The stellar populations of ultra compact dwarf galaxies

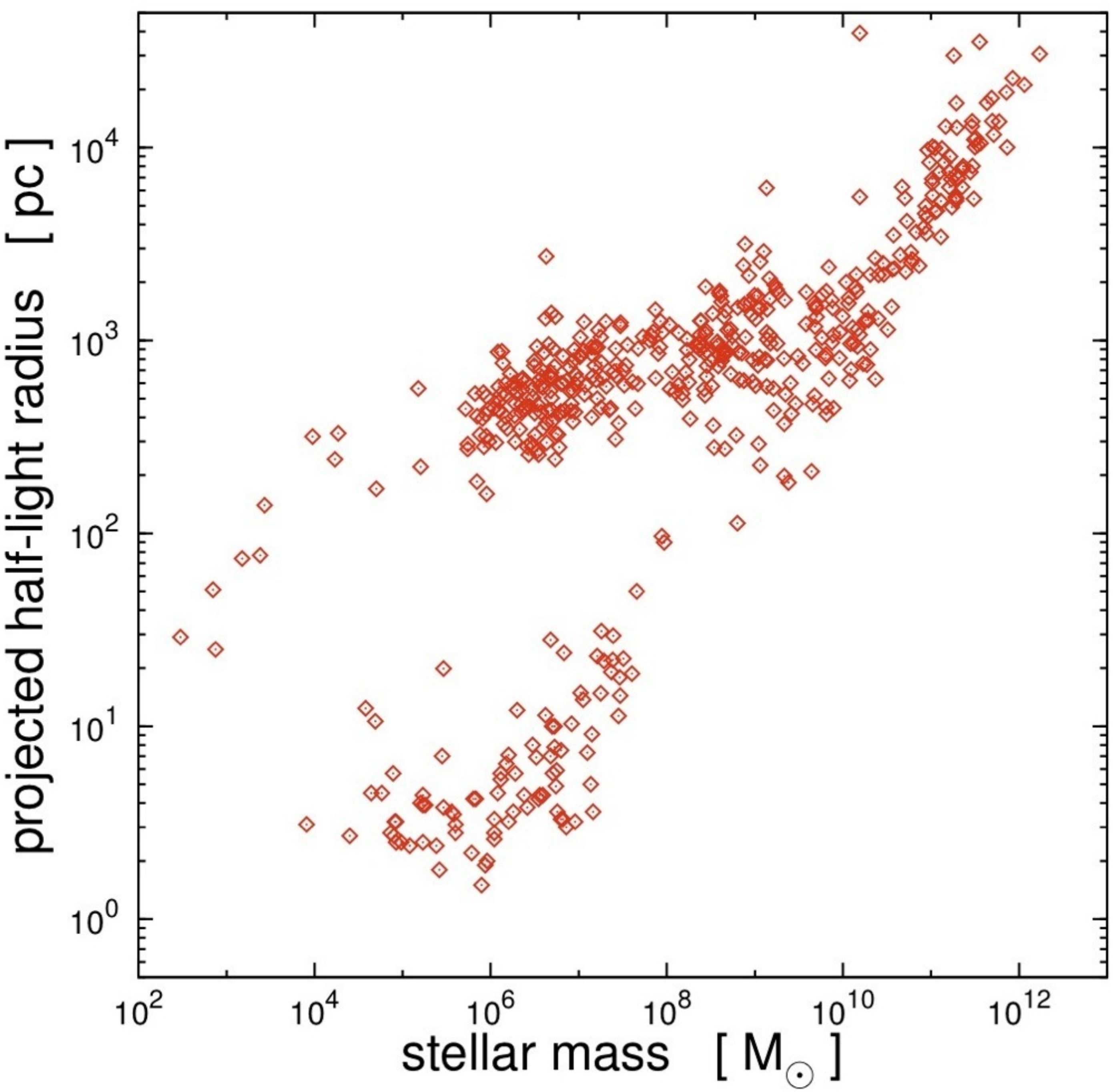
Jörg Dabringhausen

FONDECYT Postdoctoral fellow

Universidad de Concepción

What are Ultra-compact dwarf galaxies (UCDs) ?

Pressure-supported stellar systems



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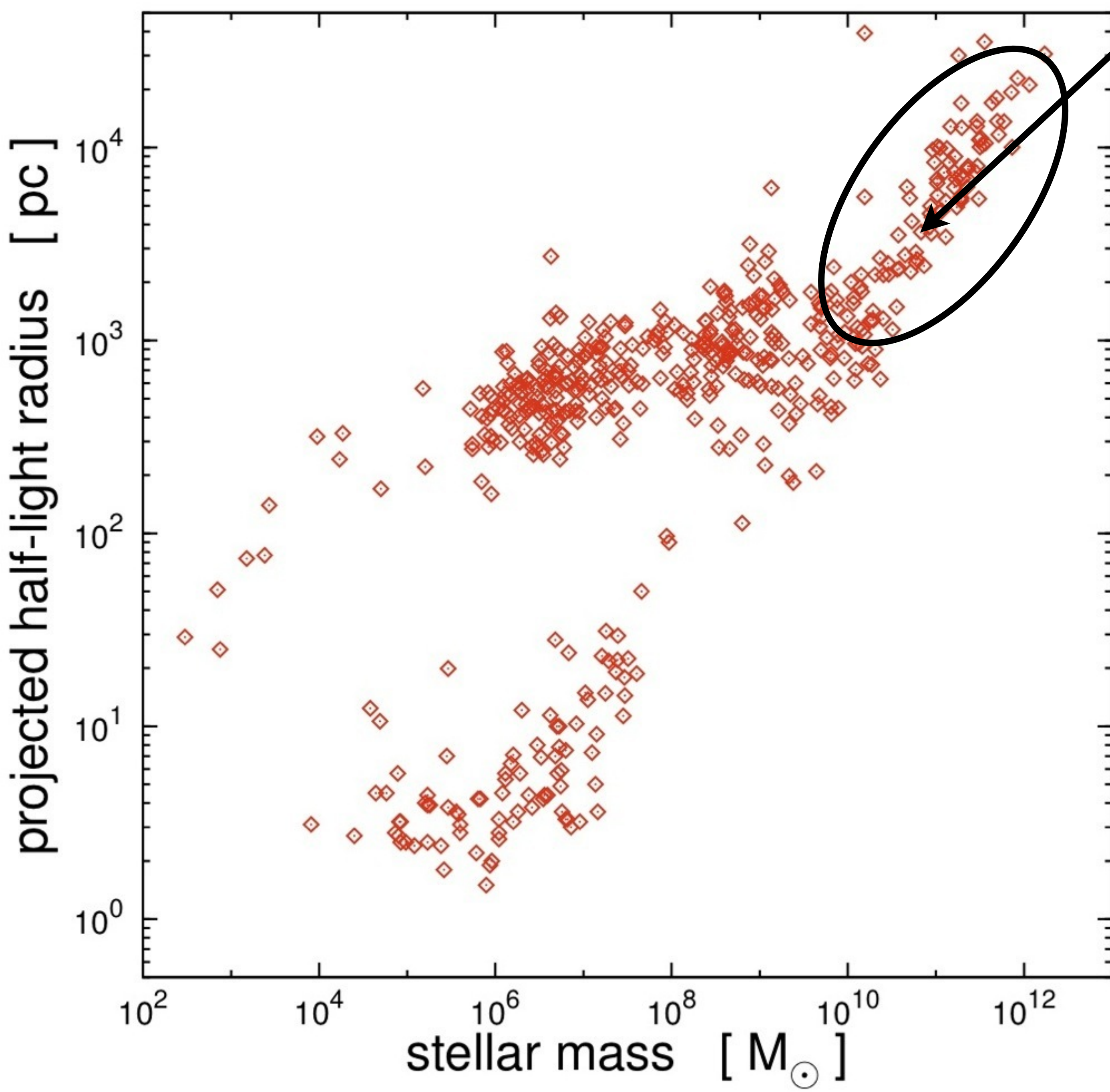

normal elliptical galaxies

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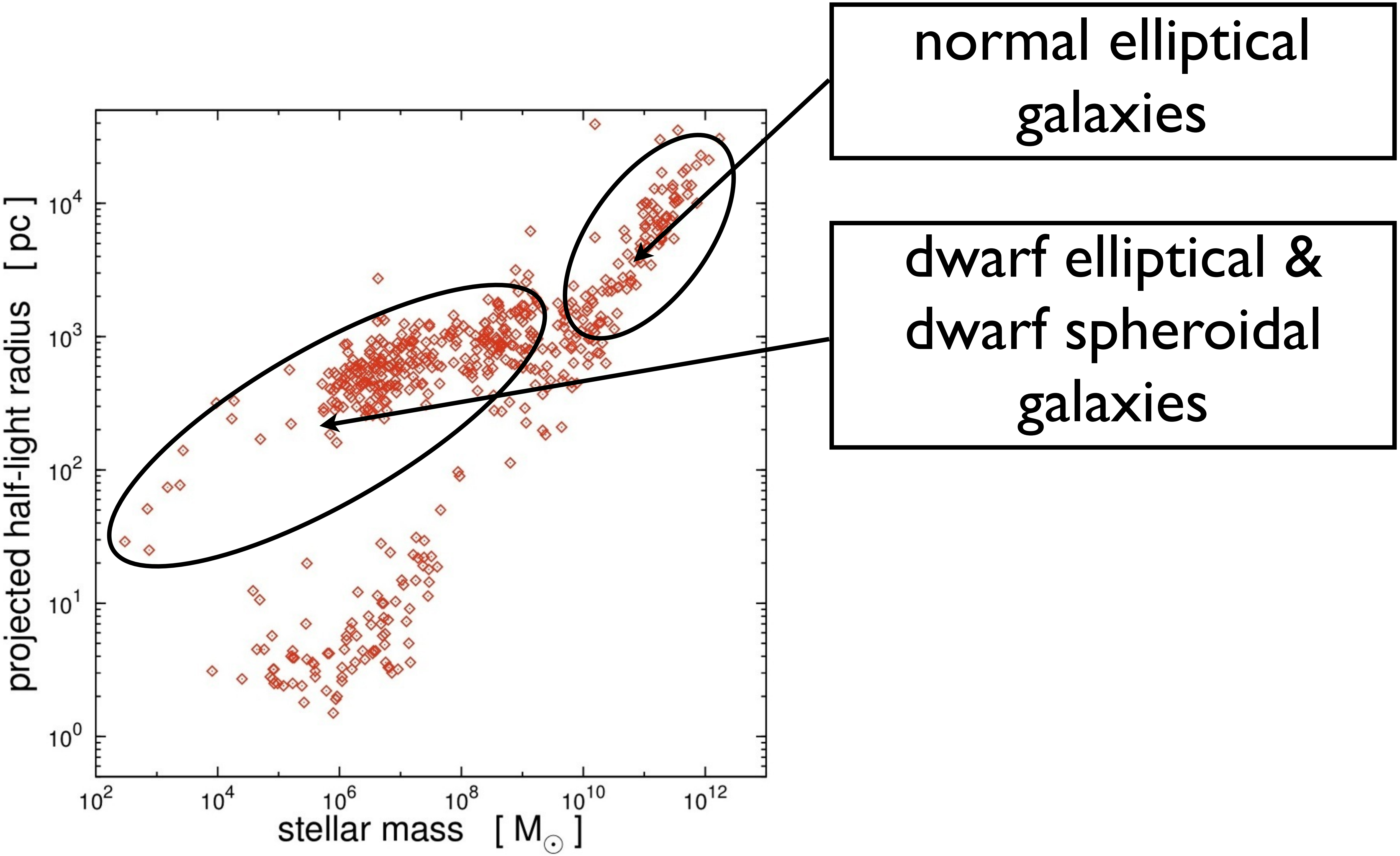

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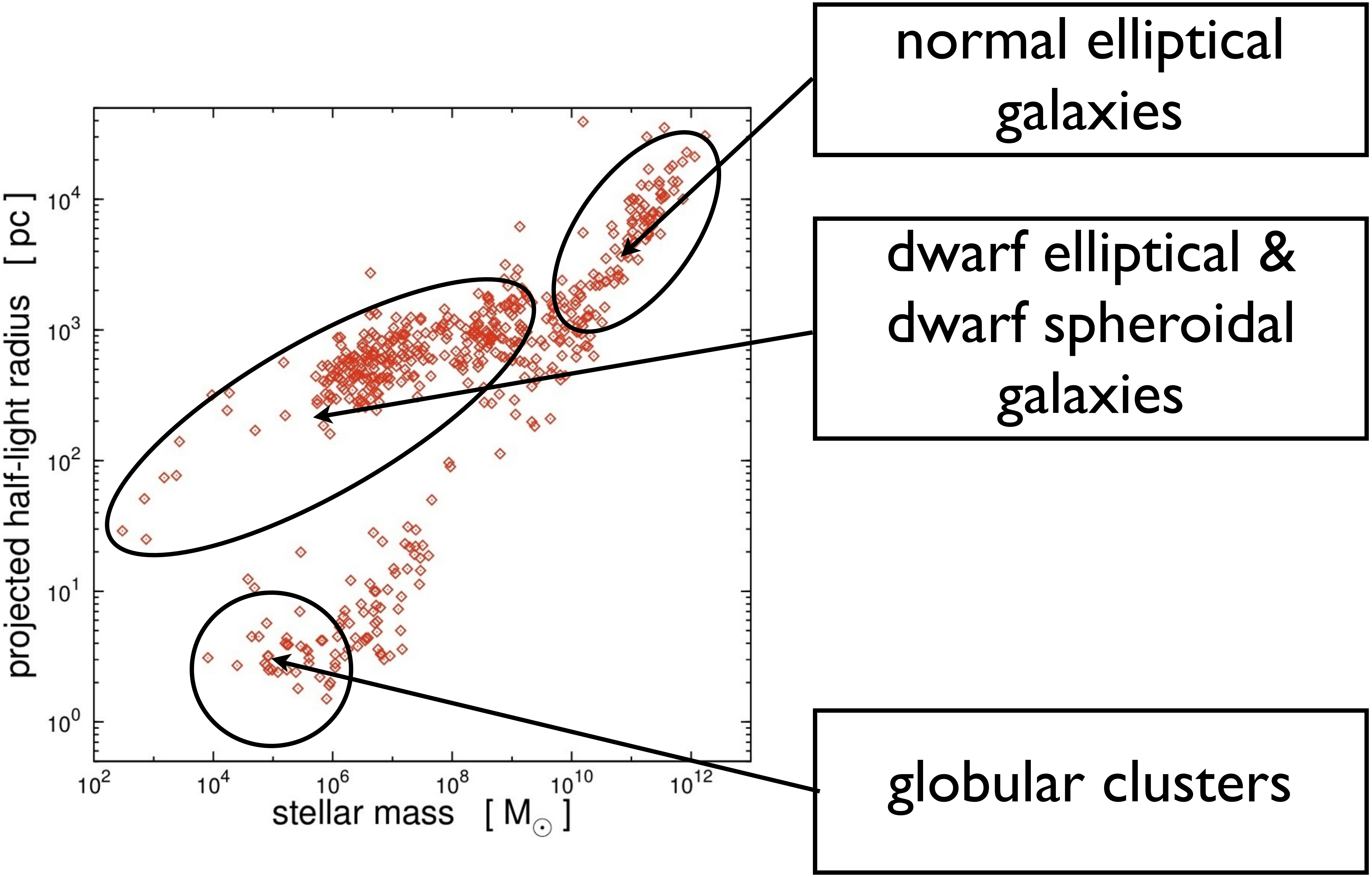

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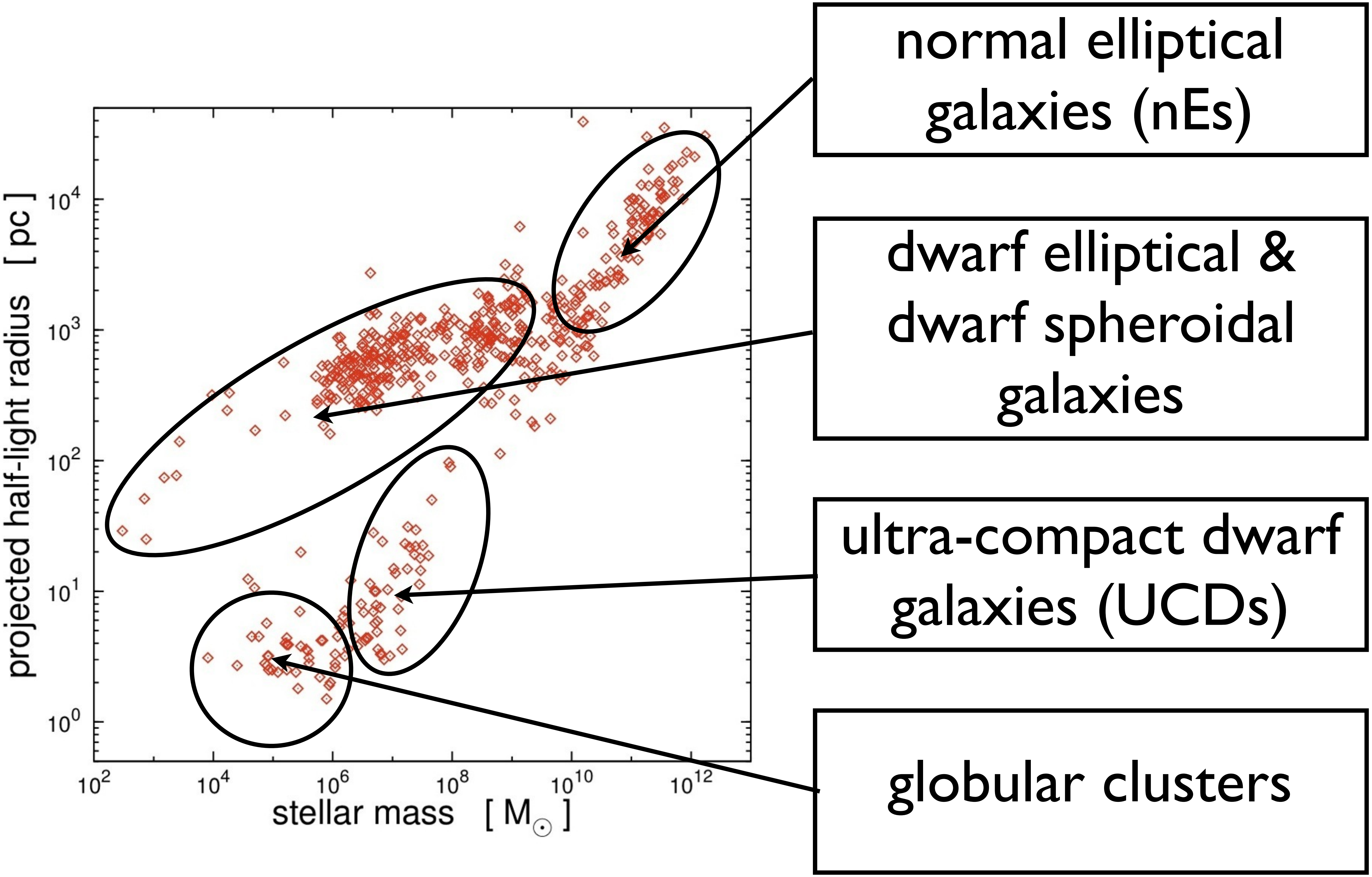

