal self-enrichment appears a normal GC property in omega Centauri regime

No need to invoke a galaxian origin for omega Centauri?

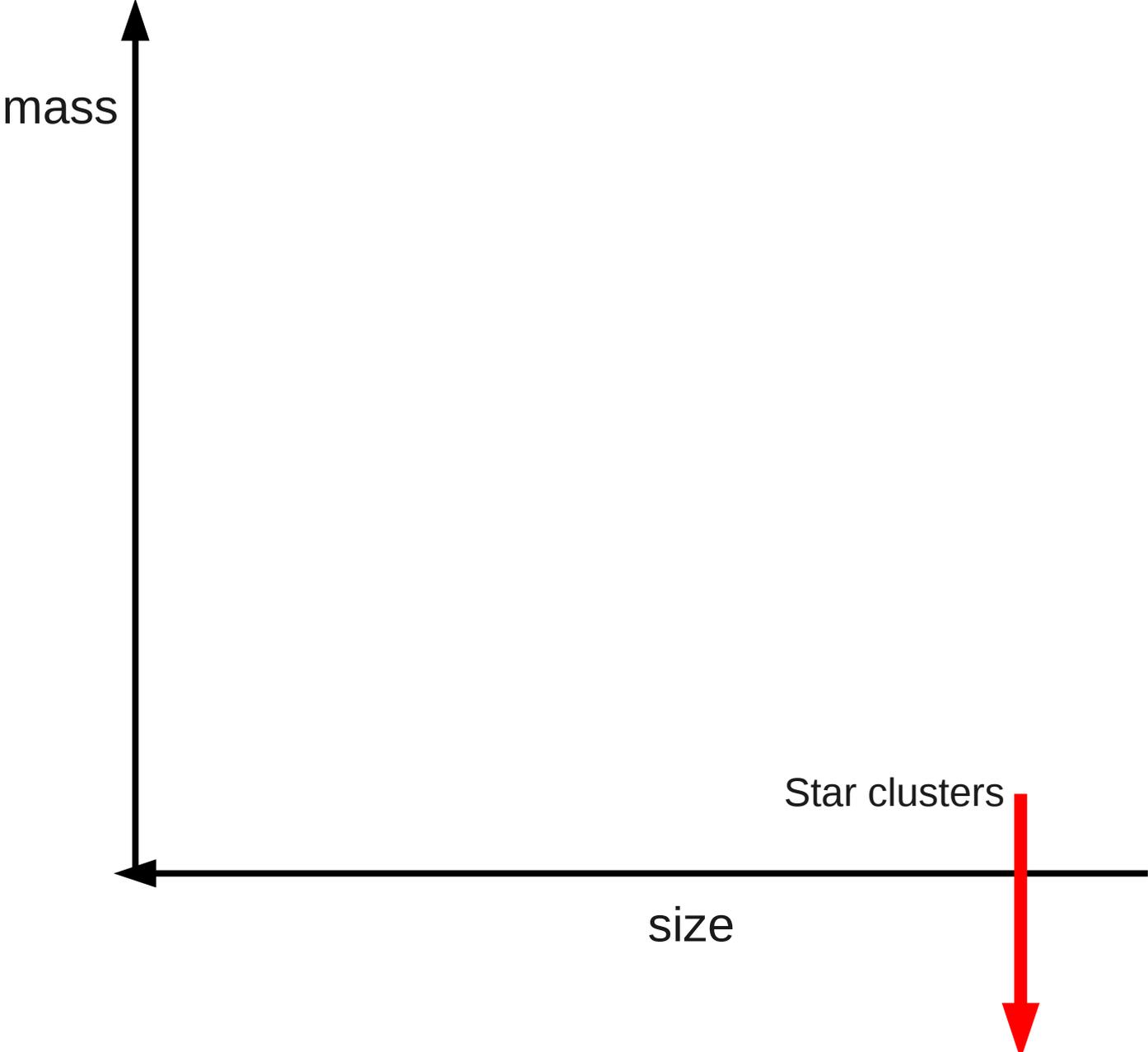
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How tidal erosion has shaped the relation between GC specific frequency and galaxy luminosity

(2014 A&A letters, 565, 6)

