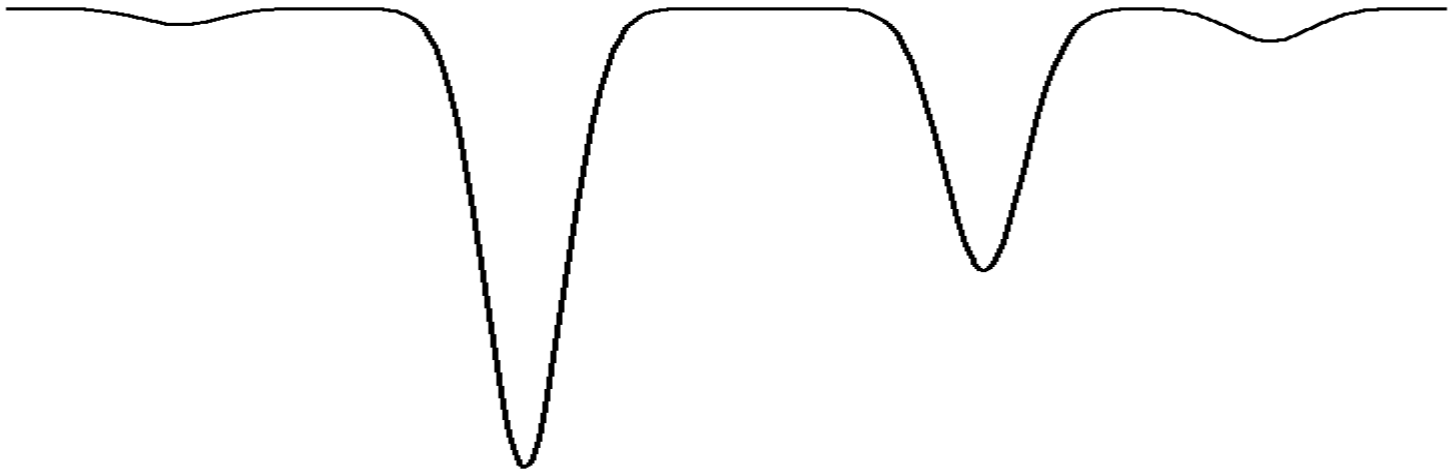
On the universality of the Initial Mass Function

Universität Zürich[UZH]

Crescenzo Tortora

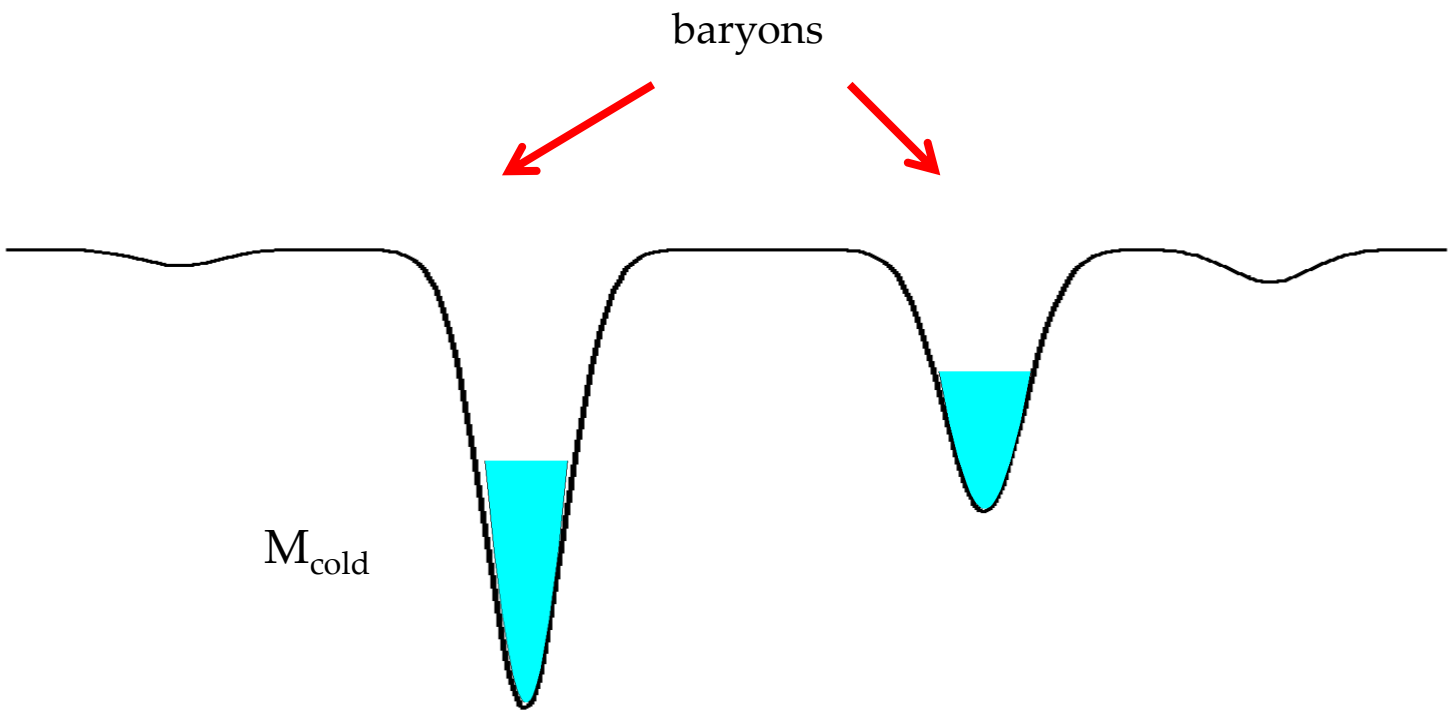
- IMF universality
- IMF and dark matter
- IMF and gravity theory