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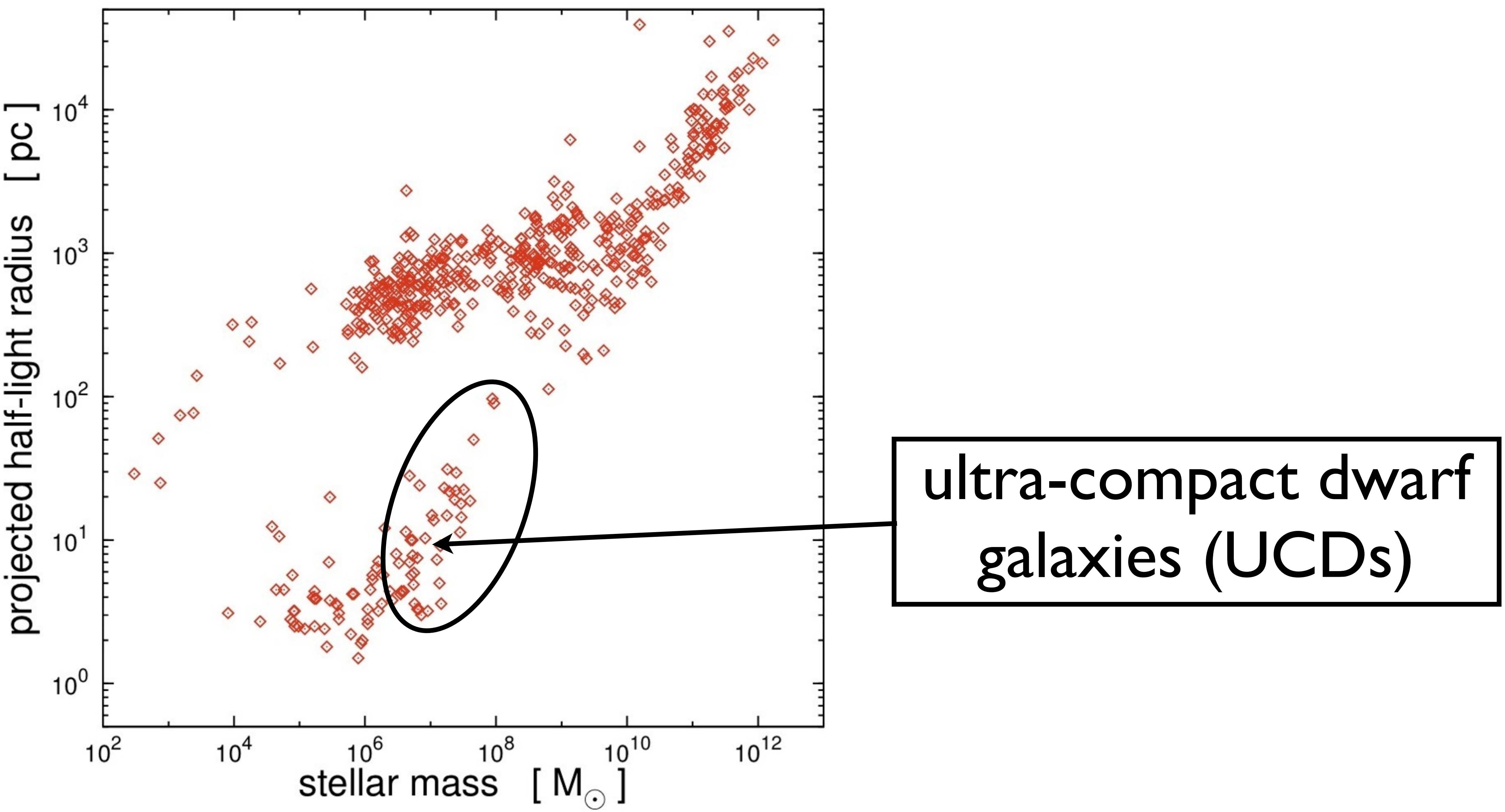
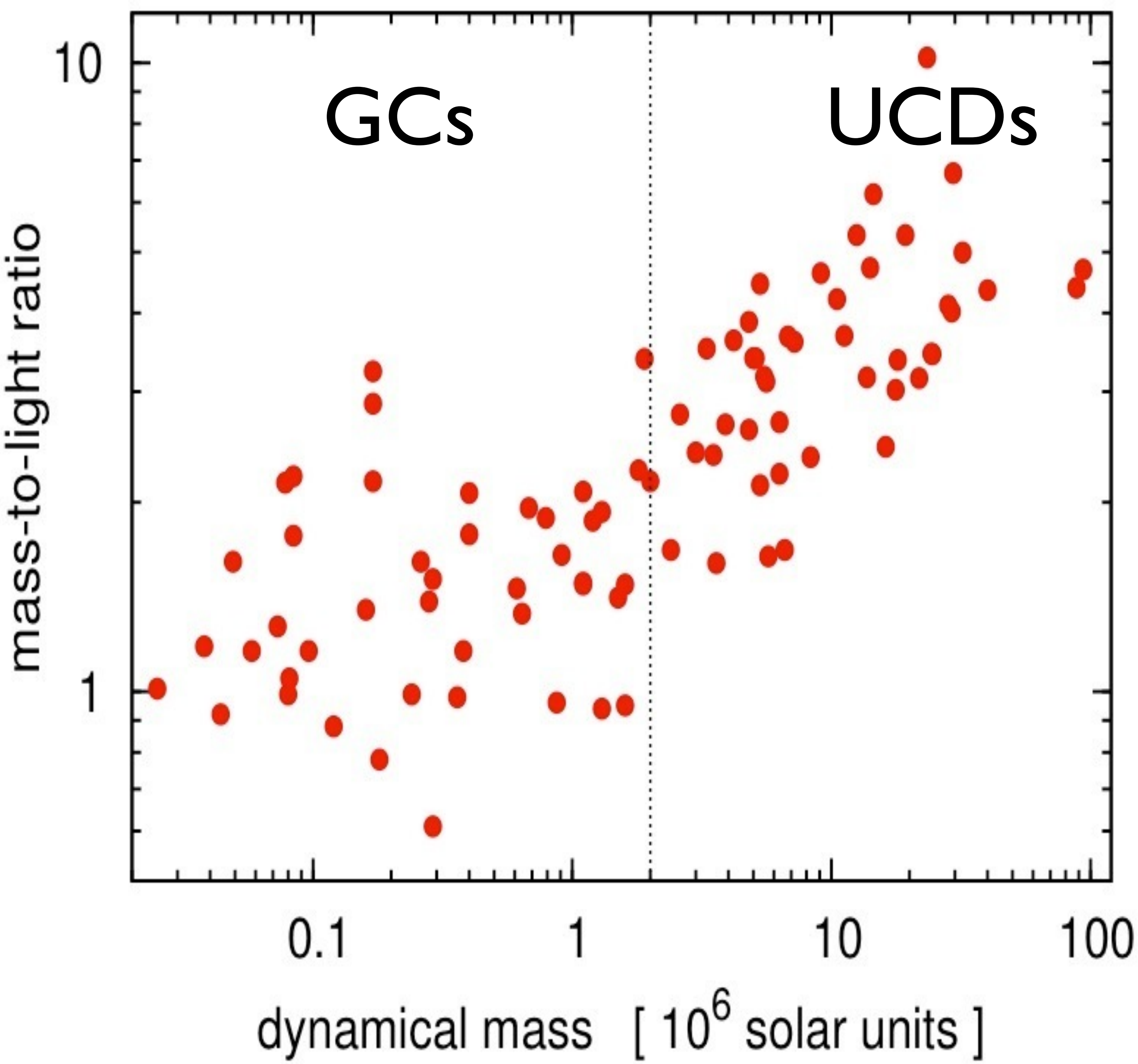


The M/L ratios of UCDs



(Data from Mieske et al.2008)

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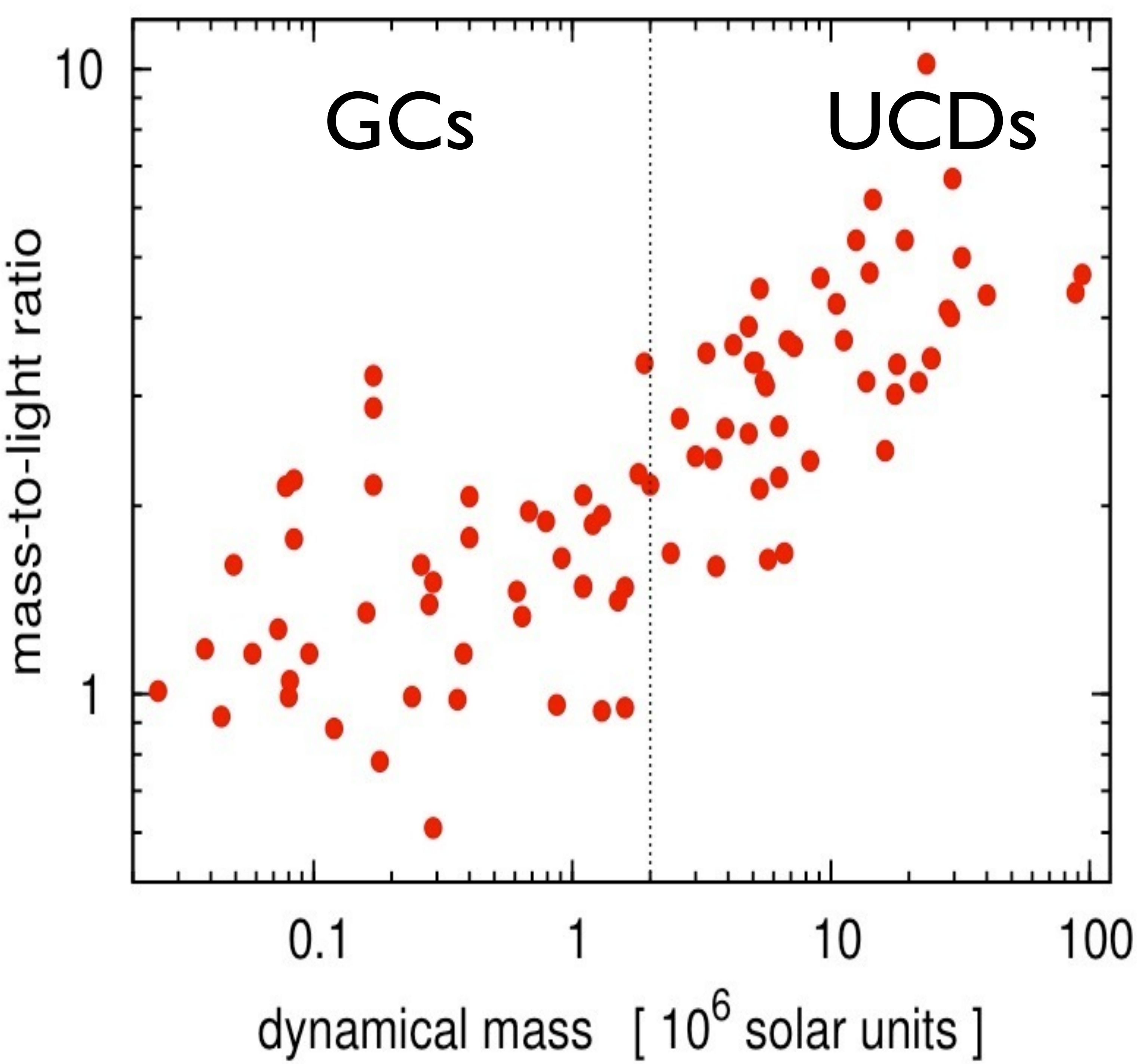

Why are the M/L ratios of UCDs higher than those of GCs?

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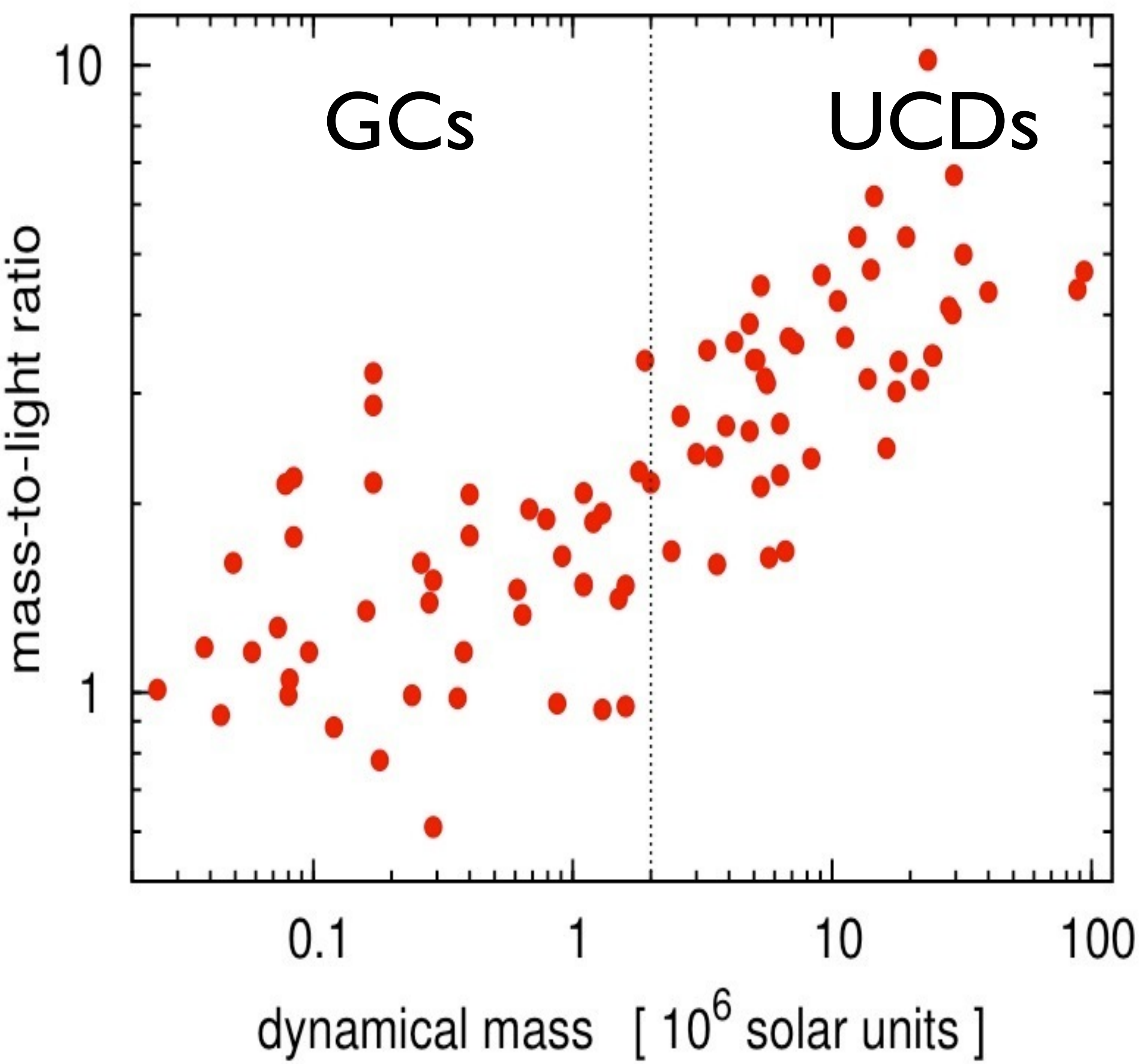

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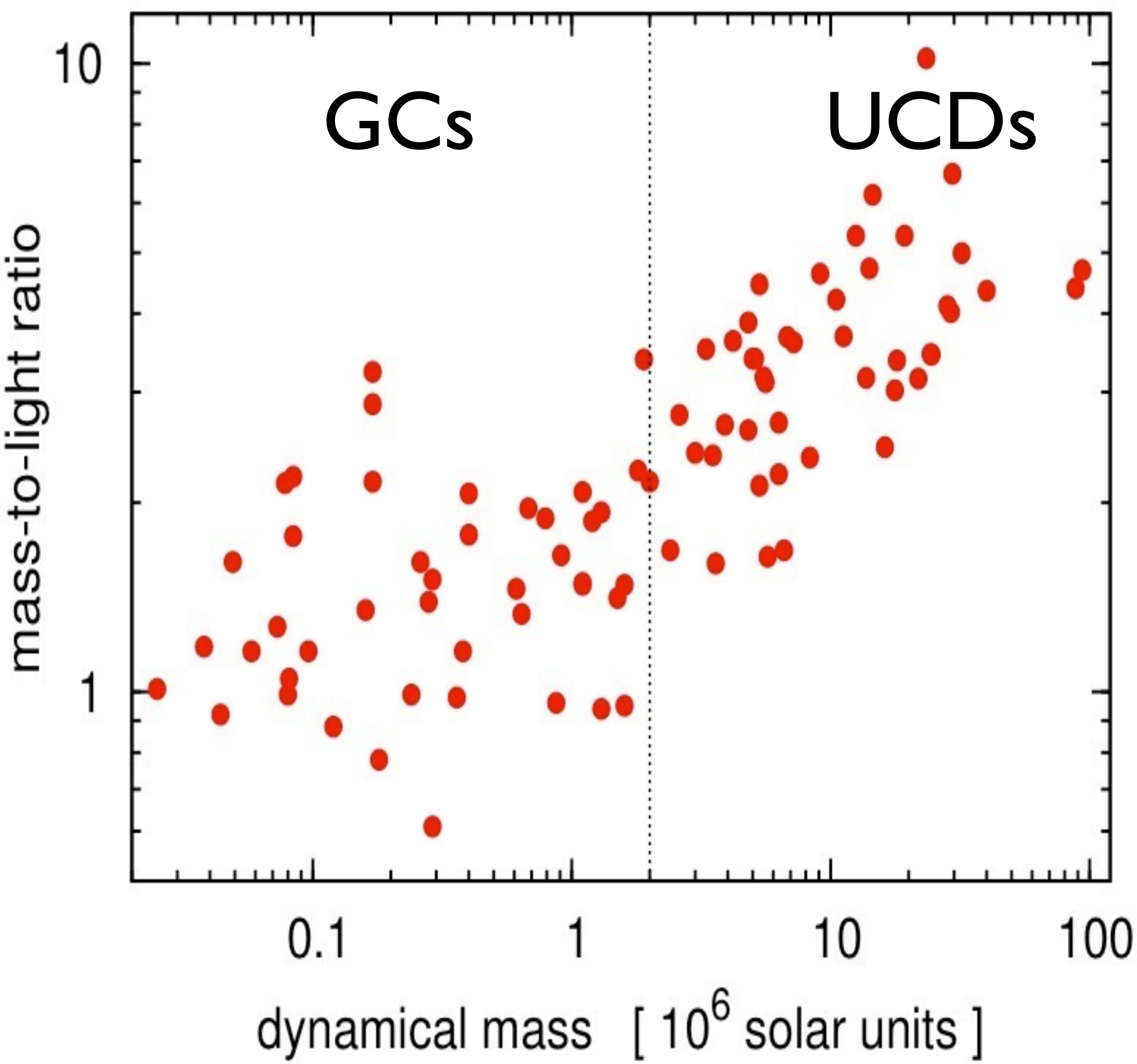
The M/L ratios of UCDs



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different stellar populations?