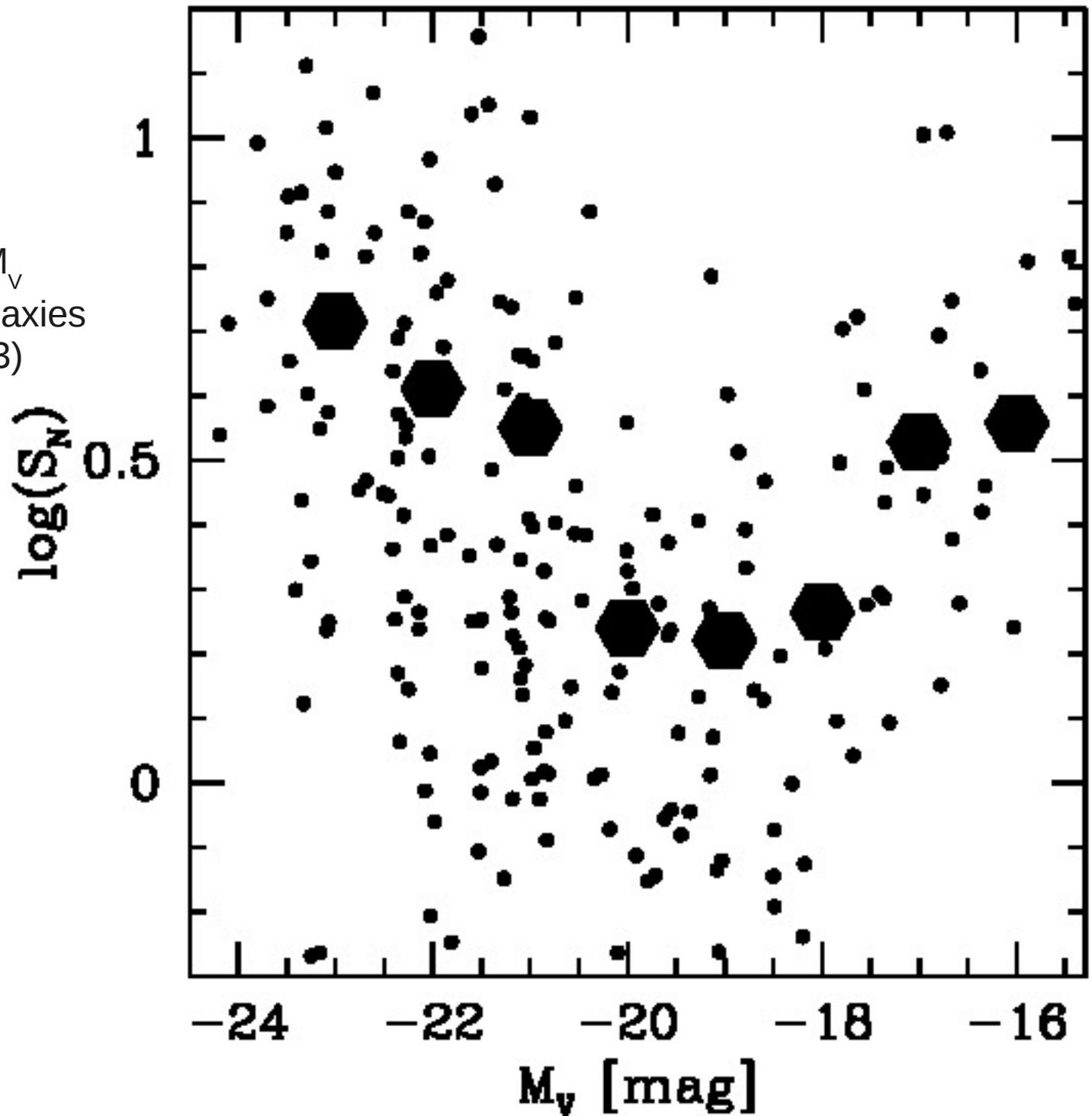
Steffen Mieske, Andreas Kuepper,



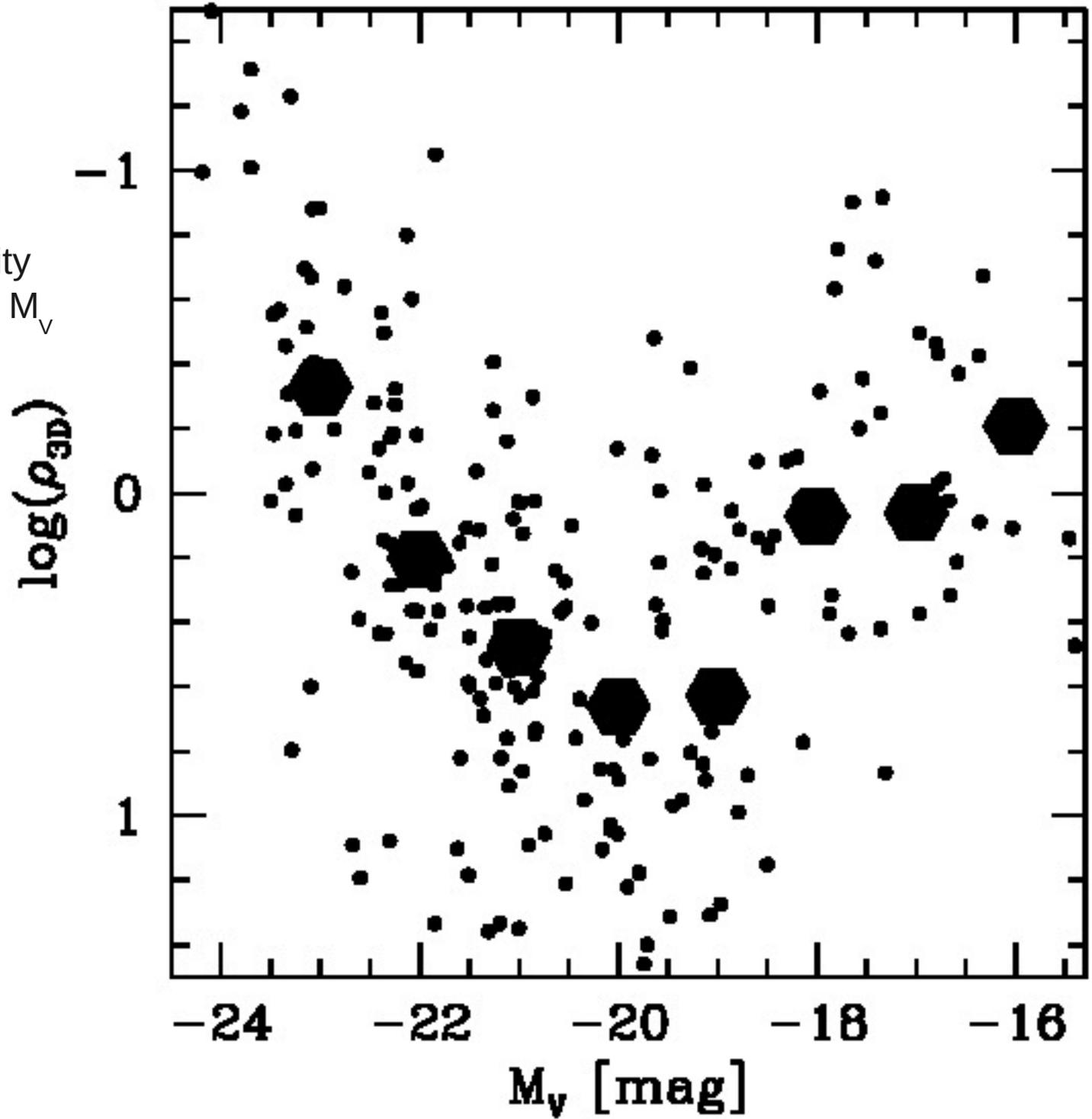
Michael Brockamp



Mieske et al. (2014):
Compilation of S_N vs M_V
for ~ 200 early-type galaxies
from Harris et al. (2013)



Mieske et al. (2014):
Dynamical mass density
 ρ_{3D} within r_h plotted vs M_V



Brockamp, Kuepper, Thies, Kroupa, Baumgardt (2014):

“Erosion of globular cluster systems: the influence of radial anisotropy, central black holes and dynamical friction”

See also:

Murali & Weinberg 1997

Vesperini 2000

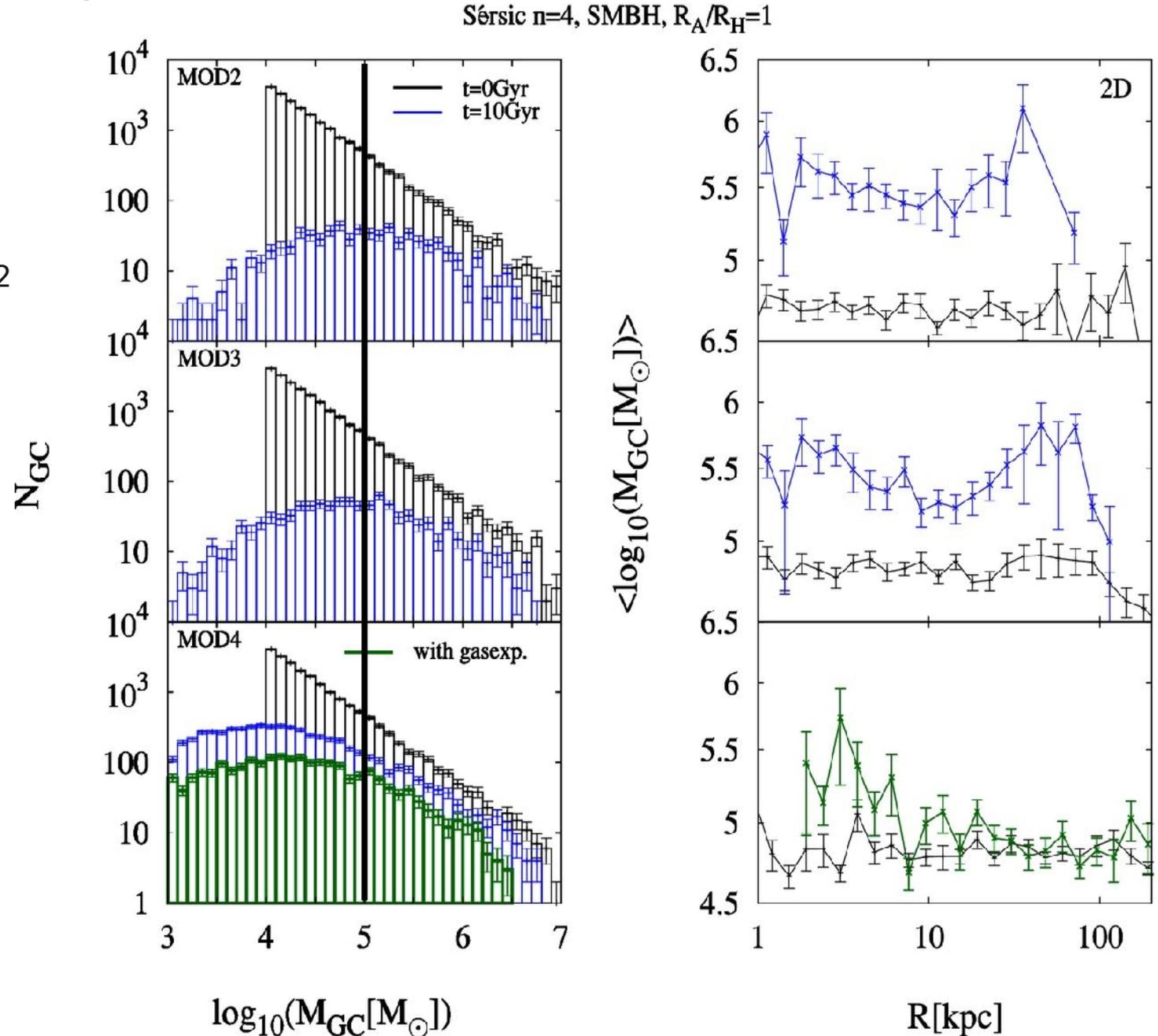
Baumgardt 1998

Fall & Zhang 2001

Vesperini et al. 2003,

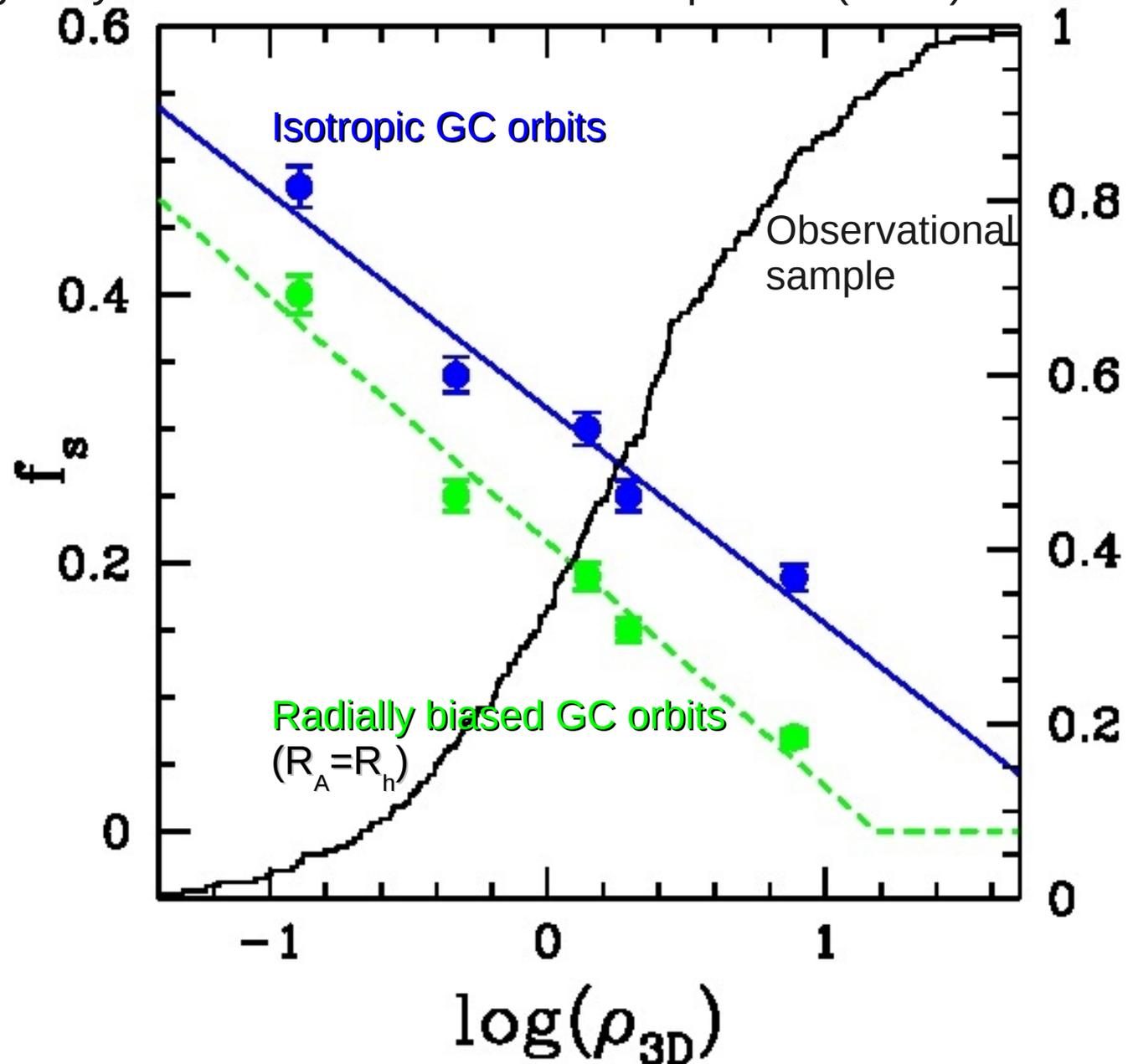
Sanchez-Janssen et al. 2012

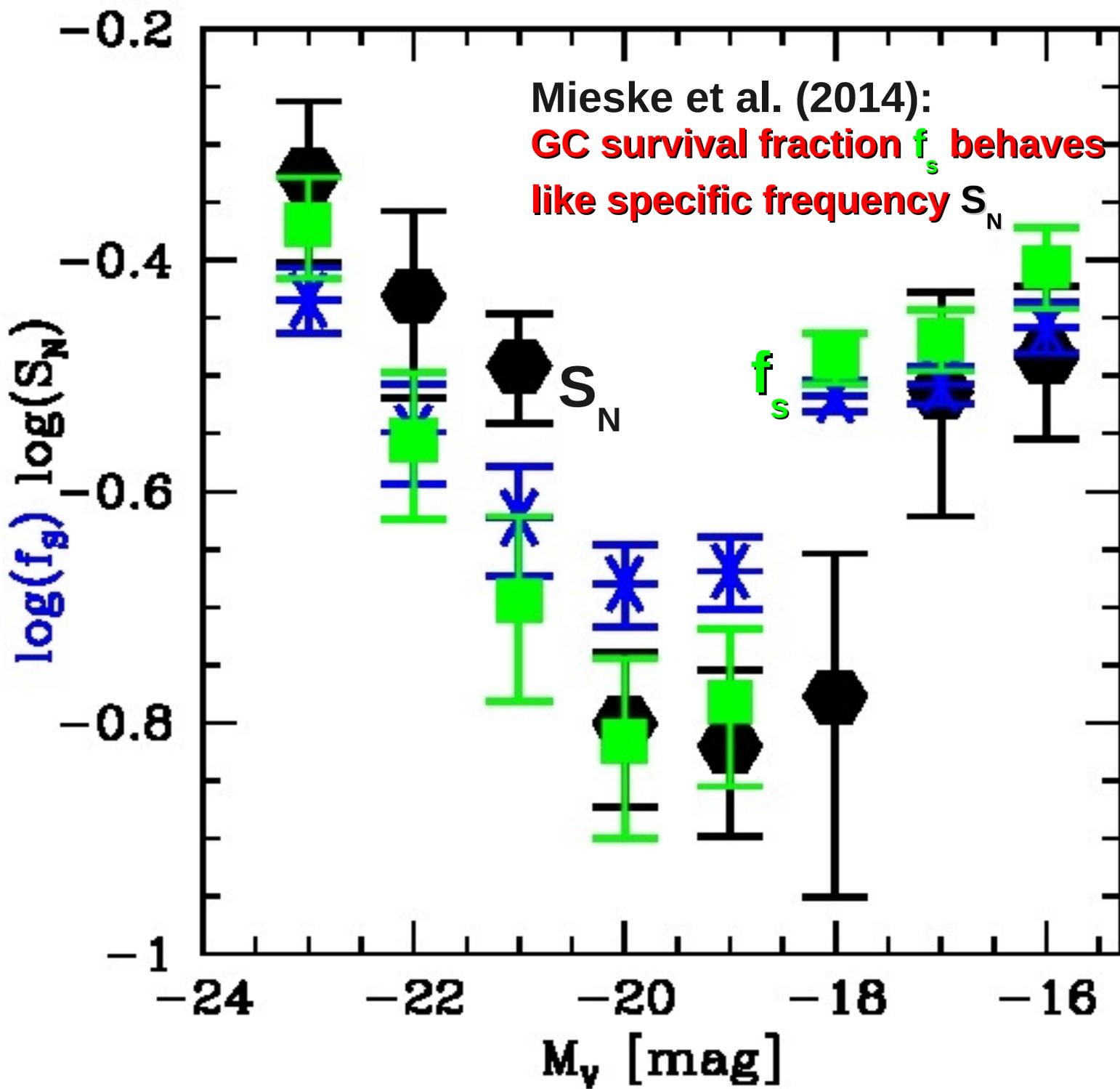
Smith et al. 2013