Current picture



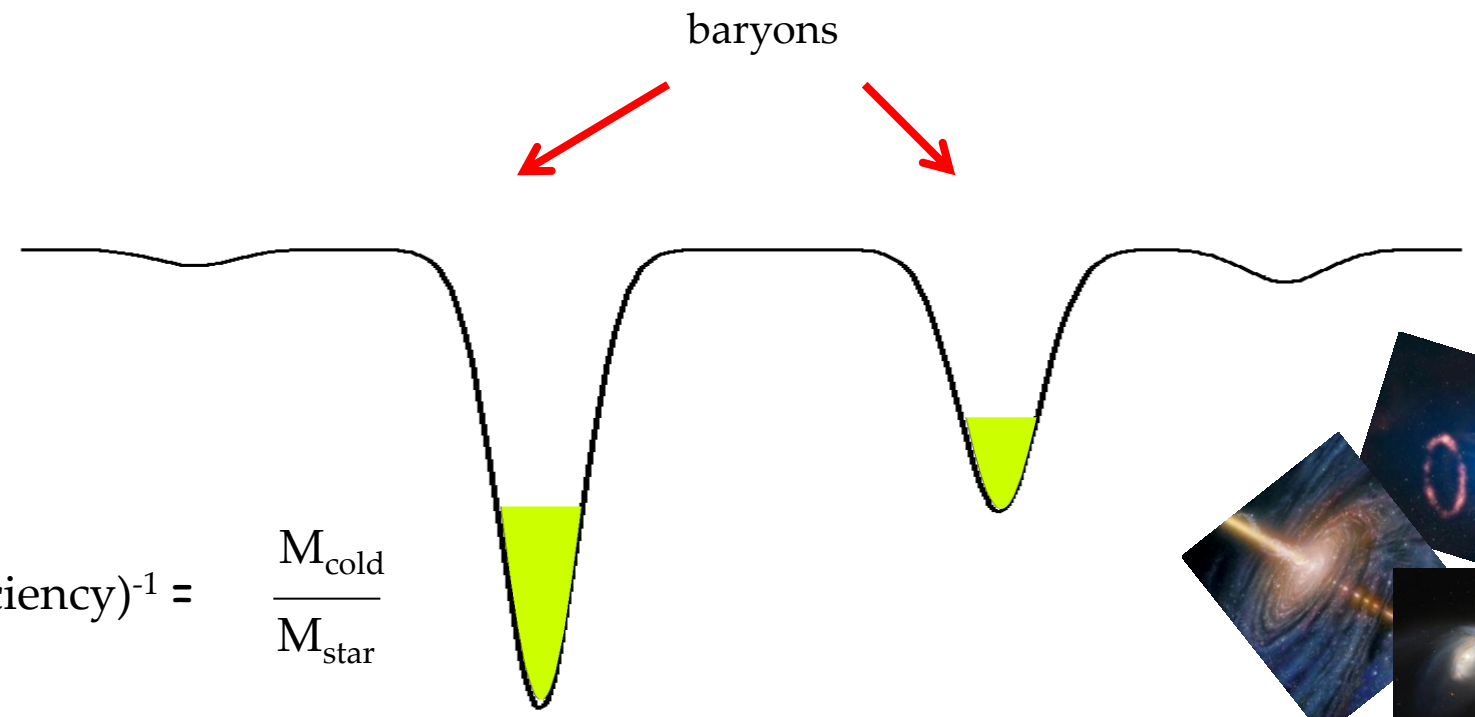
dark matter potential wells

Current picture



dark matter potential wells

Current picture

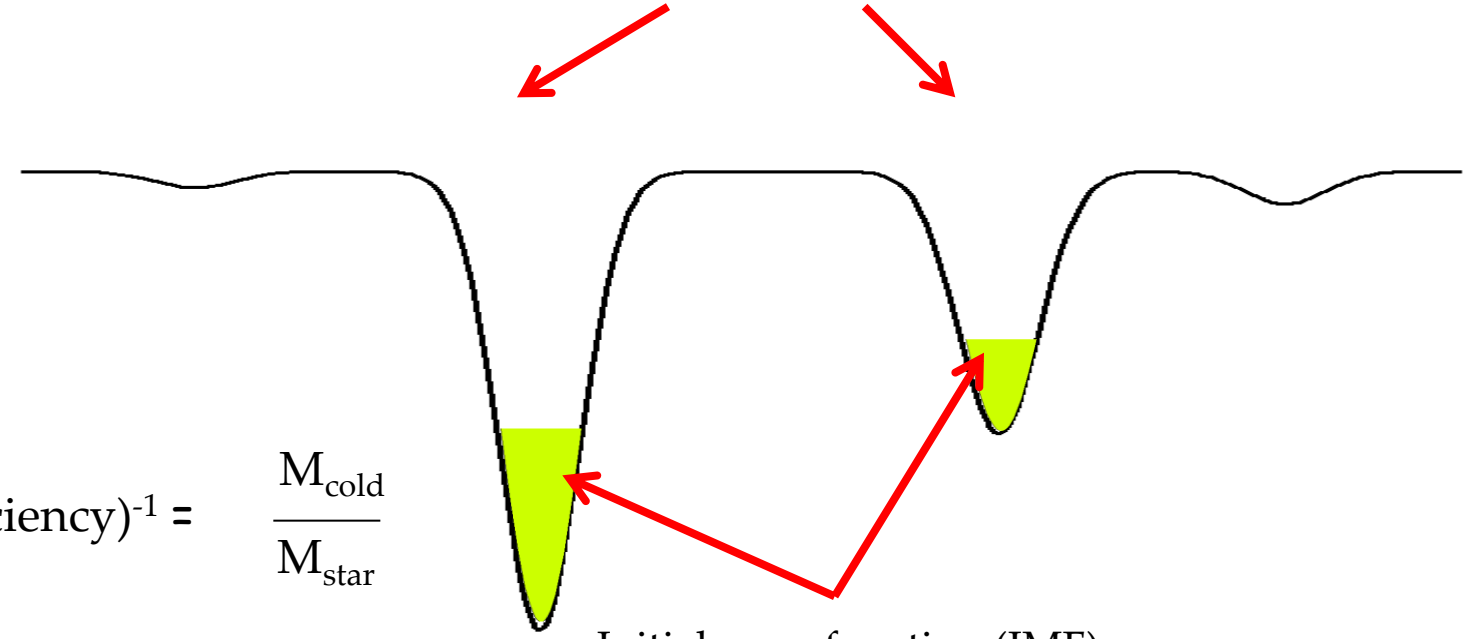


$$(\text{SF efficiency})^{-1} = \frac{M_{cold}}{M_{star}}$$

dark matter potential wells

Current picture

baryons

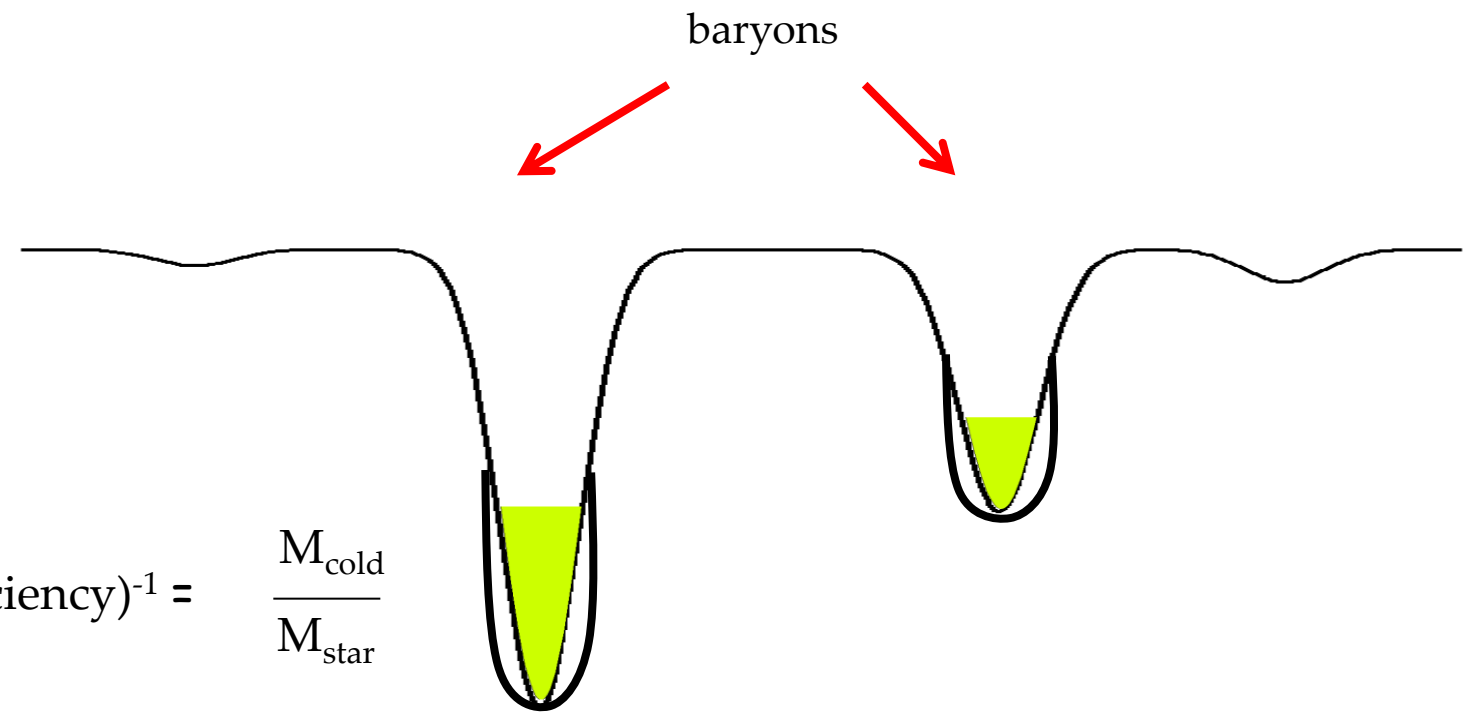


$$(\text{SF efficiency})^{-1} = \frac{M_{cold}}{M_{star}}$$

Initial mass function (IMF)

dark matter potential wells

Current picture



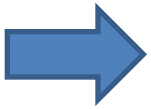
$$(\text{SF efficiency})^{-1} = \frac{M_{cold}}{M_{star}}$$

halo contraction

dark matter potential wells

Non universality of the IMF?

"…if we assume the IMF to be the same for all galaxies, we have to reject the Salpeter IMF (and any IMF with larger slope) as it gives unphysical results."	*Cappellari et al. 2006*