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Dark matter in UCDs cannot be non-baryonic cold dark matter - UCDs are too compact to contain an appreciable amount of it (Murray 2009).

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↓

This motivates to have closer look at the stellar populations of UCDs.

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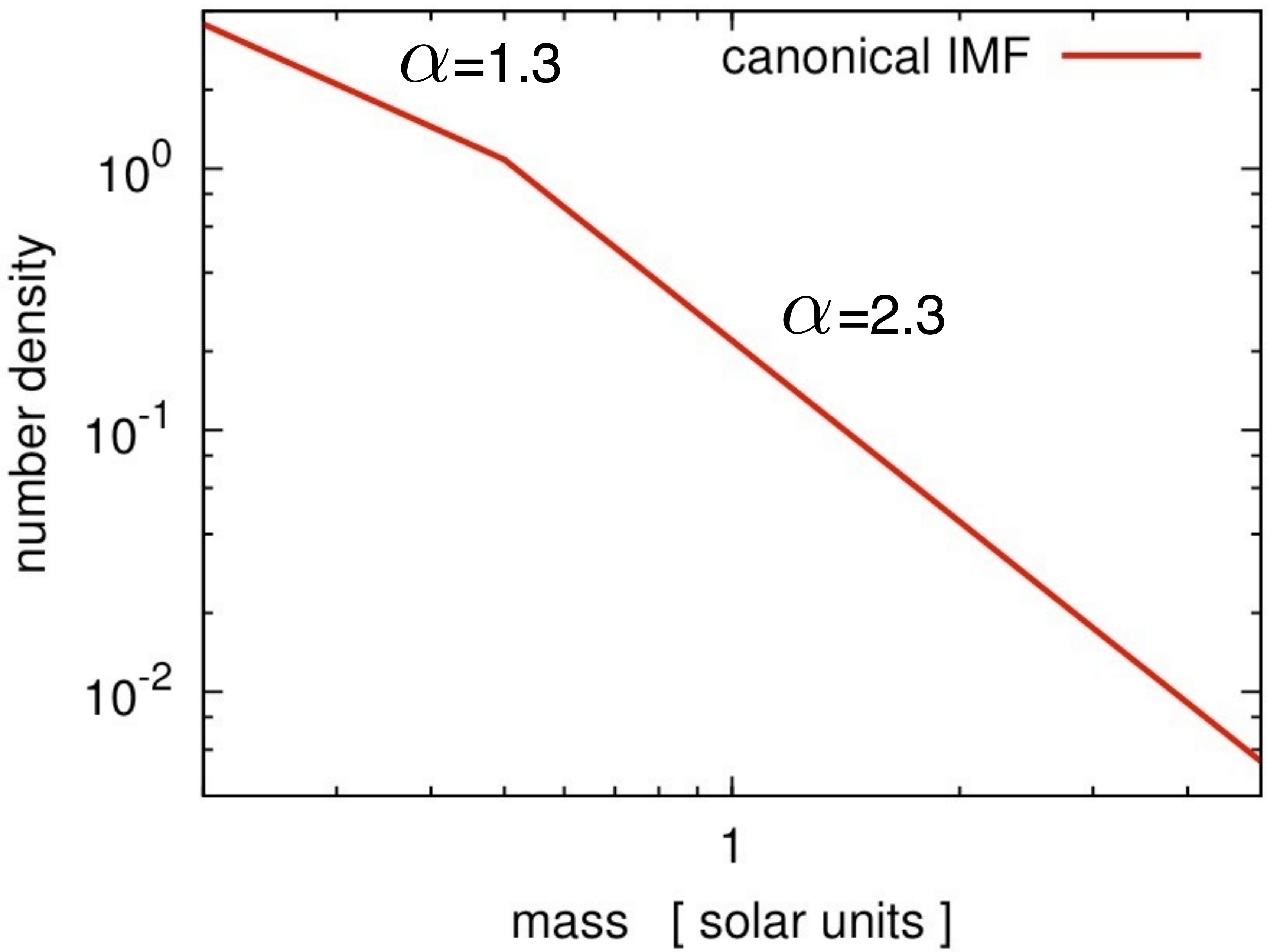

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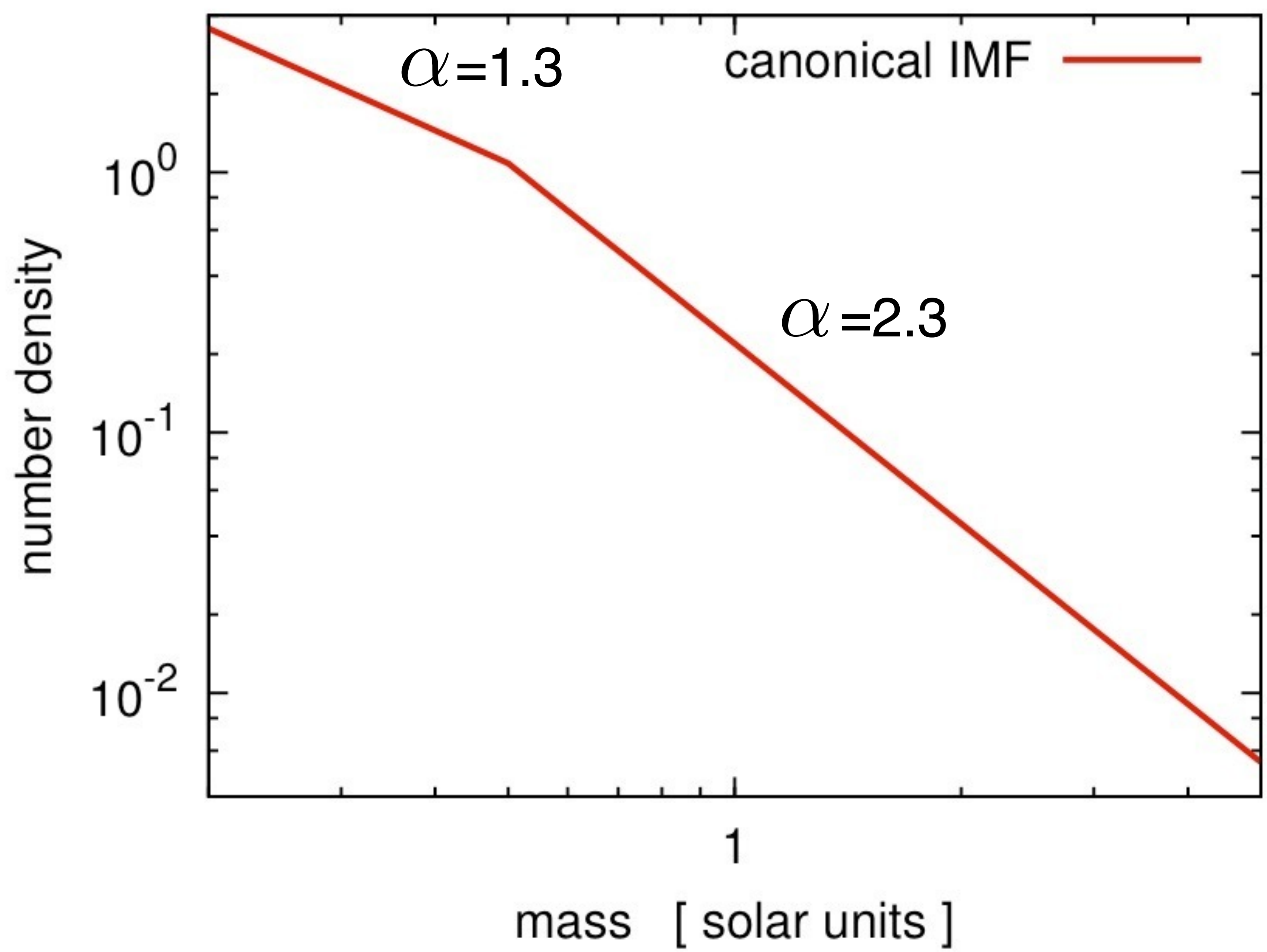
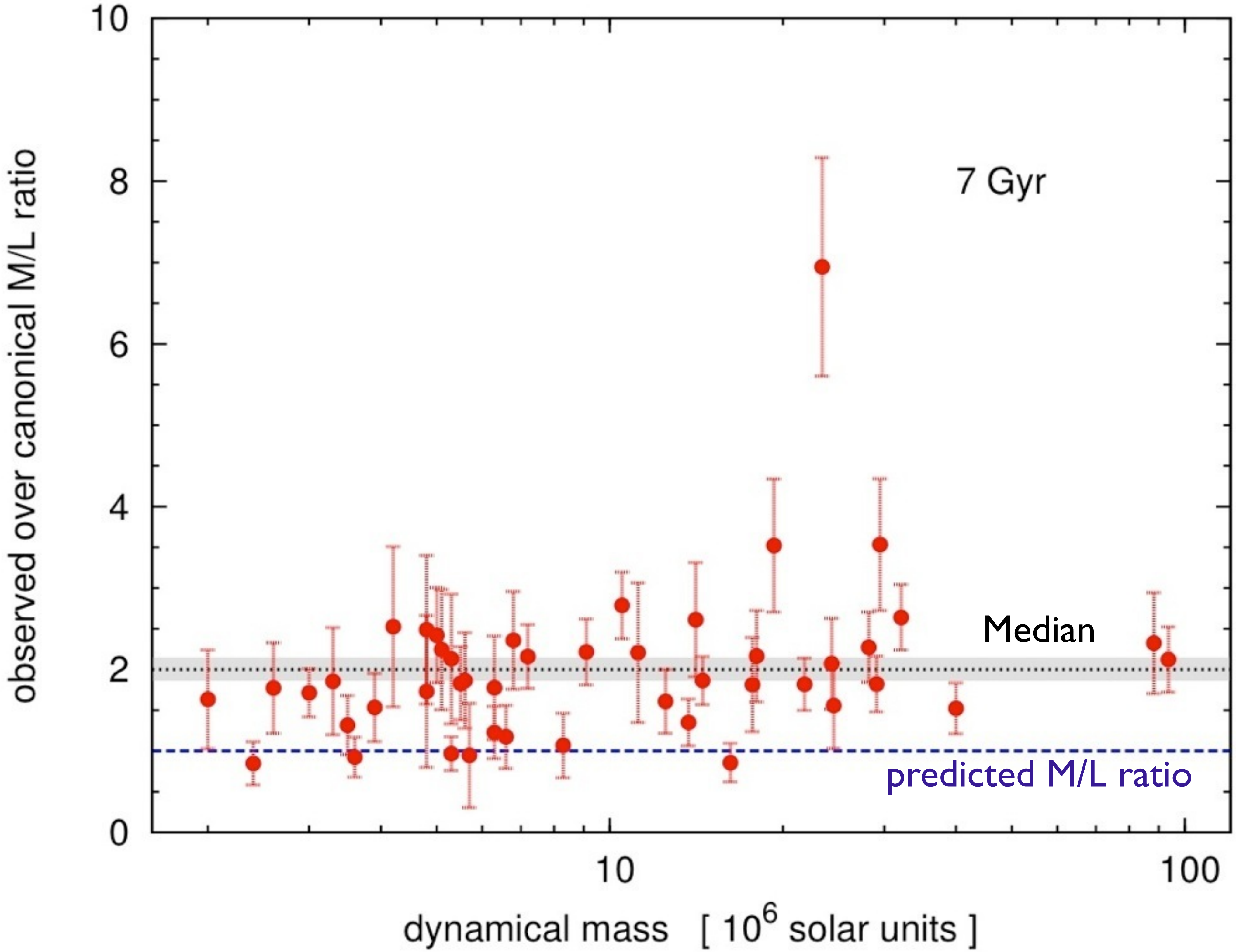


This IMF is apparently invariant in open clusters (Kroupa 2001), which makes it a good initial assumption for UCDs as well.

The M/L ratios of UCDs



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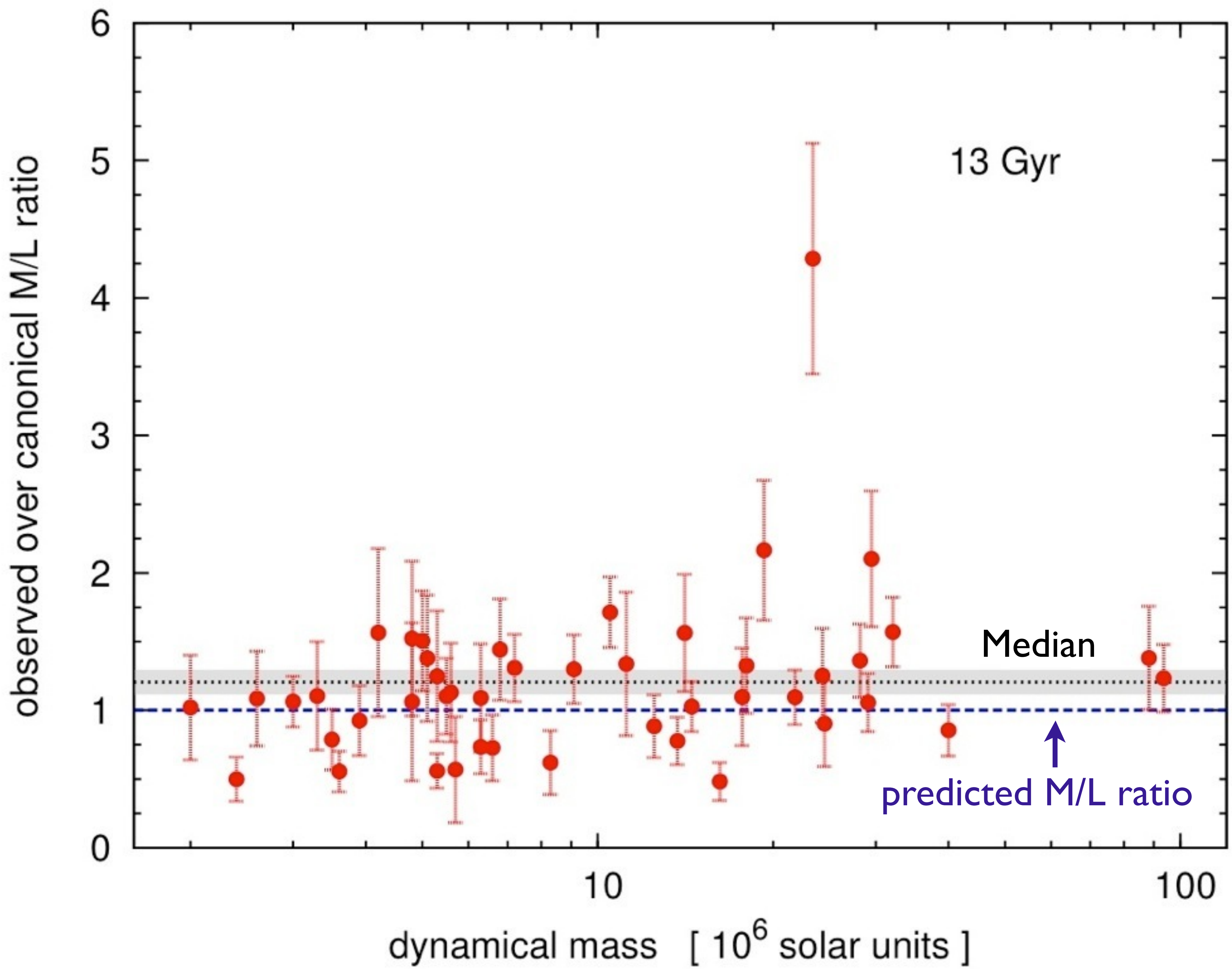

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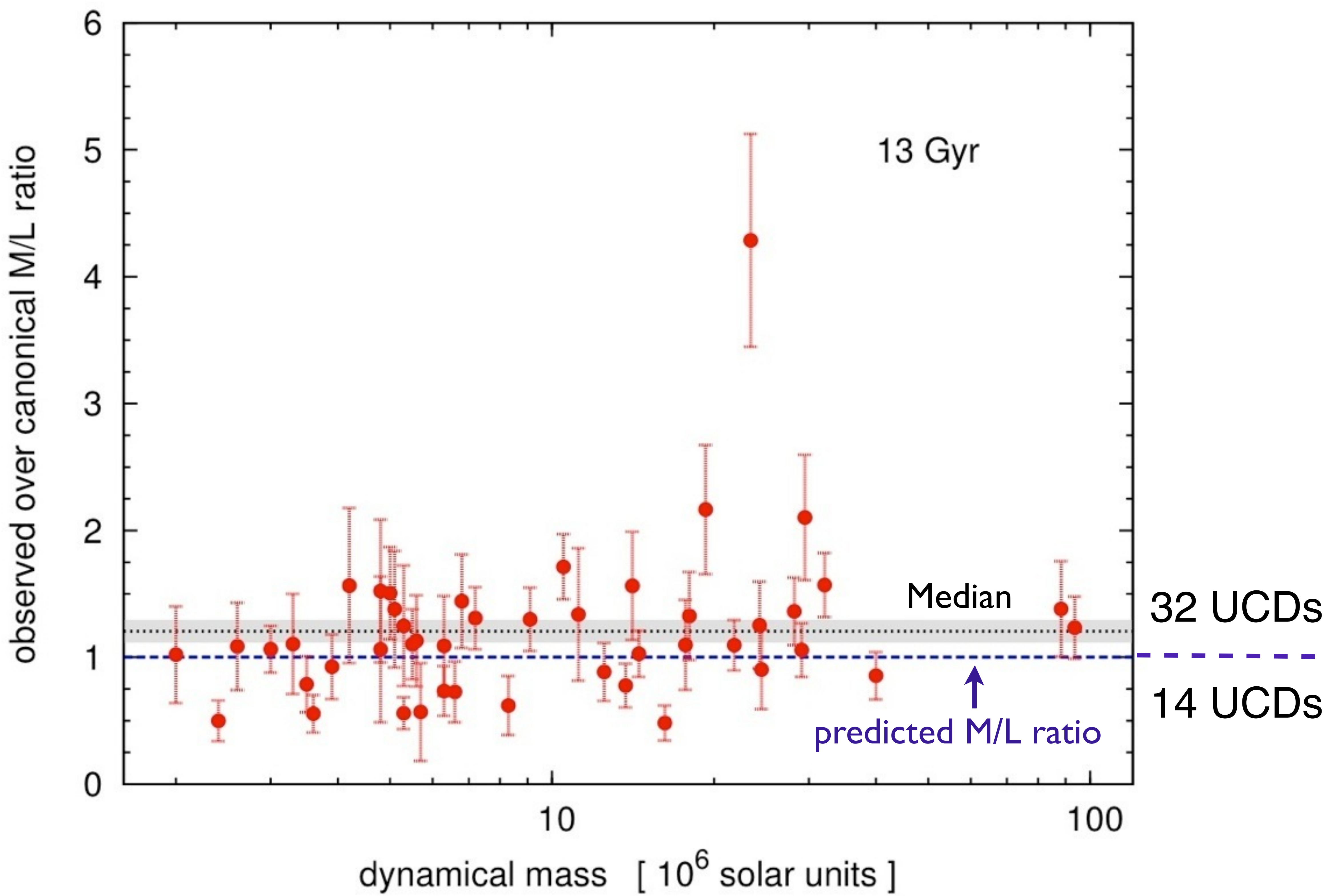

The most likely M/L ratios of UCDs exceed the prediction of simple stellar population models (with the canonical IMF)!