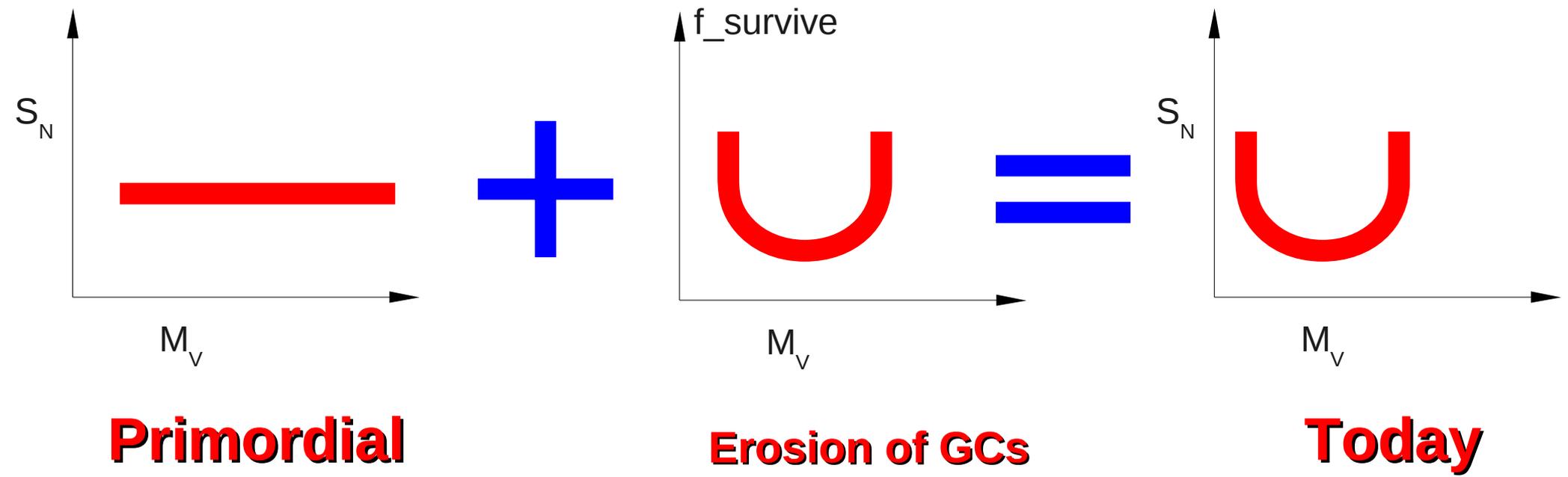
Mieske et al. (2014):

Fraction of surviving globular clusters after 10 Gyr as a function of mass density for 5 representative galaxy models taken from Brockamp et al. (2014)





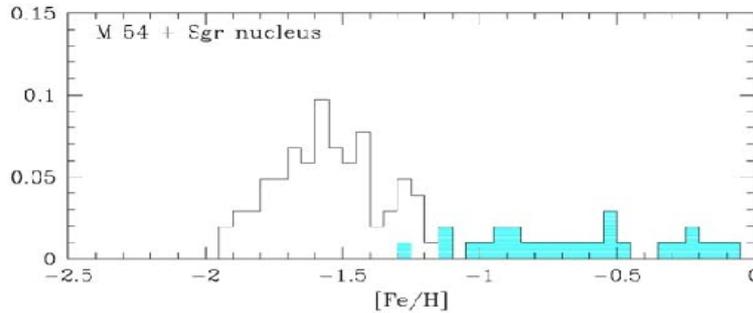
Tidal erosion is an important contributor to the u-shaped relation between GC specific frequency and host galaxy luminosity



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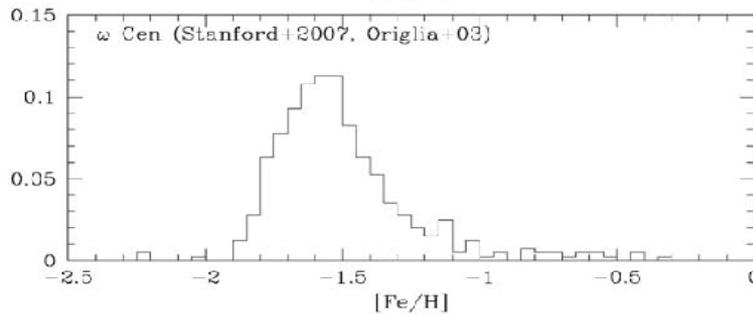
Is ω Cen a star cluster after all?

ω Cen & M54
[Fe/H]
Carretta et al.