"…the absolute IMF normalization is found to be close to that of a Salpeter IMF…"	*Treu et al. 2010*
"…Models with AC fit well overall with a Kroupa IMF, while models without AC prefer a Salpeter IMF."	*Napolitano et al. 2010*
"… Renzini & Ciotti (1993) pointed out that a variation in the IMF with luminosity could easily account for the FP tilt…… would be enough to explain the FP tilt with no further ingredients"	*Tortora et al. 2009*



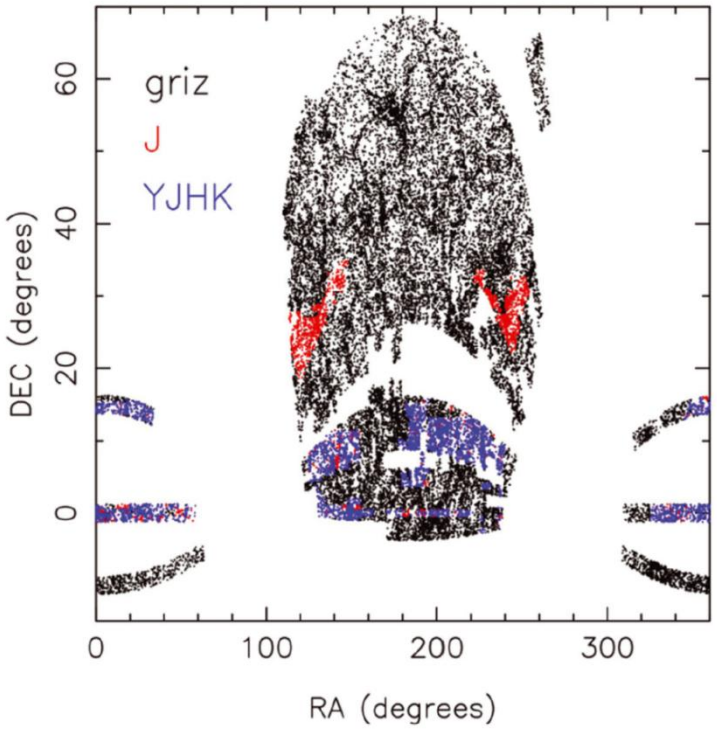
Systematic variation in terms of mass

Treu et al. 2010; Conroy & van Dokkum 2012; Cappellari et al. 2012; Dutton et al. 2012; Tortora et al. 2012, 2013; Ferreras et al. 2013, etc. ec.

SPIDER

Spheroids Panchromatic Investigation in Different Environmental Regions

SDSS + UKIDSS



La Barbera et al. 2010

~ 4500 massive ETGs
with grizYJHK photometry

- structural parameters in all wavebands (determined using 2DPHOT, *La Barbera et al. 2008*)
- stellar masses derived from fitting SPS models (*Bruzual & Charlot 2003*) to observed colours
- recomputed velocity dispersions which allow to probe the total mass
- different environments

AN INVENTORY OF THE STELLAR INITIAL MASS FUNCTION IN EARLY-TYPE GALAXIES

C. TORTORA[1], A. J. ROMANOWSKY[2,3], AND N. R. NAPOLITANO[4]

Method

SPS analysis → Stellar M/Ls assuming a Chabrier IMF

Central dynamics → Dynamical estimate of M/Ls

Fixing halo model accordingly to the predictions from simulations
(c-M relation, SF efficiency, halo contraction, warm vs cold DM, ….)