(Dabringhausen, Hilker & Kroupa 2008)

Possible variations of the IMF

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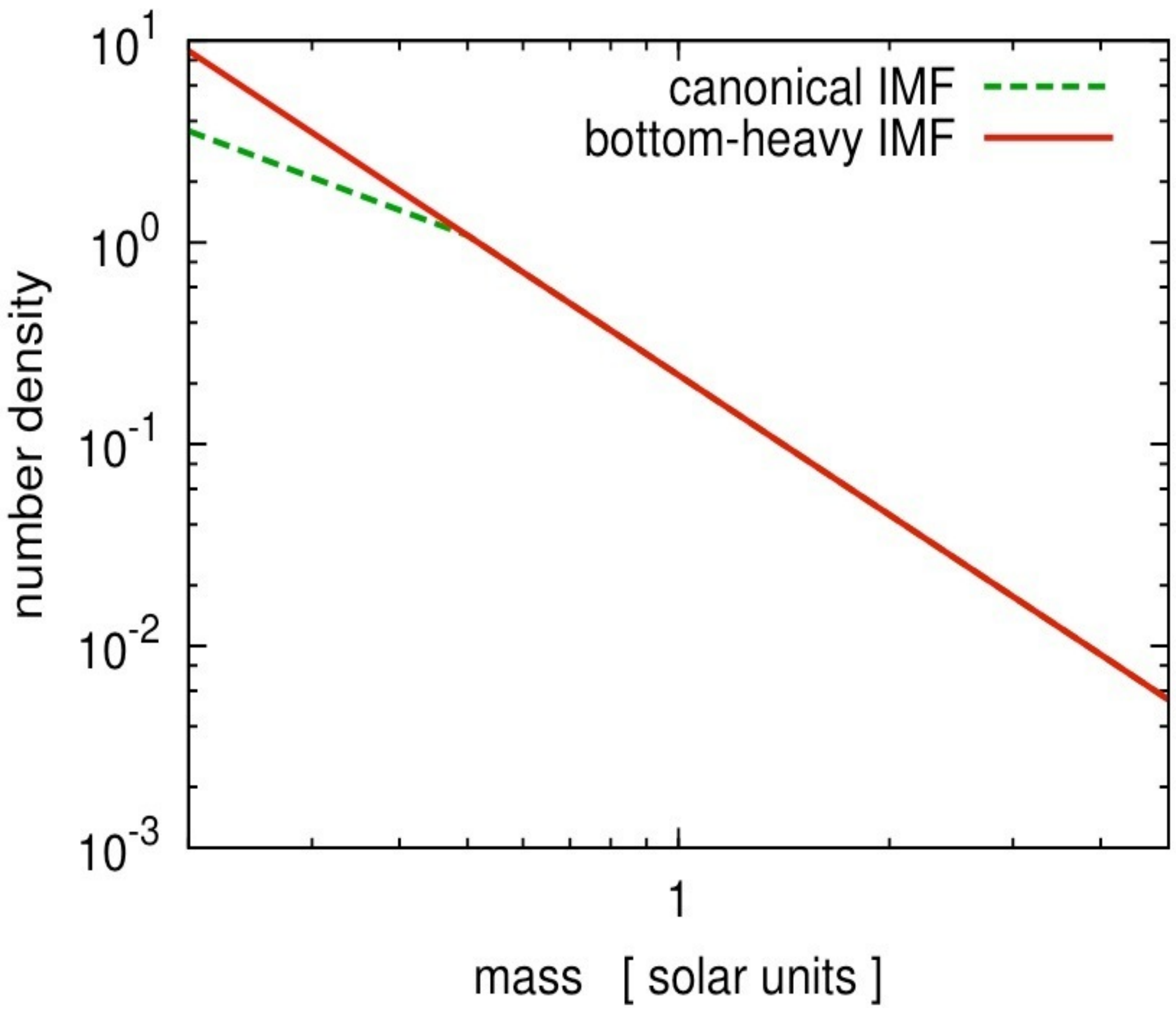
Bottom-heavy IMF:



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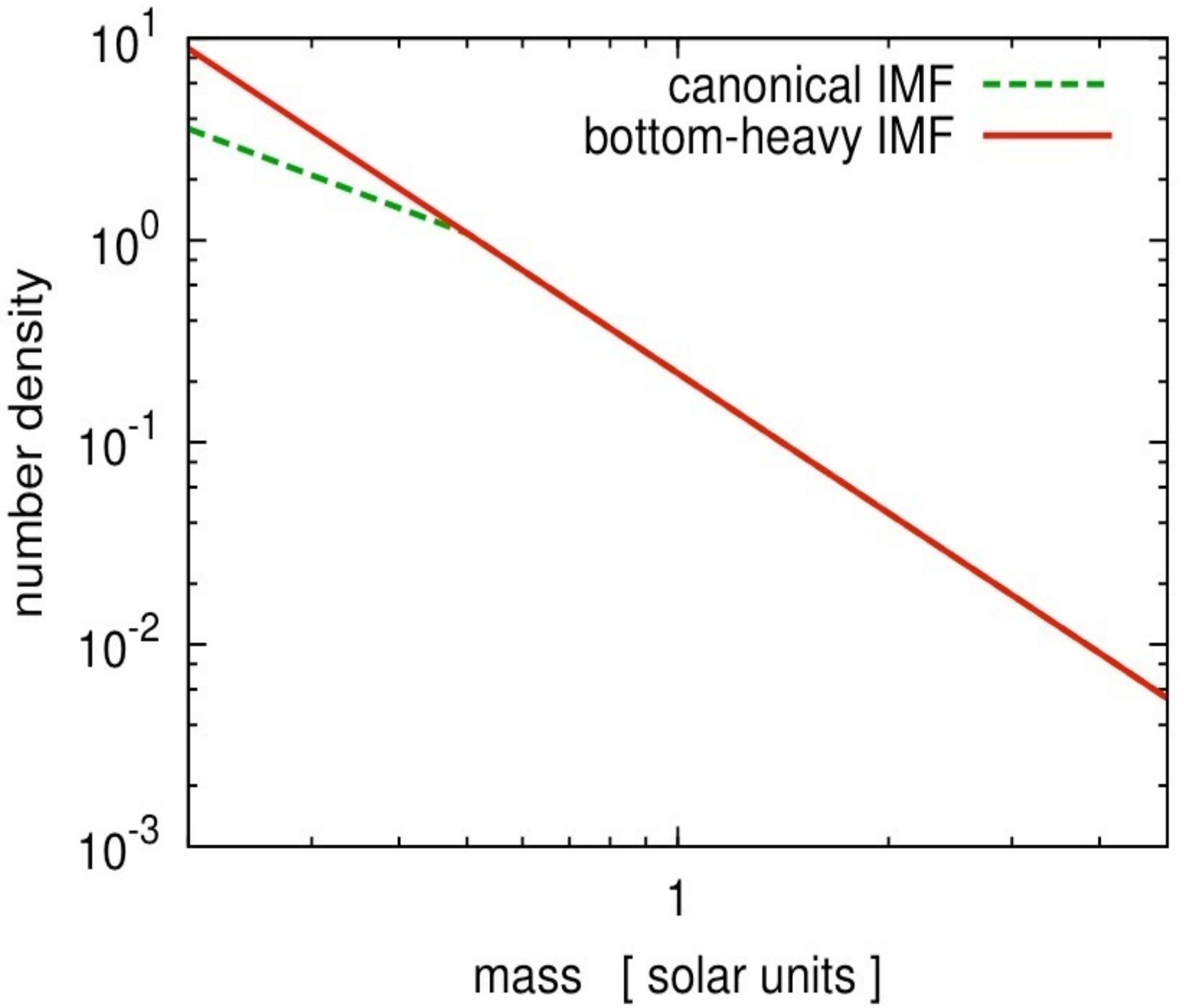

high M/L ratio through over-abundance of faint low-mass stars

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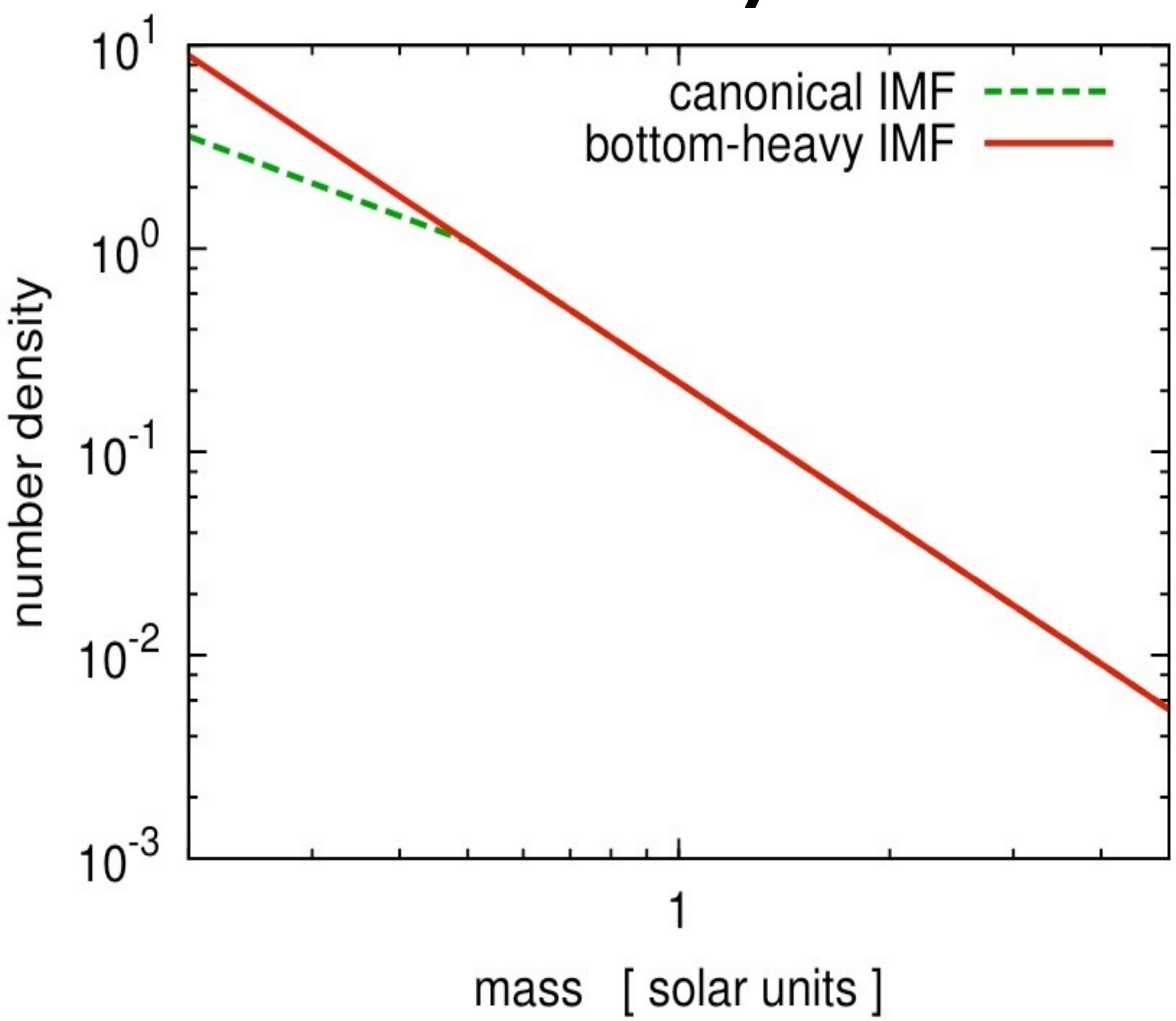

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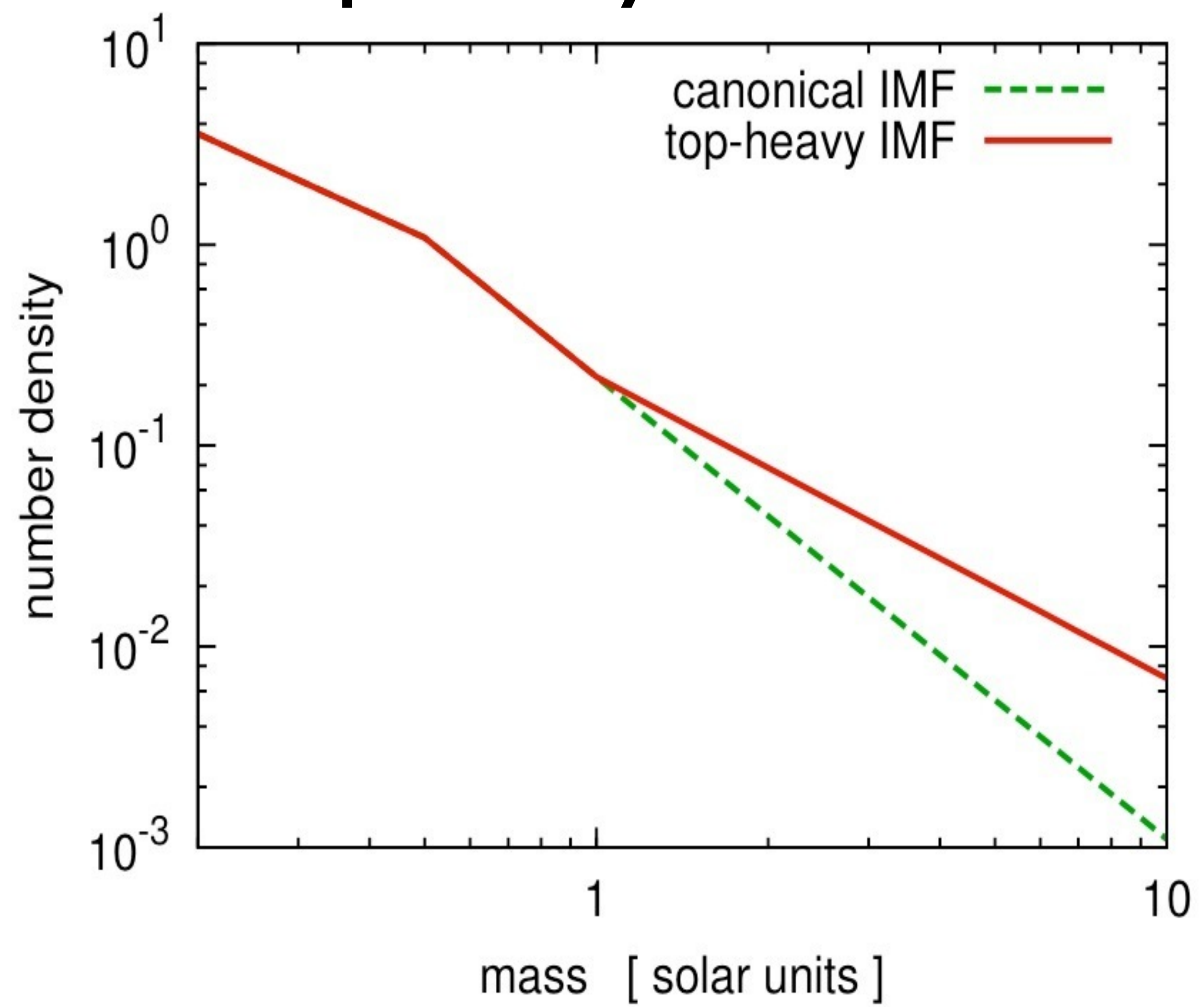

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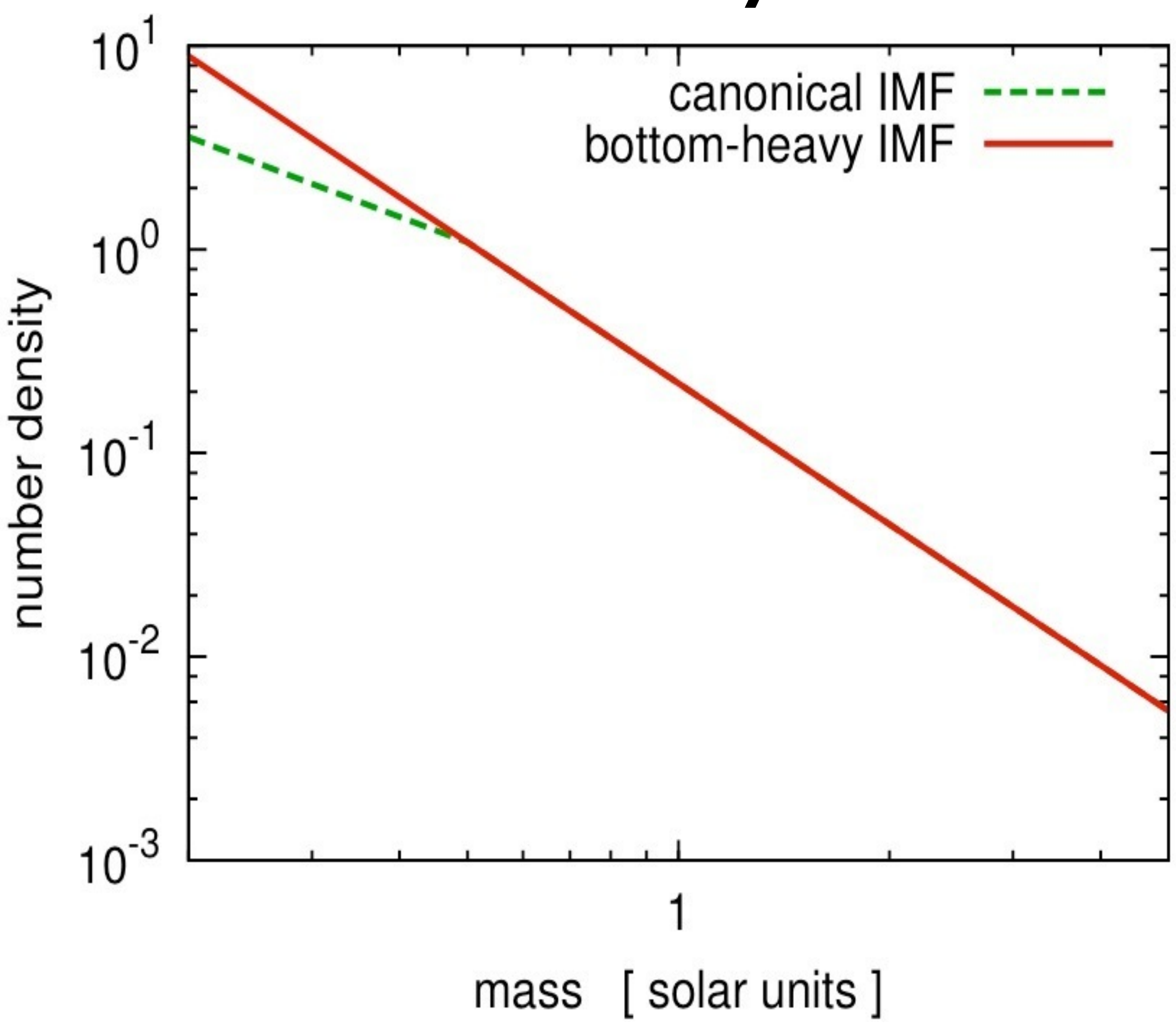