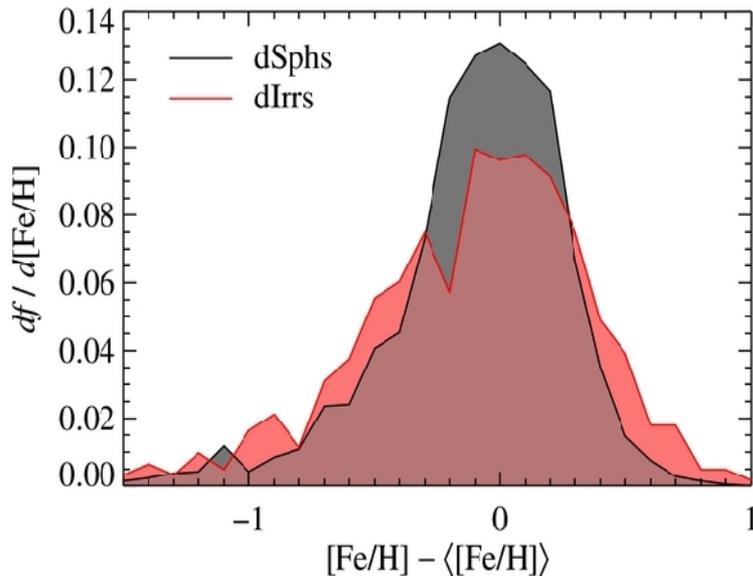


BROAD
[Fe/H]
distribution

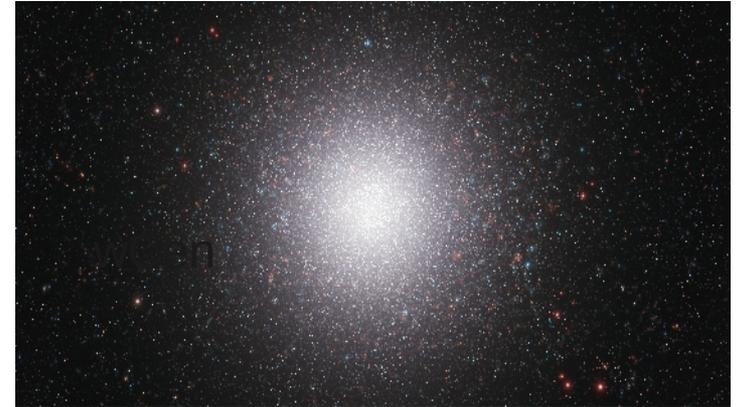
Other GCs
have sharp
peak



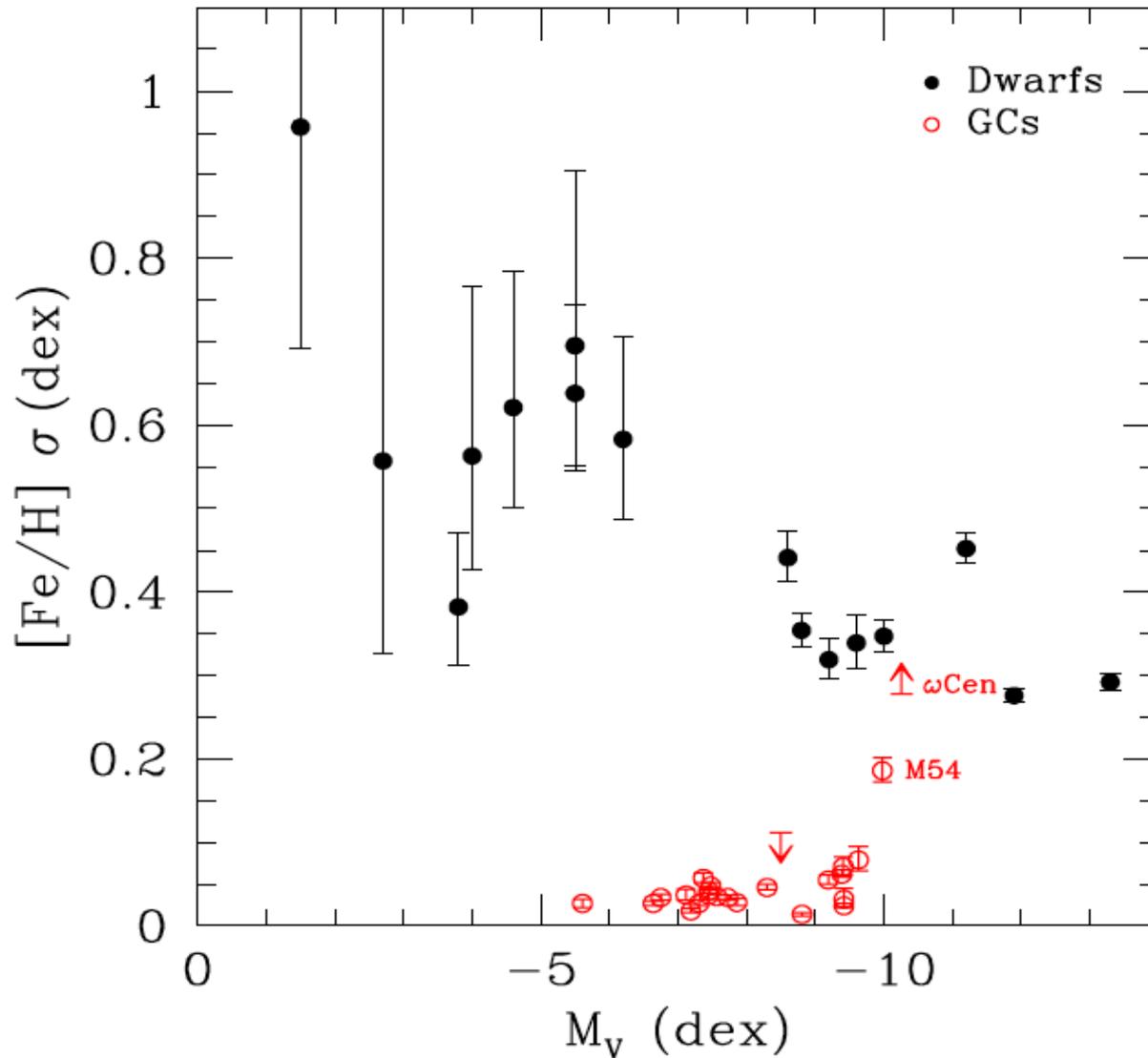
dSphs
[Fe/H]
Kirby et al.