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Central dynamics → Dynamical estimate of M/Ls

Fixing halo m… ccordingly to the predictions from simulations
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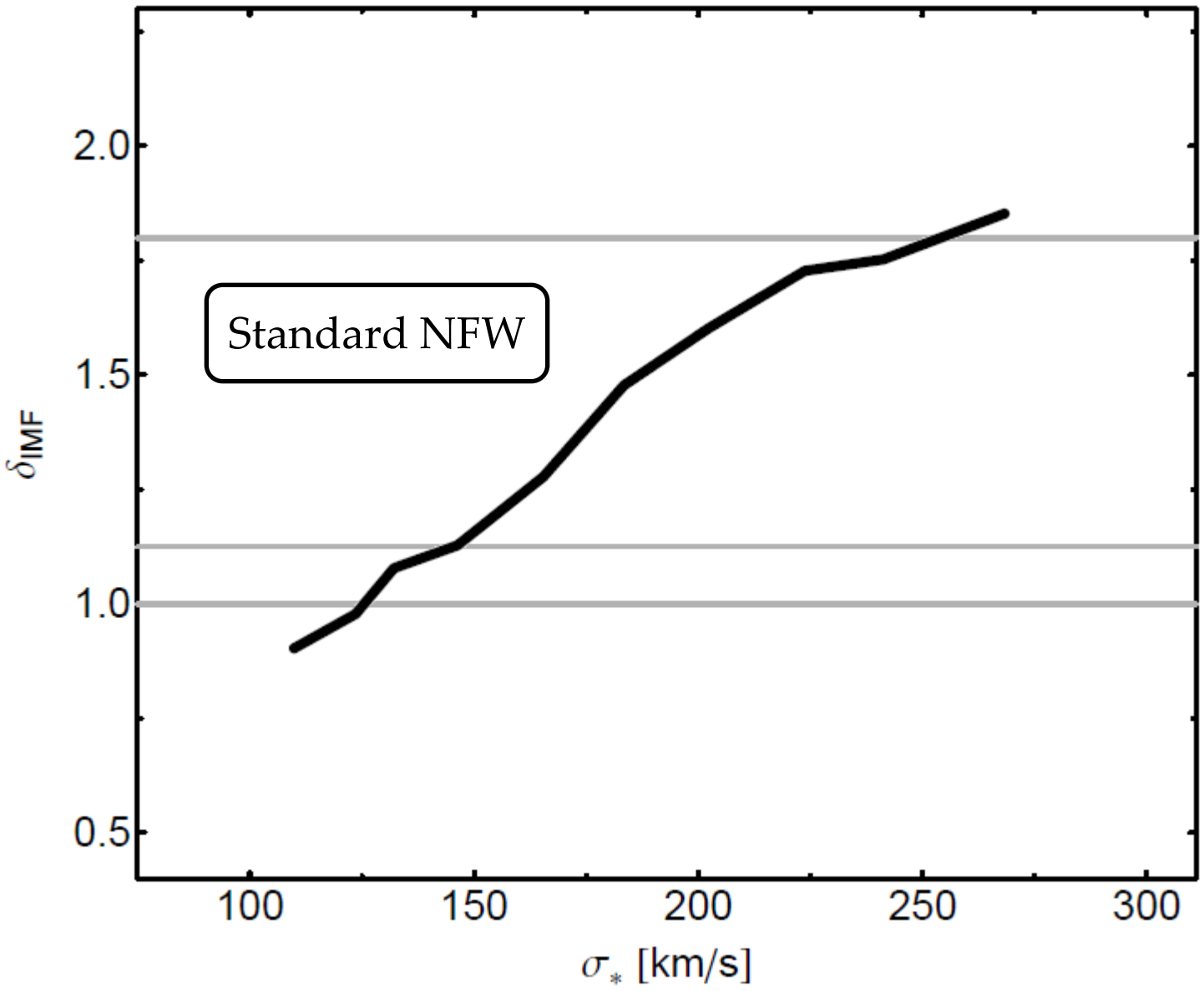
$\Upsilon_{\star}$