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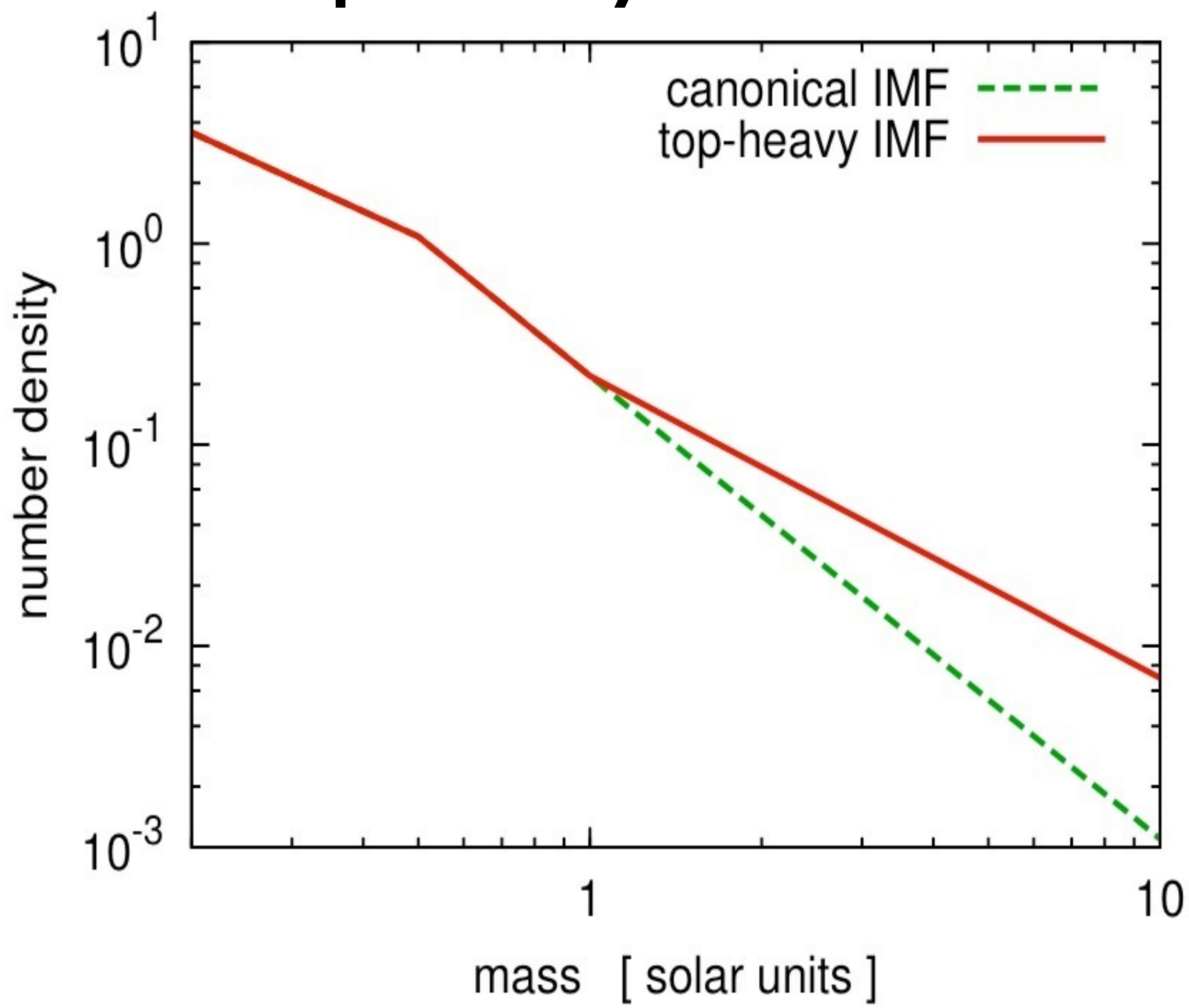

high M/L ratio through over-abundance of stellar remnants

Top-heavy IMF in UCDs

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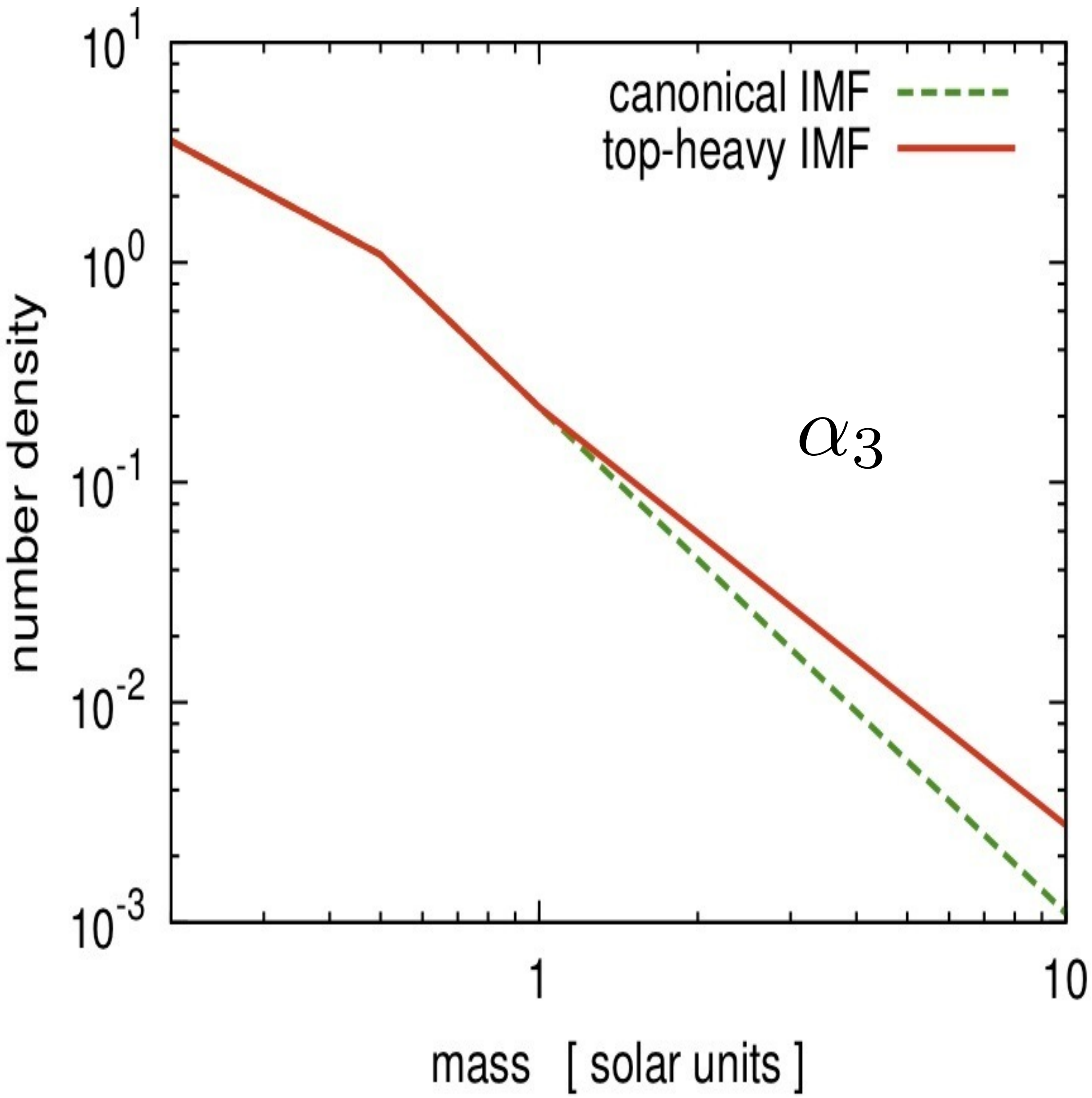
Vary the high-mass part of the IMF such that stellar remnants can explain the M/L ratio of UCDs



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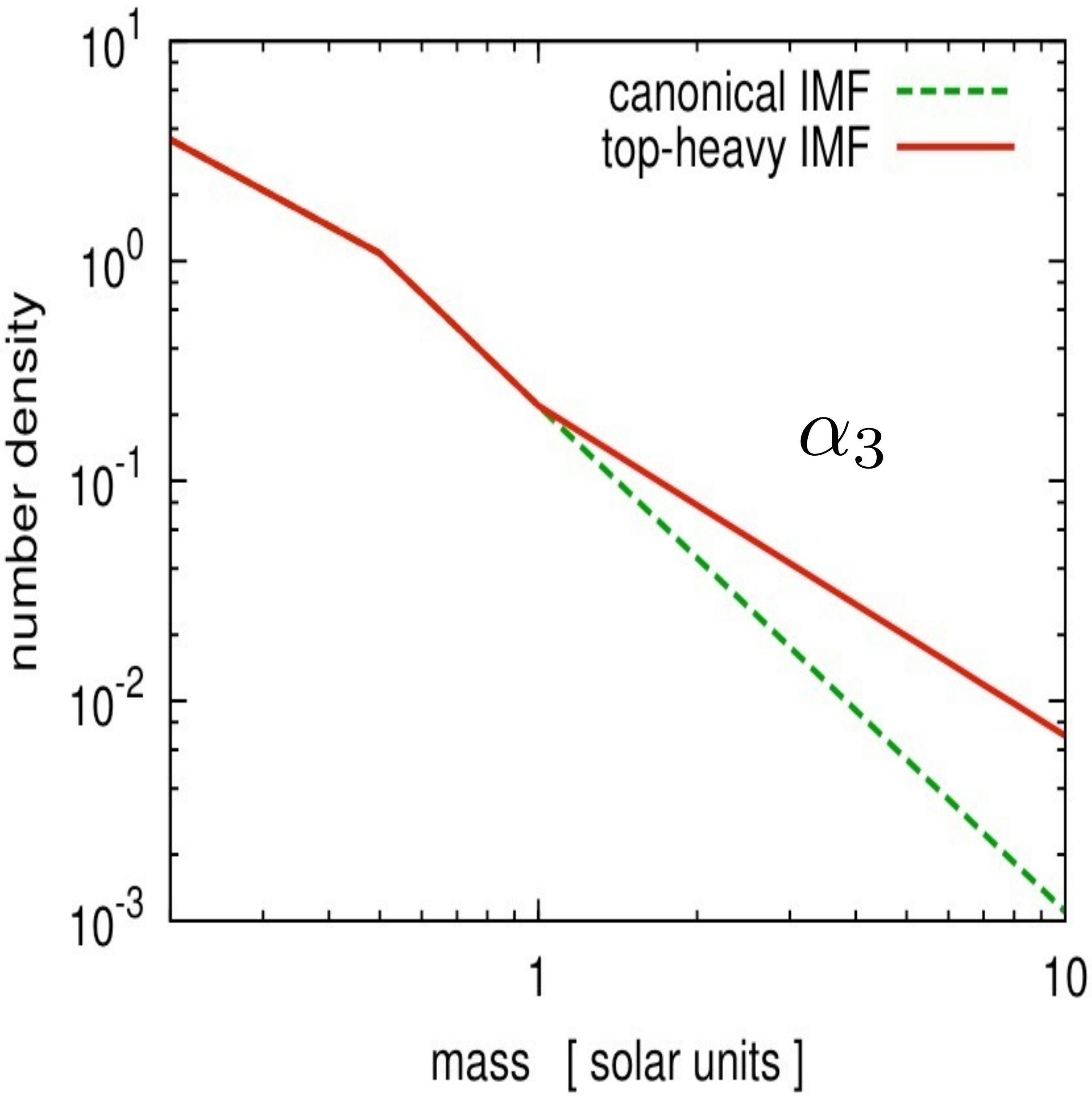

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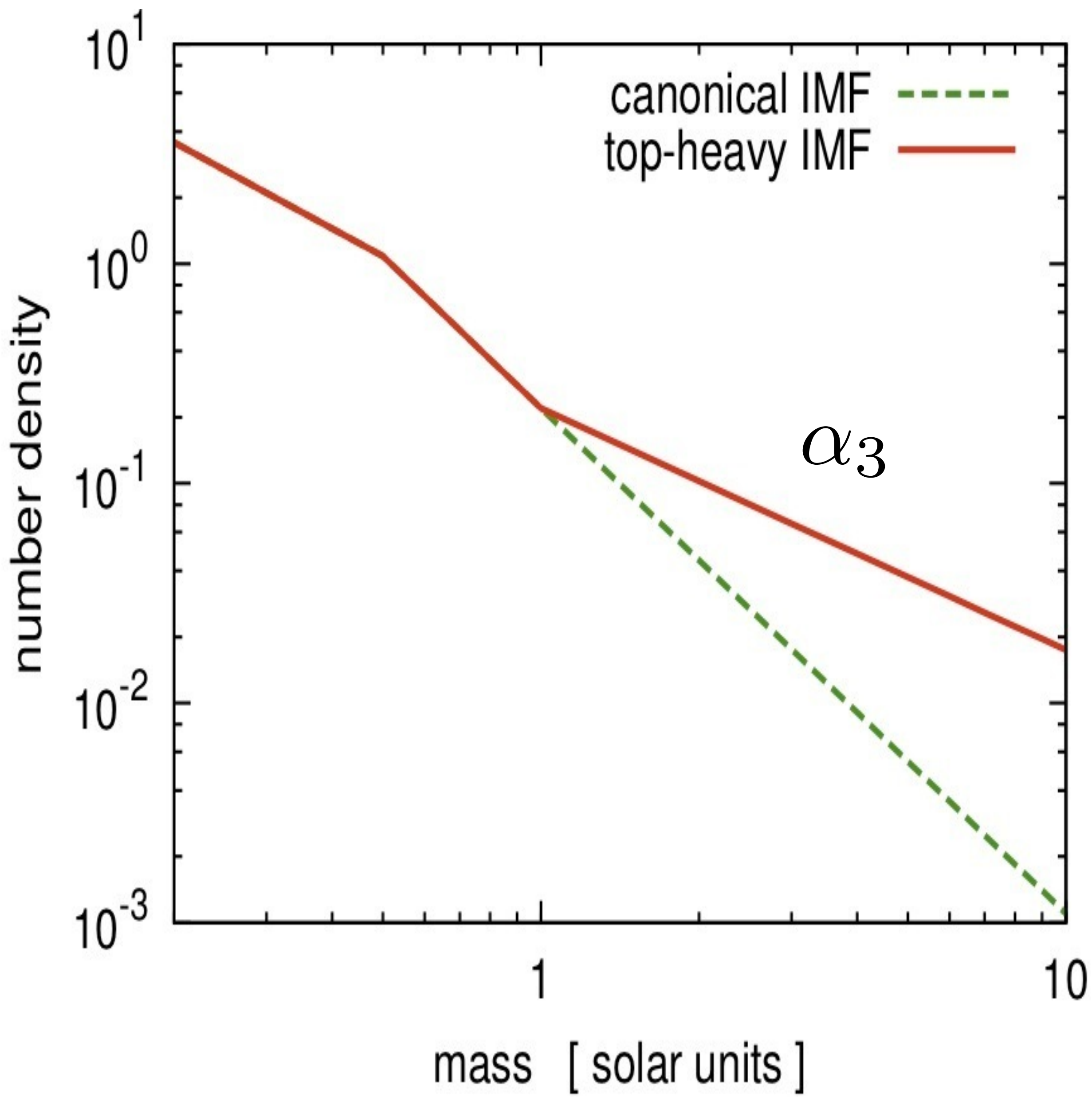

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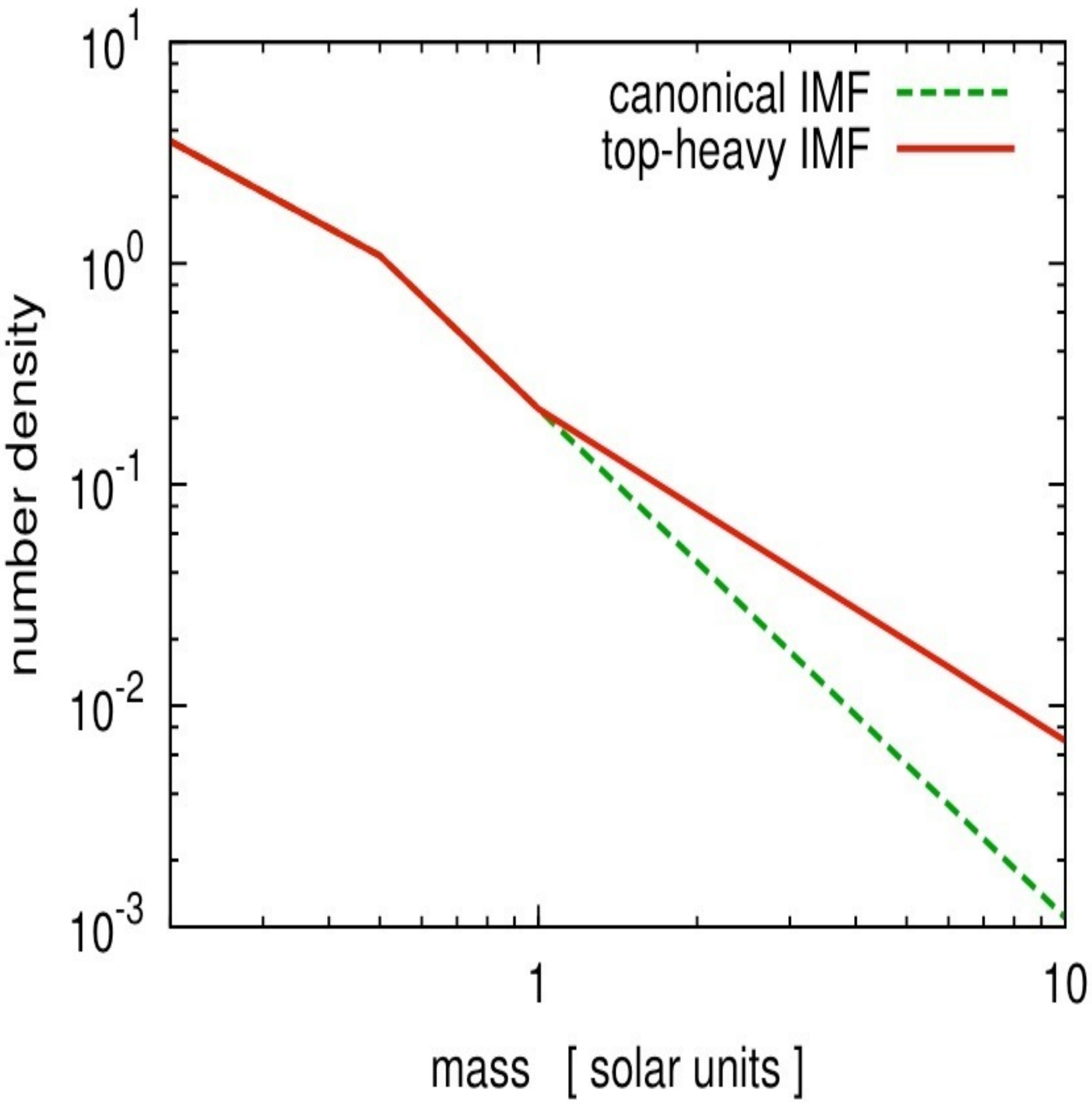