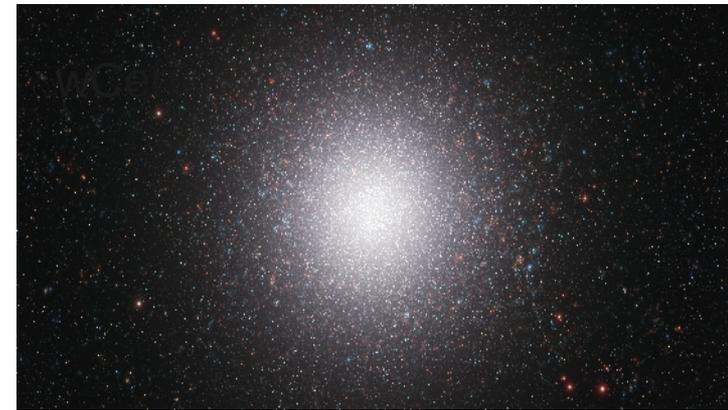
also BROAD



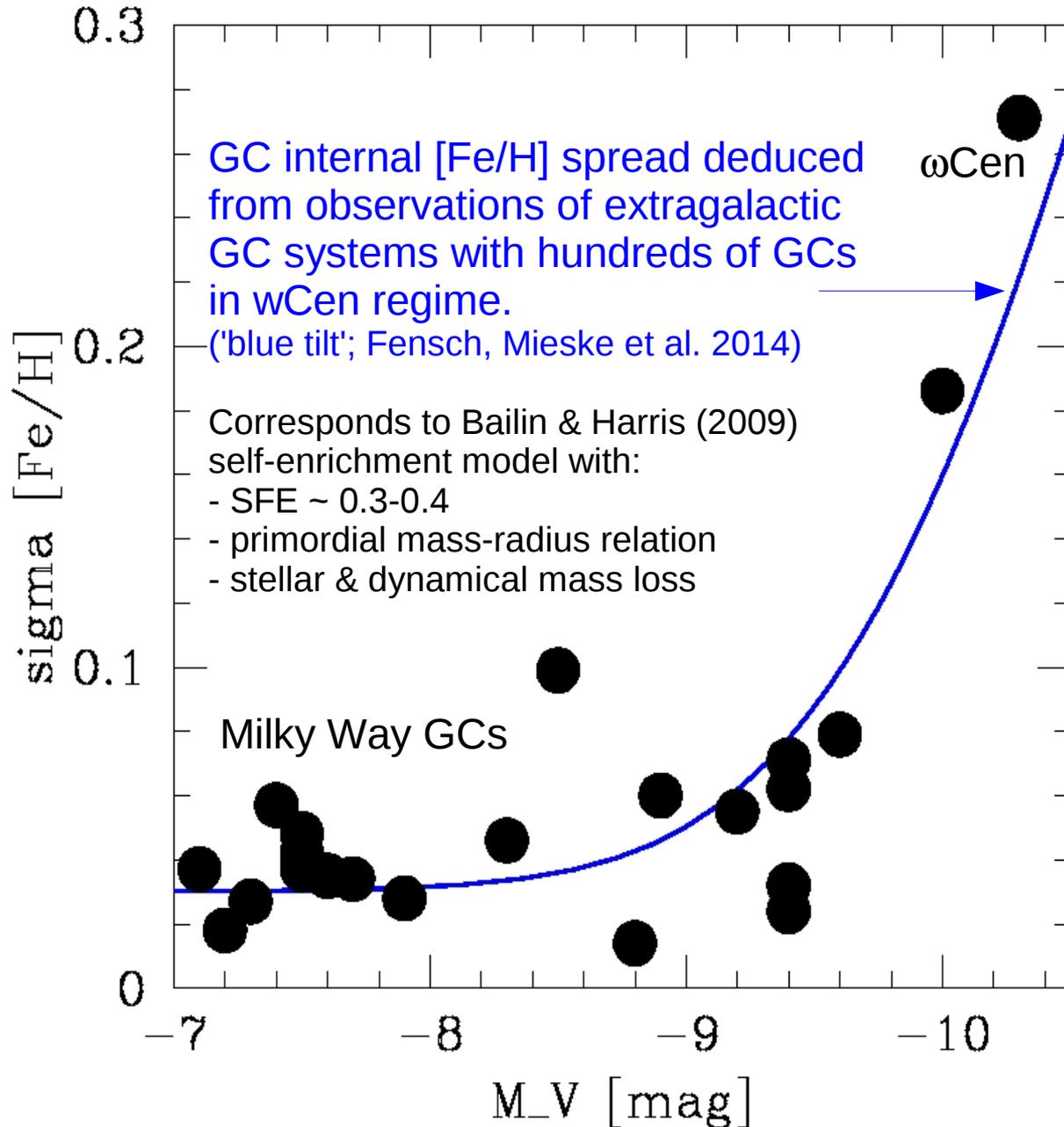
Is ω Cen a star cluster after all?



Strader & Willman (2012)
Forbes & Kroupa (2011)



Is ω Cen a star cluster after all?



Details in

Fensch, Mieske, Mueller-Seidlitz, Hilker 2014, A&A in press (arXiv:1406.1397)

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