$$\delta_{\rm IMF} = \frac{\Upsilon_{\star}}{\Upsilon_{\star MW}}$$

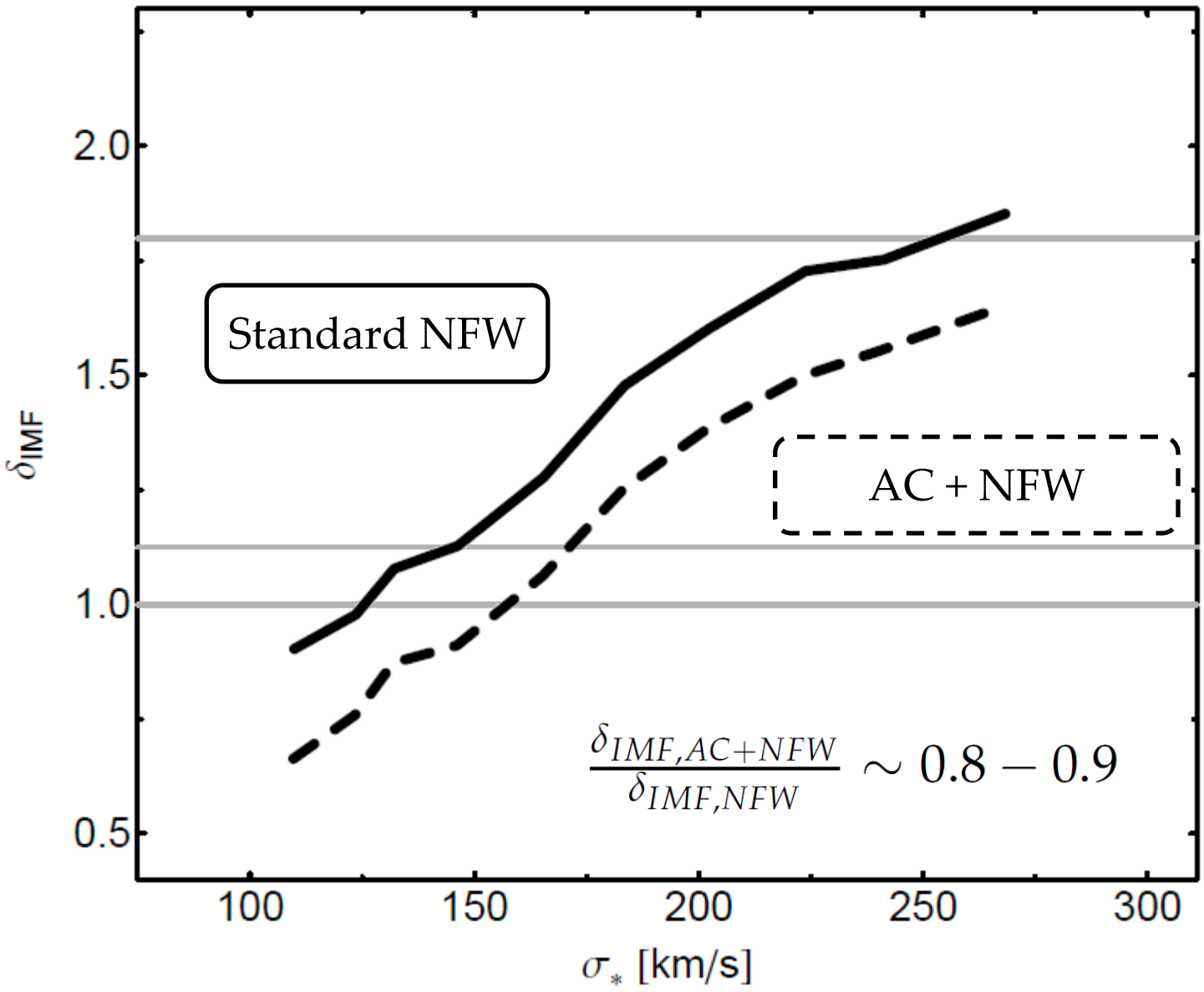


Salpeter

Kroupa

Chabrier

No environmental dependence