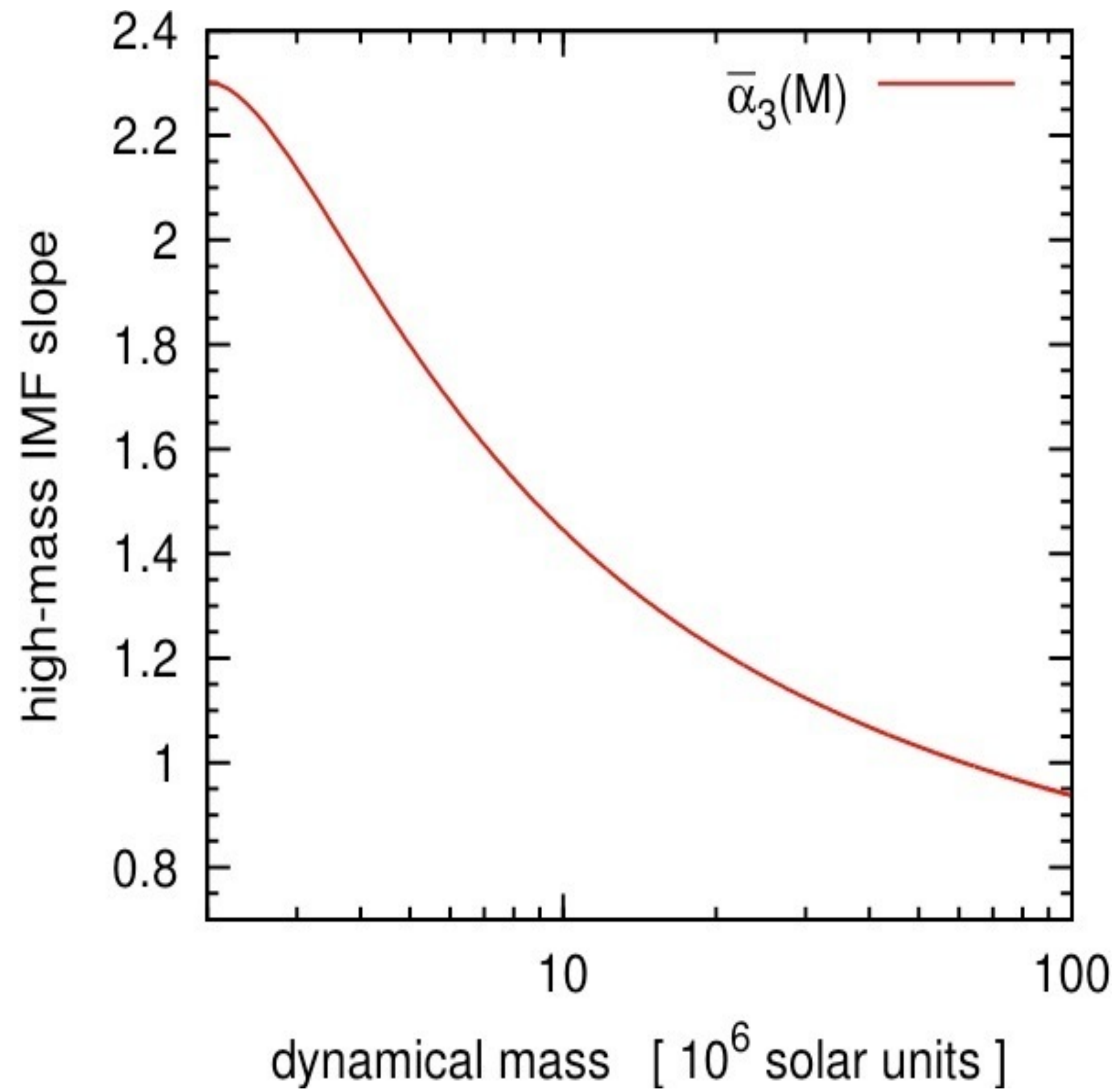

(Dabringhausen, Kroupa & Baumgardt 2009)

Tracing neutron stars and black holes in UCDs

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Such binary systems are called low-mass X-ray binaries (LMXBs)

The encounter rate

The rate at which LMXBs form is given by the encounter rate:

$$\Gamma \propto \frac{n_{\mathrm{s}}\ n_{\mathrm{ns}}\ r_{\mathrm{c}}^3}{\sigma}$$

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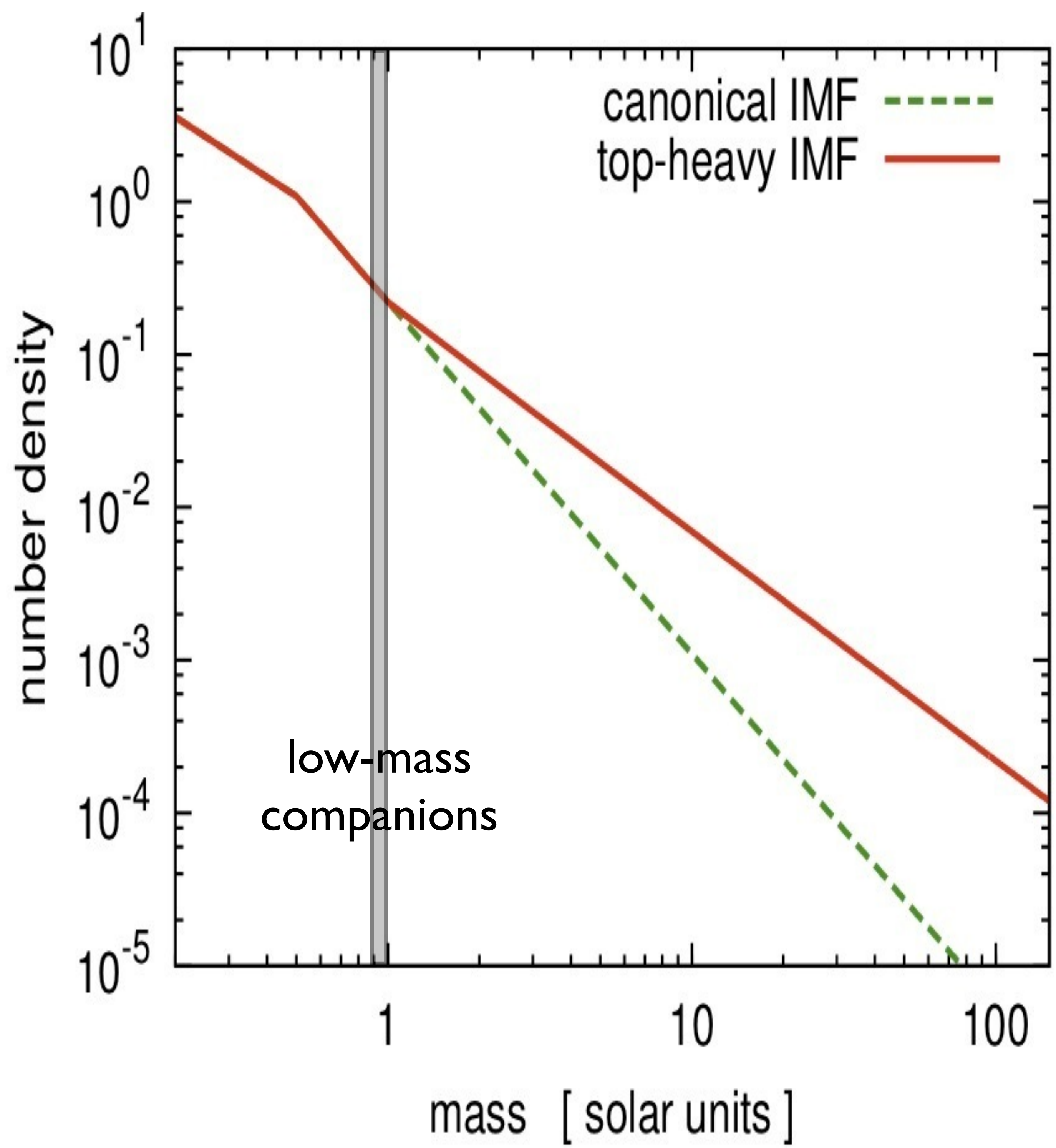

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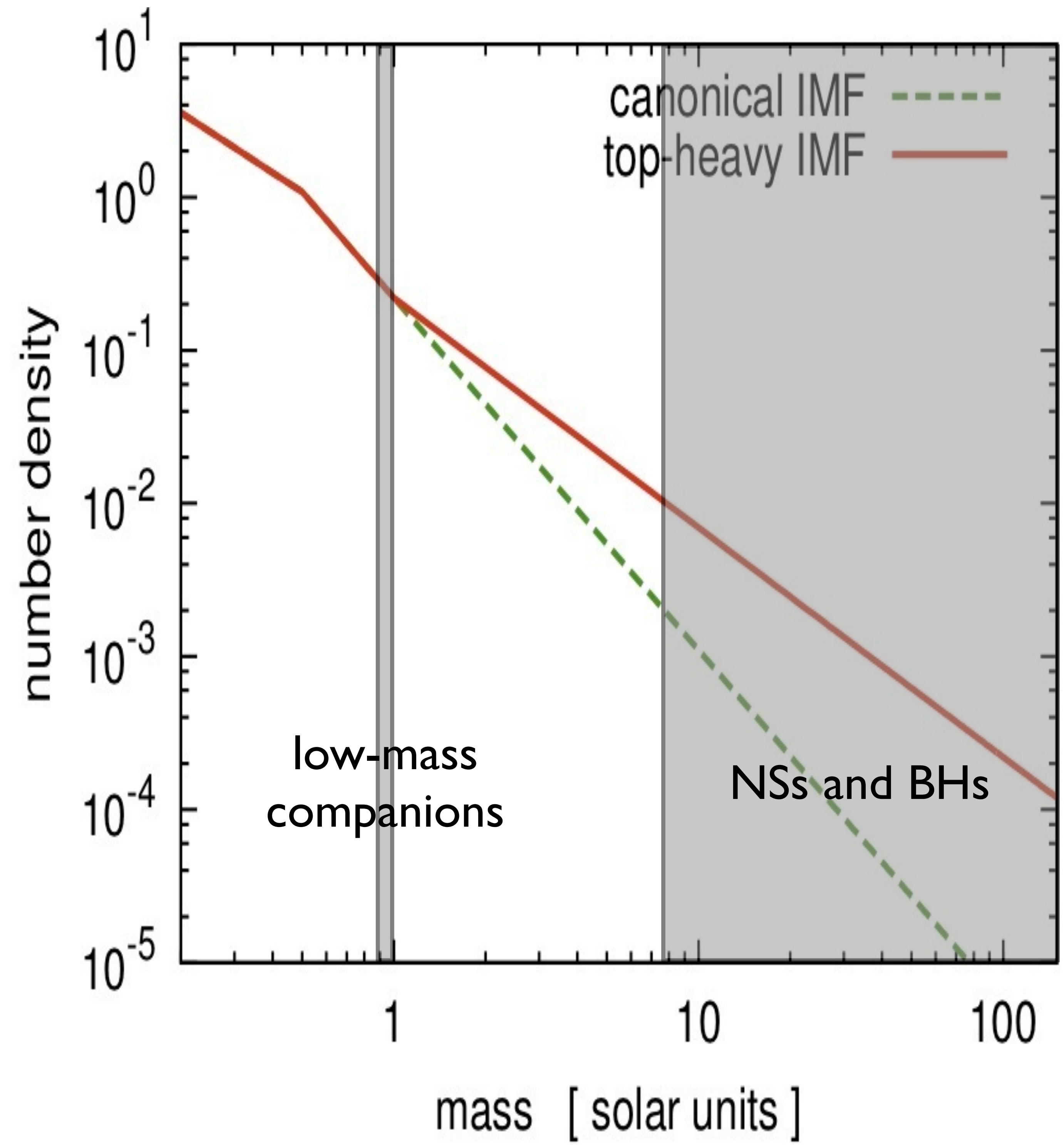
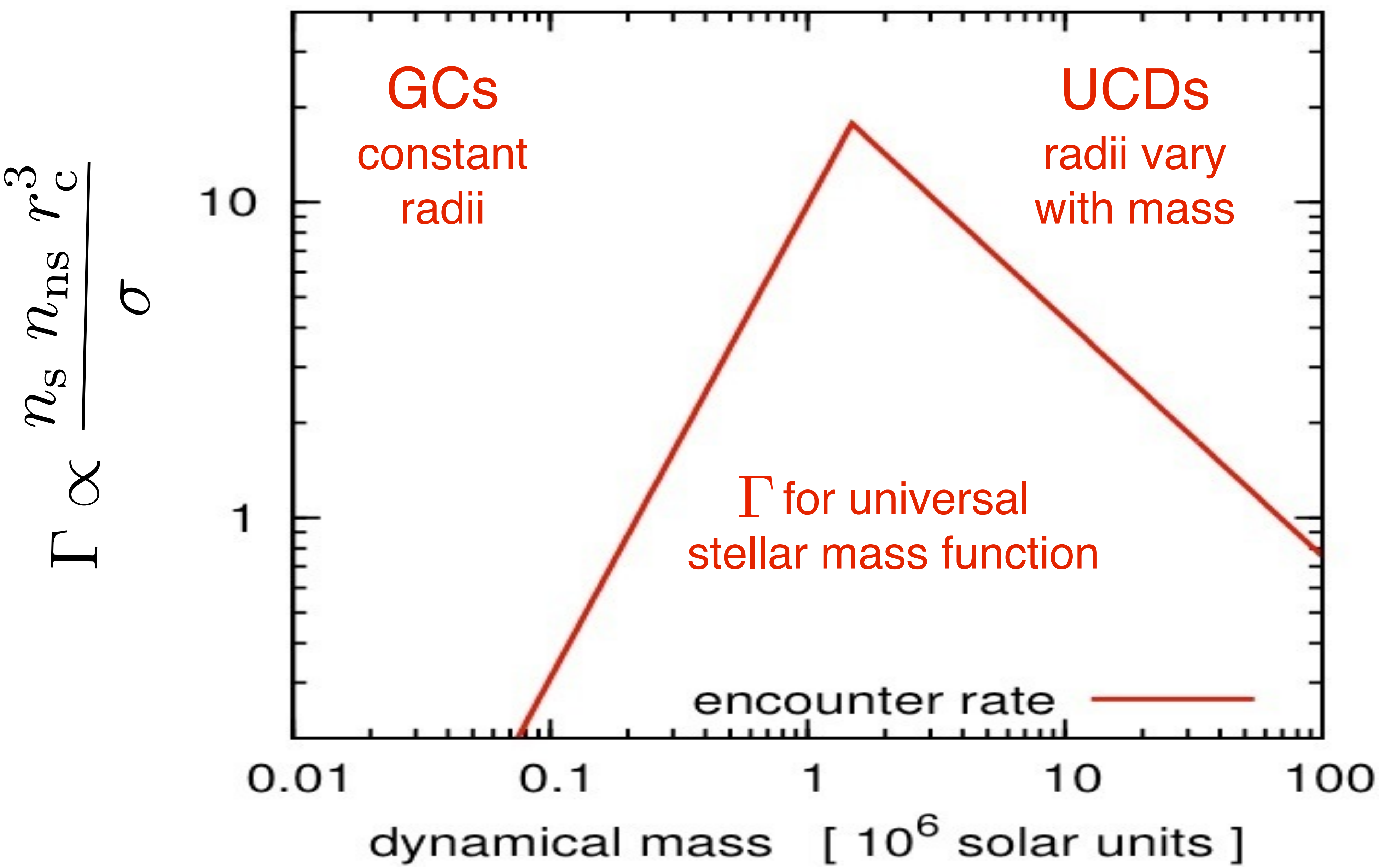


LMXBs in GCs and UCDs in the Virgo Cluster

The encounter rate for GCs and UCDs in Virgo:



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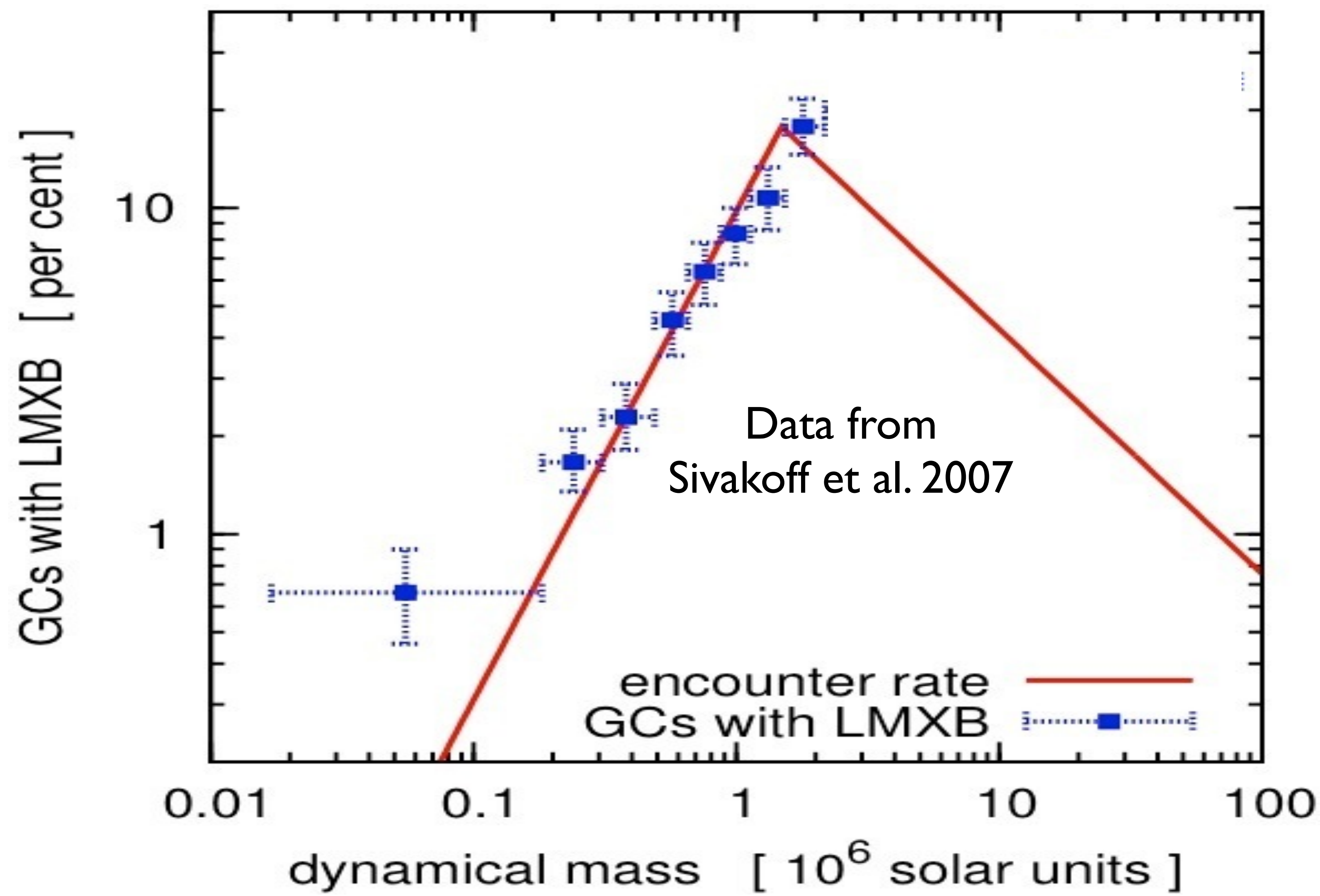
Comparison to observational results for the LMXB-frequency:



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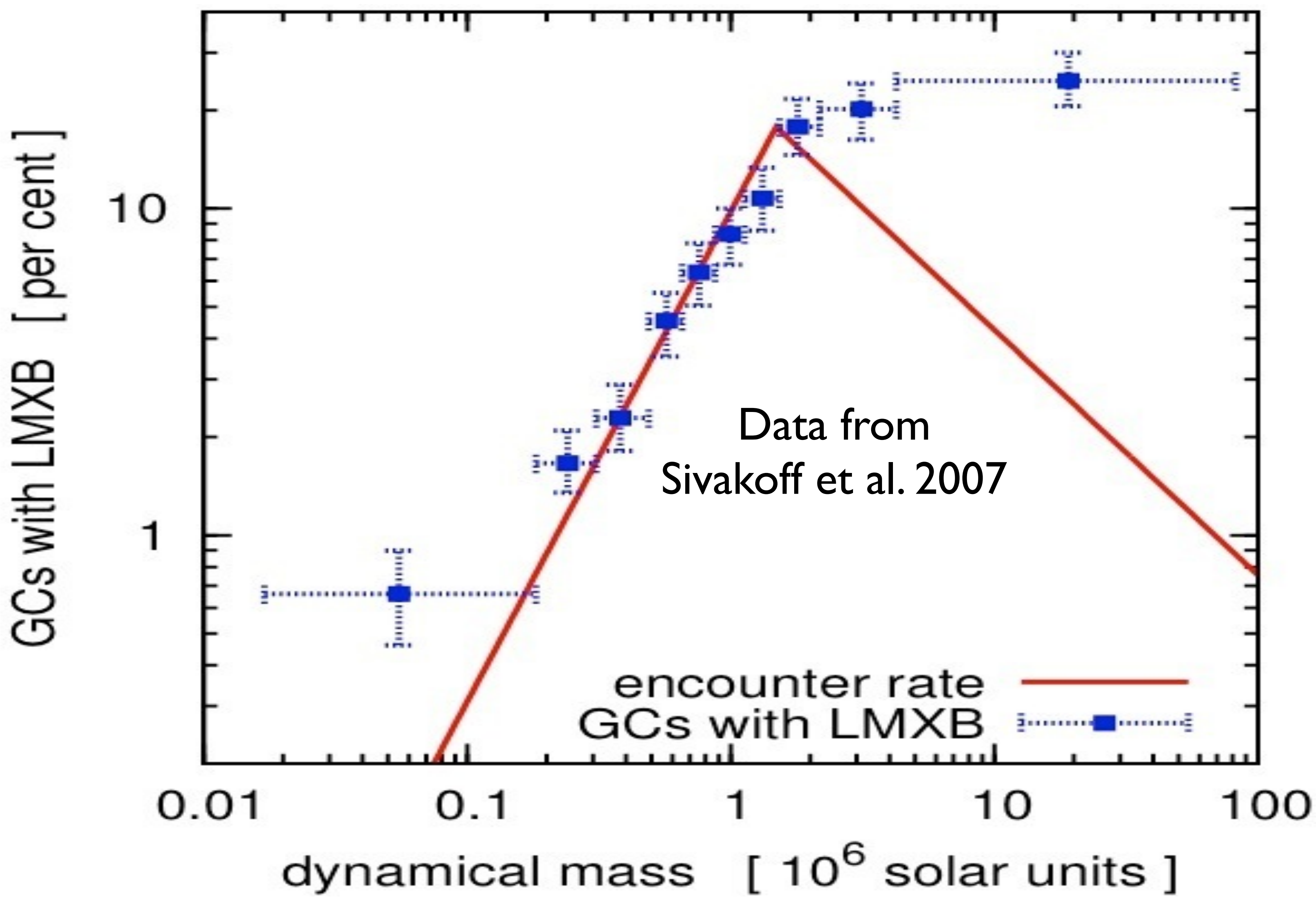

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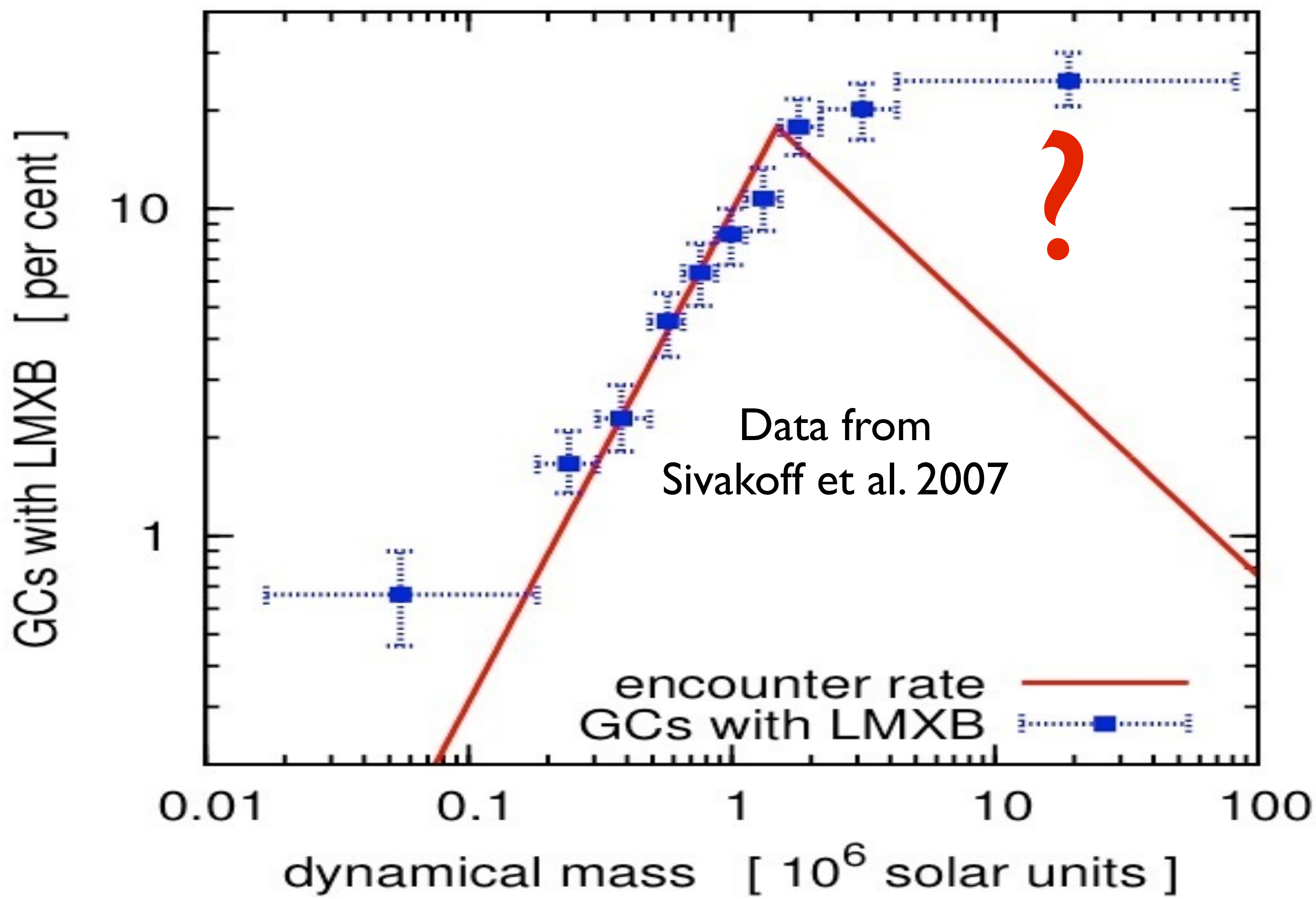
Is there an IMF such that the probability for an LMXB in a UCD can be proportional to the encounter rate?



Fitting the encounter rate to the LMXB-frequency

A variation of the IMF implies that the parameters n_{s}, n_{ns} and σ change in the encounter rate

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Thus, an appropriate set of these parameters has to be found in order to explain the LMXB-frequency in UCDs with a variation of the IMF.

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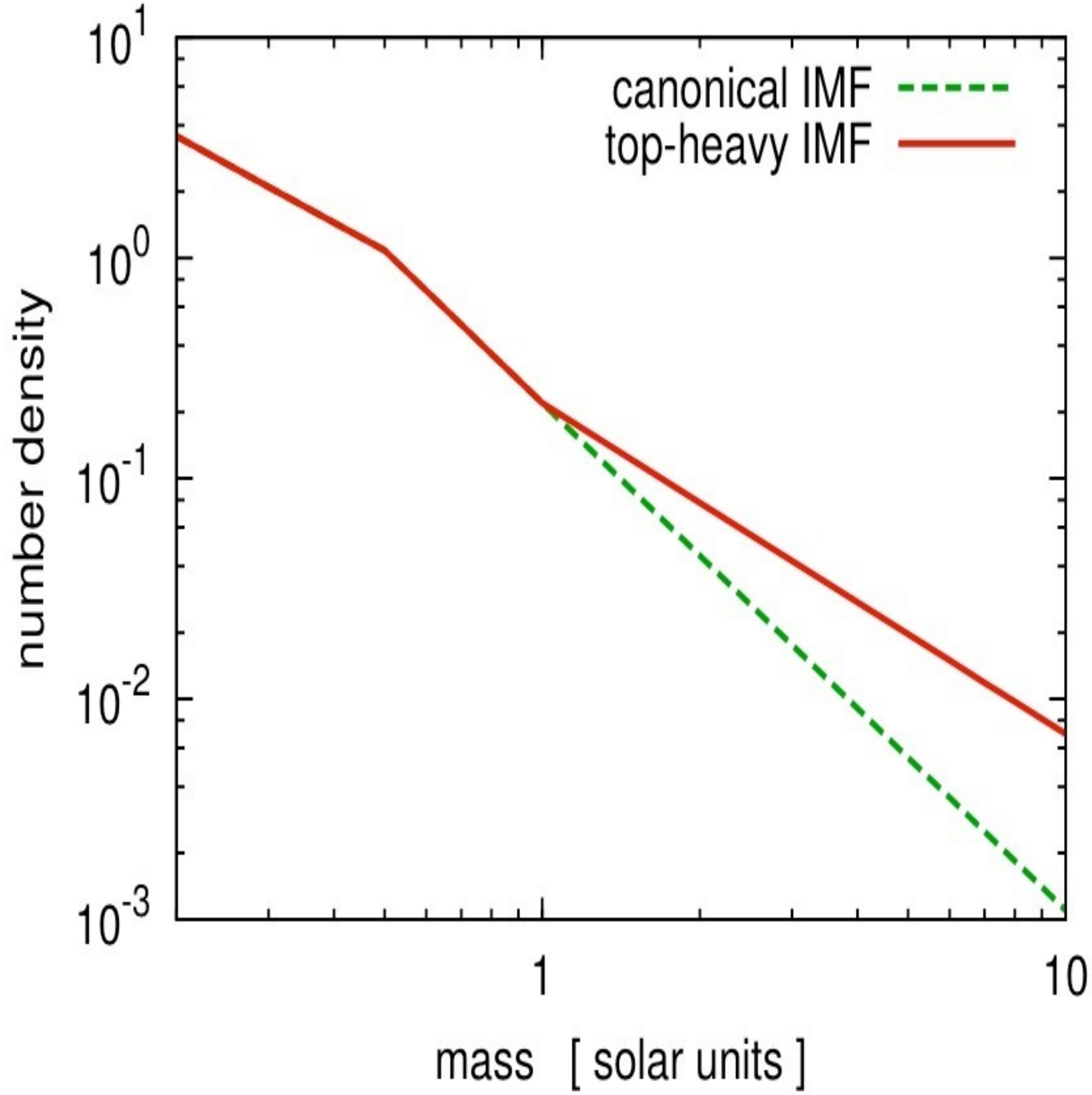

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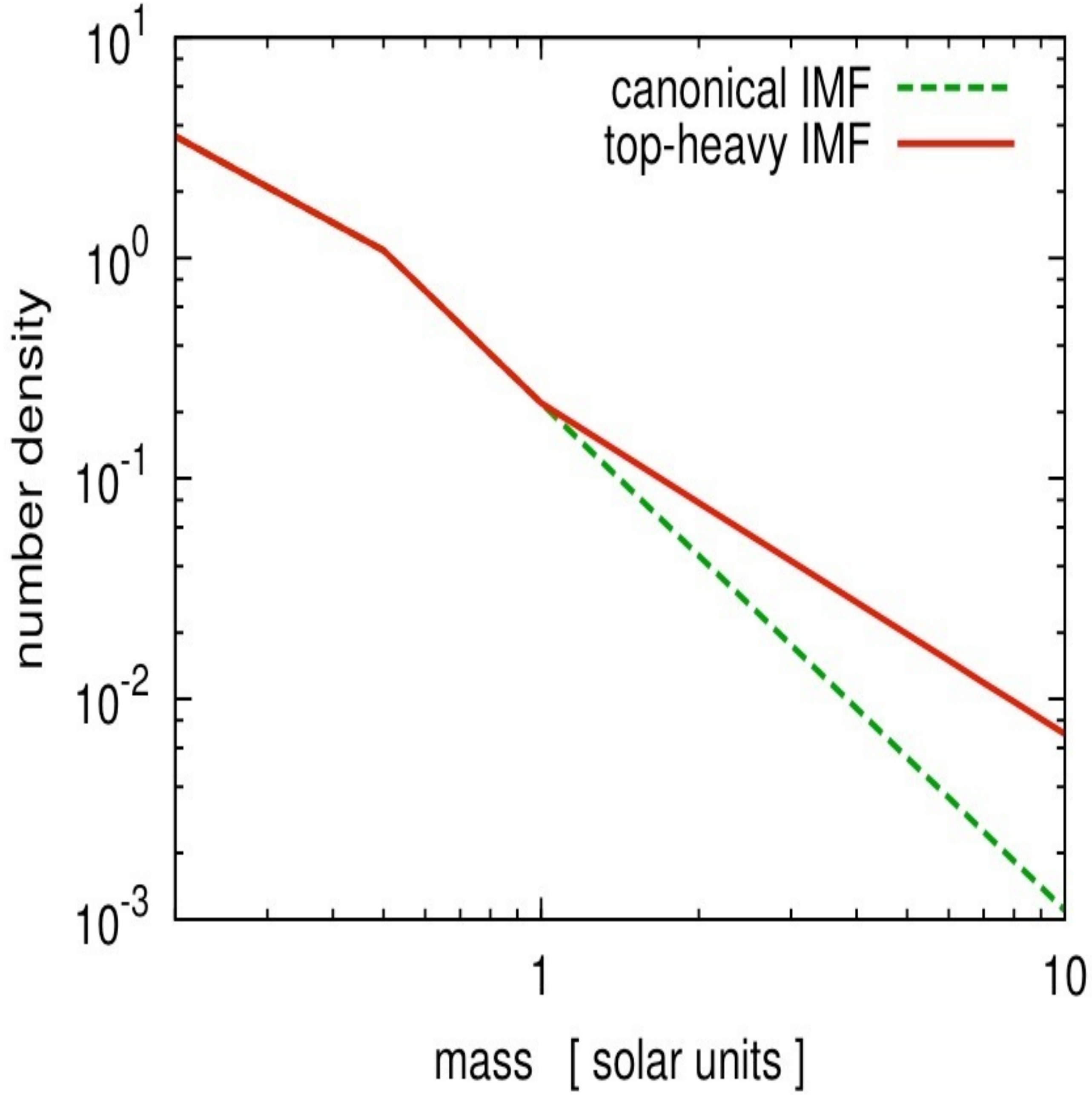