Salpeter

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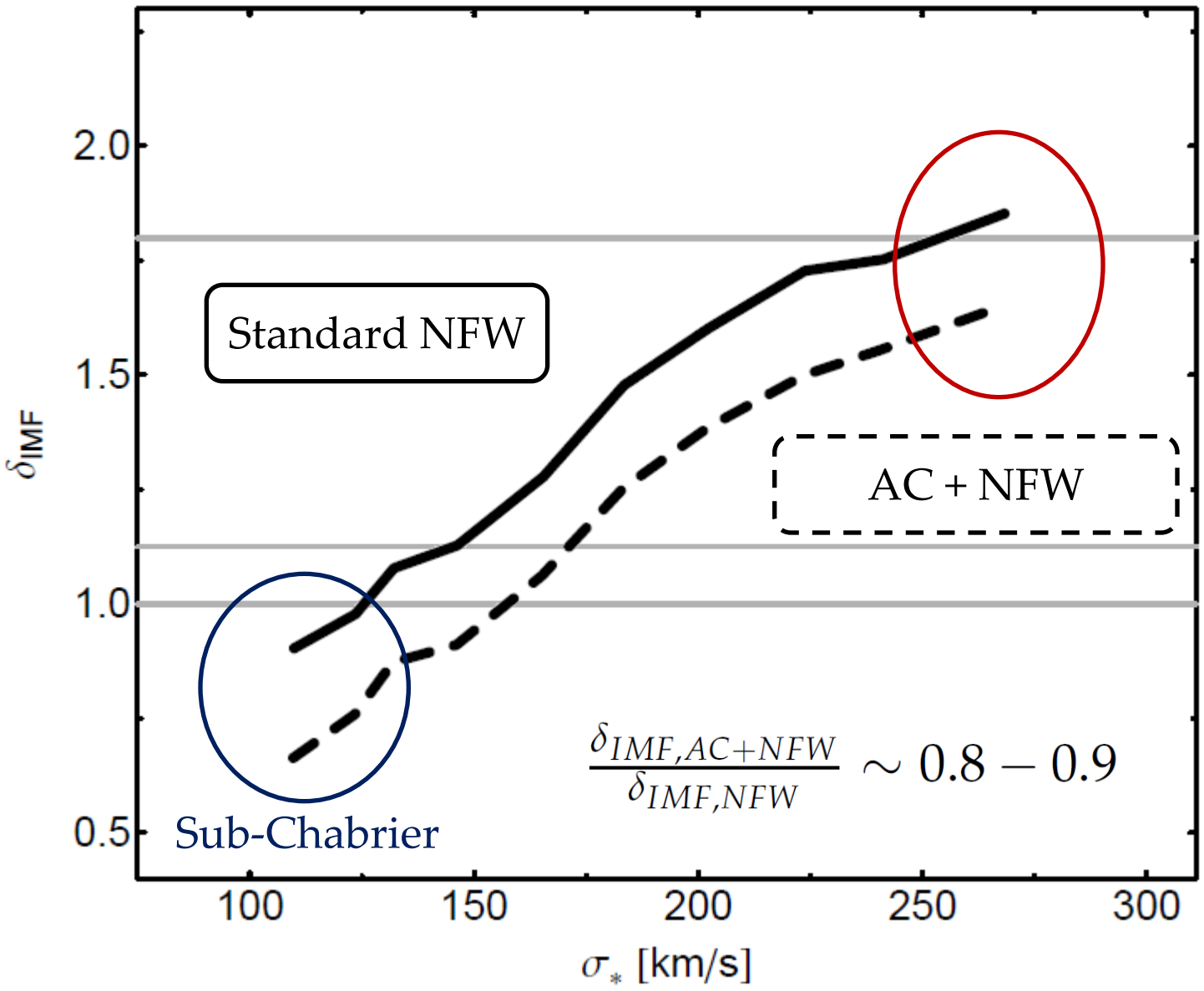
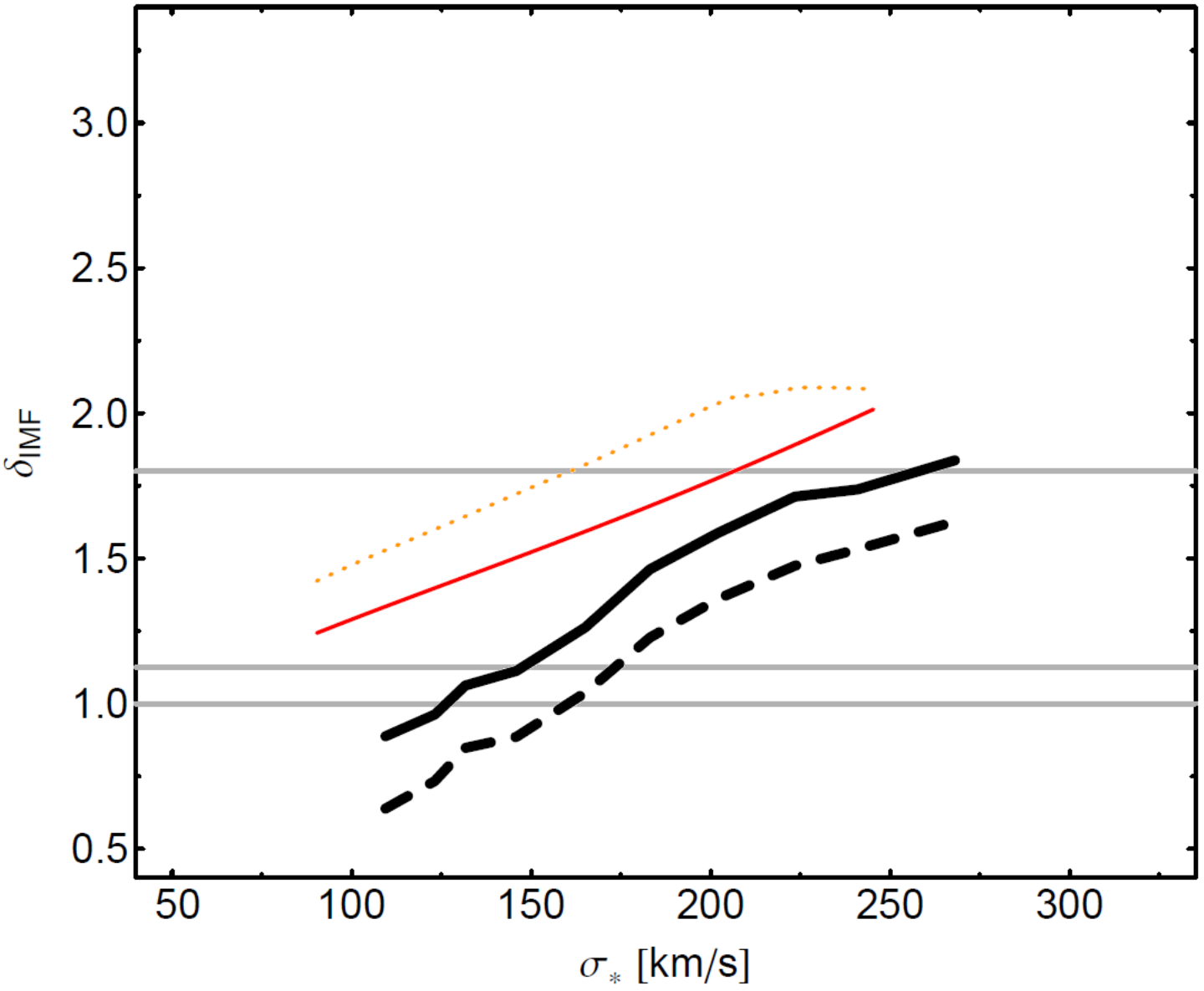