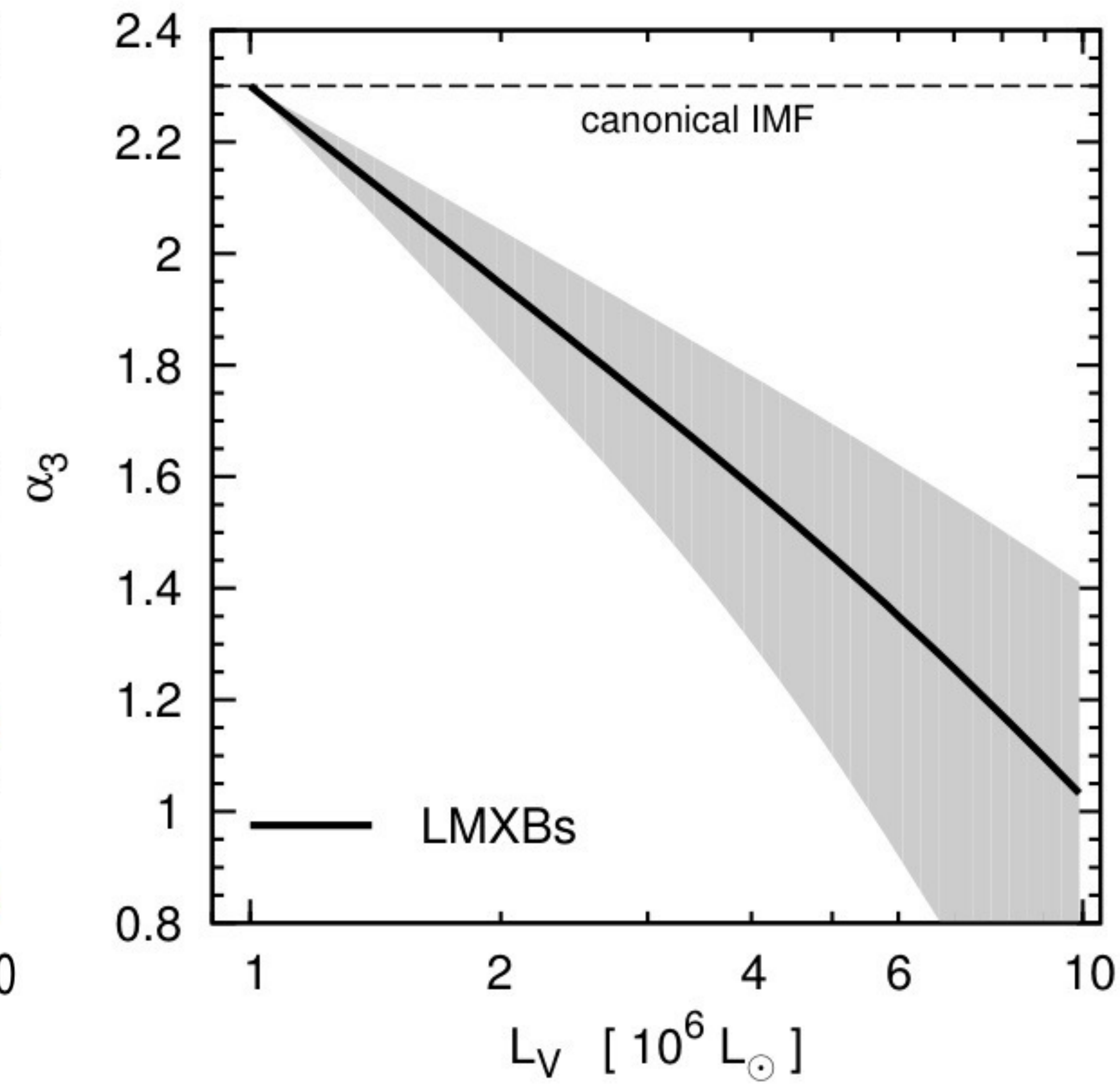

(Dabringhausen, Kroupa, Pflamm-Altenburg & Mieske 2012)

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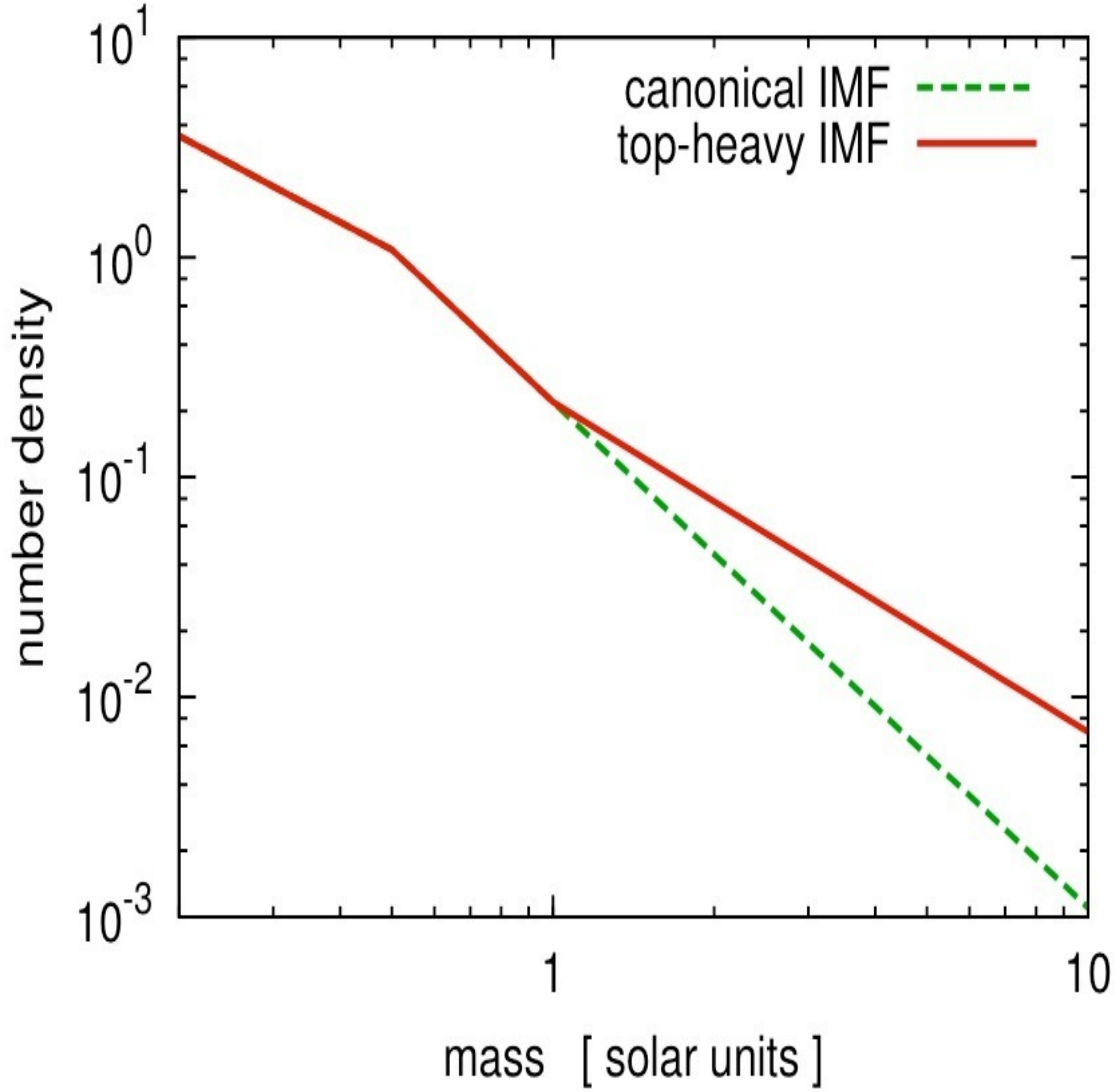

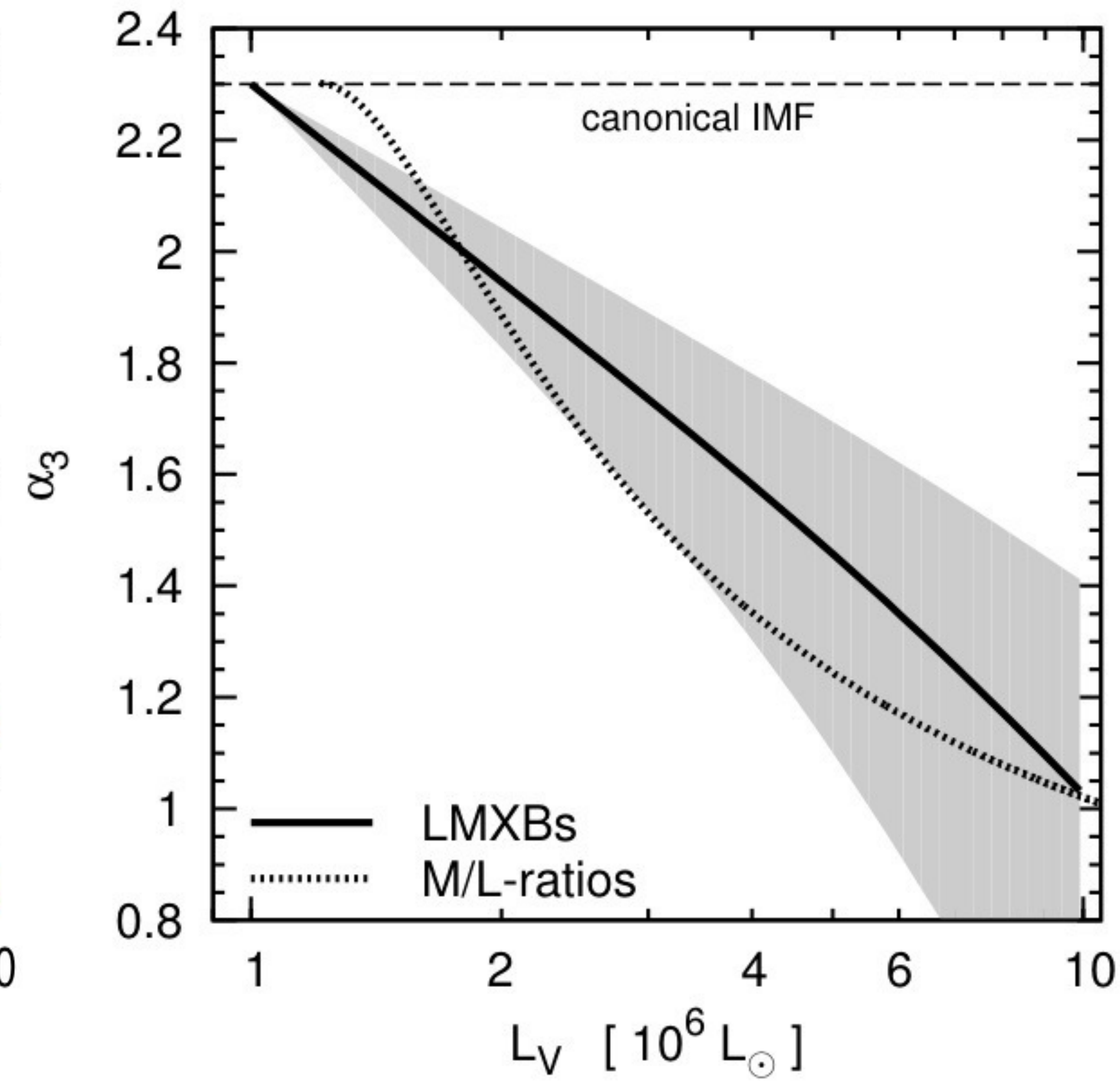

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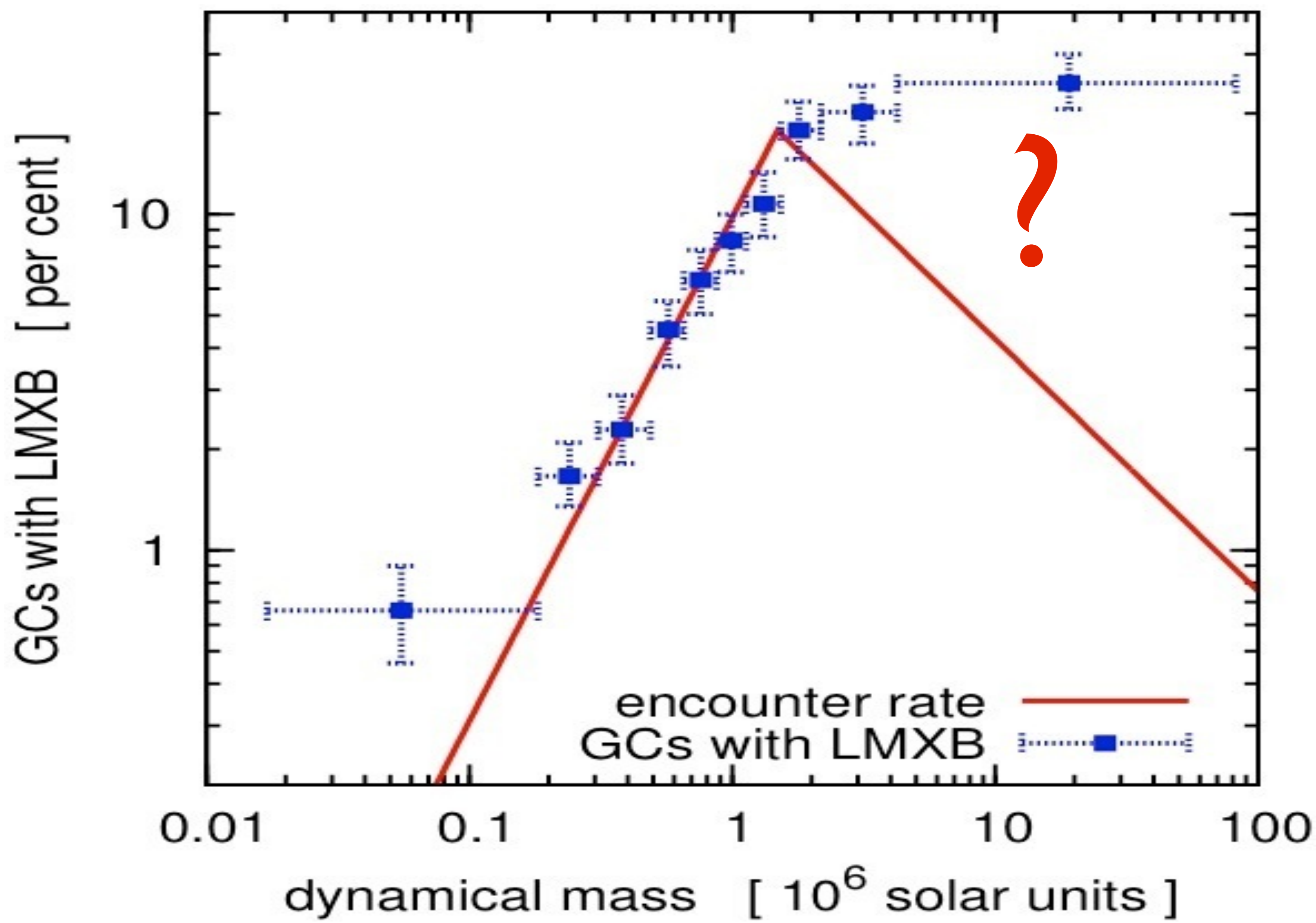
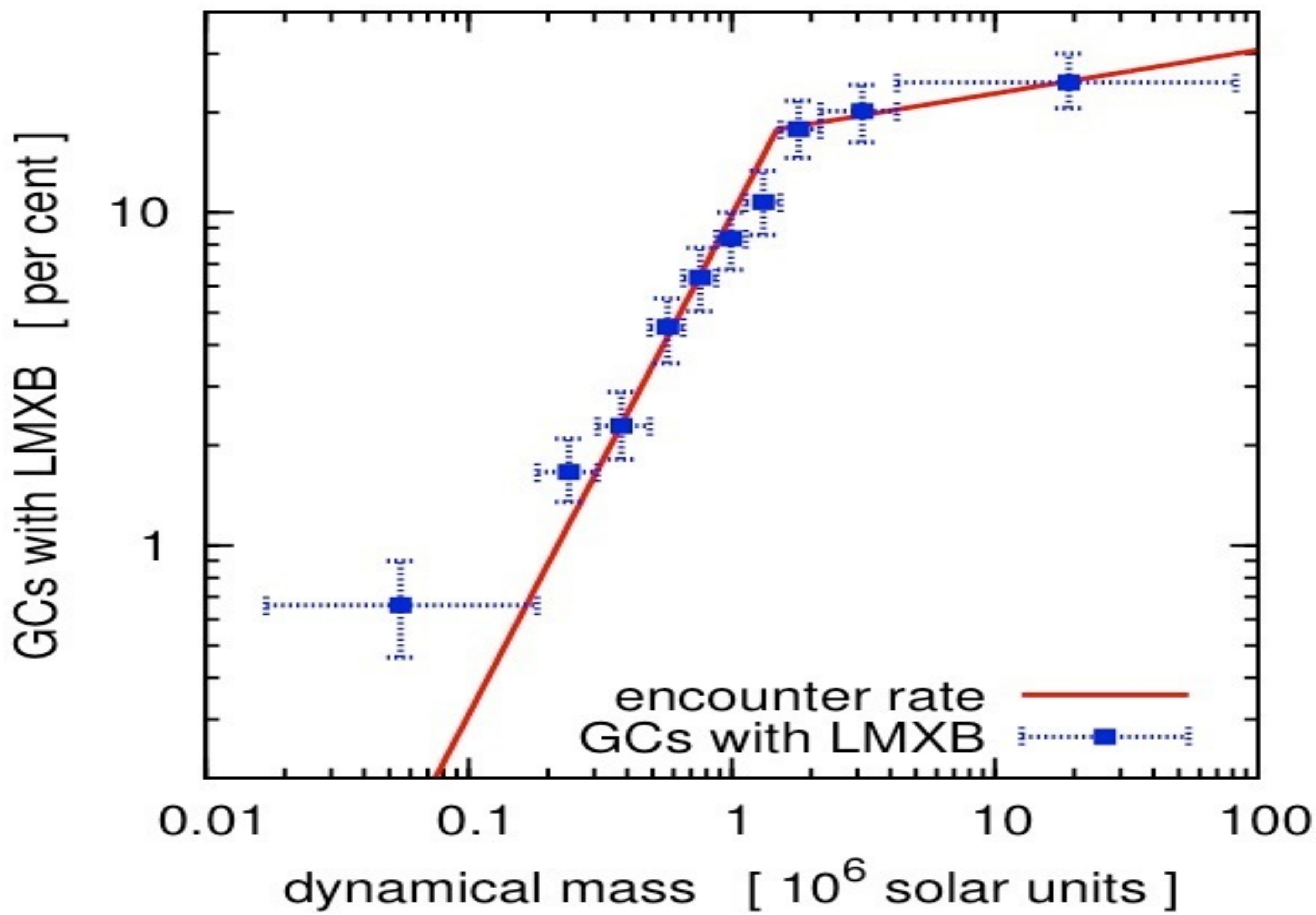


LMXBs in GCs and UCDs in the Virgo Cluster

The LMXB-frequency in UCDs in the Virgo Cluster can be explained with a top-heavy IMF!



Initial conditions of UCDs

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Top-heavy IMFs in UCDs explain their M/L ratios
and their LMXB-frequencies.
(Dabringhausen et al. 2009)
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Top heavy IMFs imply however
extreme initial conditions for the UCDs.
(Dabringhausen et al. 2010)
(Marks et al. 2012)

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Initially, it may have had:

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- A mass of some 10^8 solar masses...

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Consider a UCD with 10^7 solar masses today. Initially, it may have had:

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- A population of 10^6 O-stars...

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- ...but a half-mass radius of only a few pc! (expansion through mass-loss!)
- A population of 10^6 O-stars...
- ...with a total luminosity of 10^{11} solar luminosities.