Salpeter

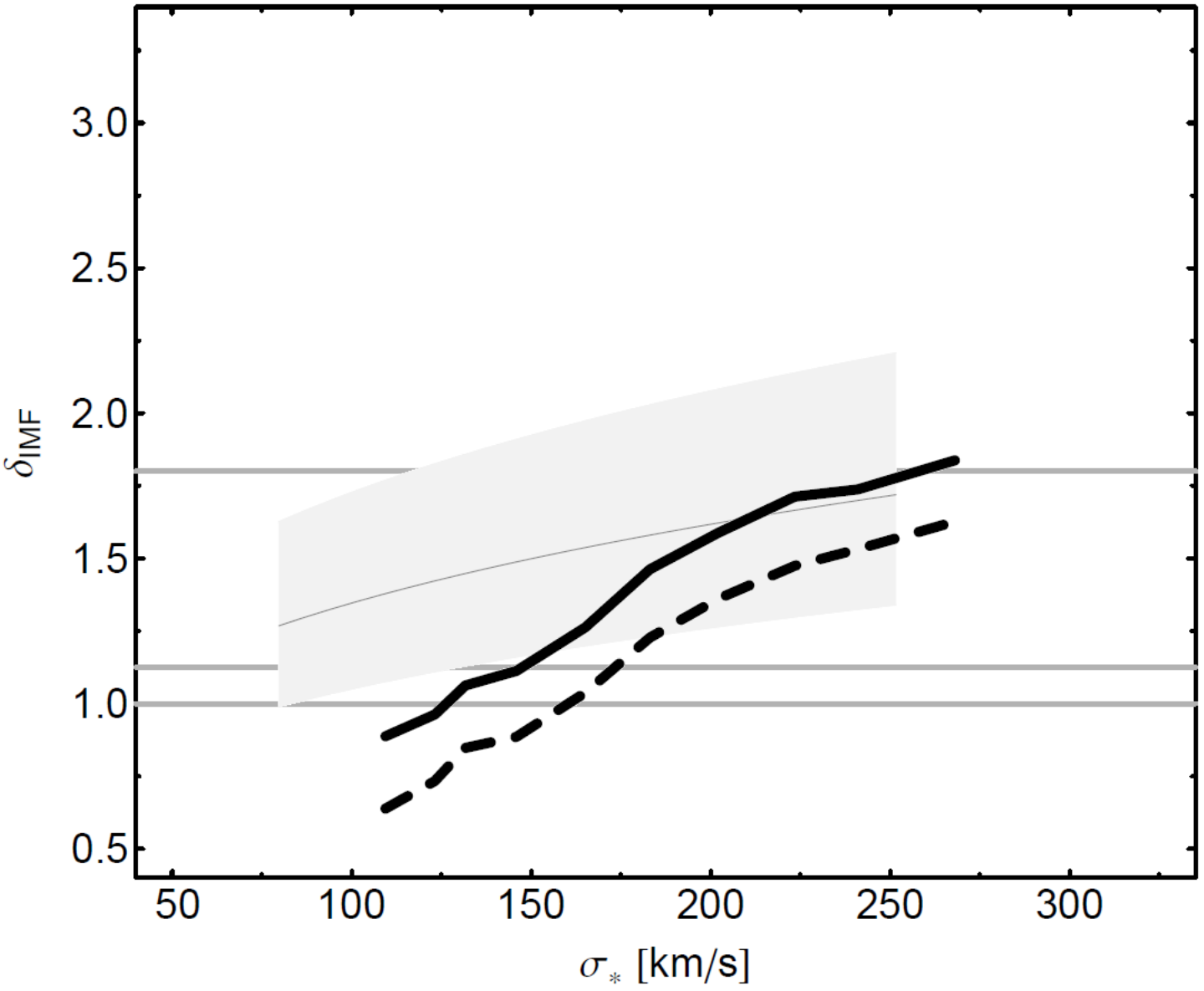
Kroupa

Chabrier

No environmental dependence

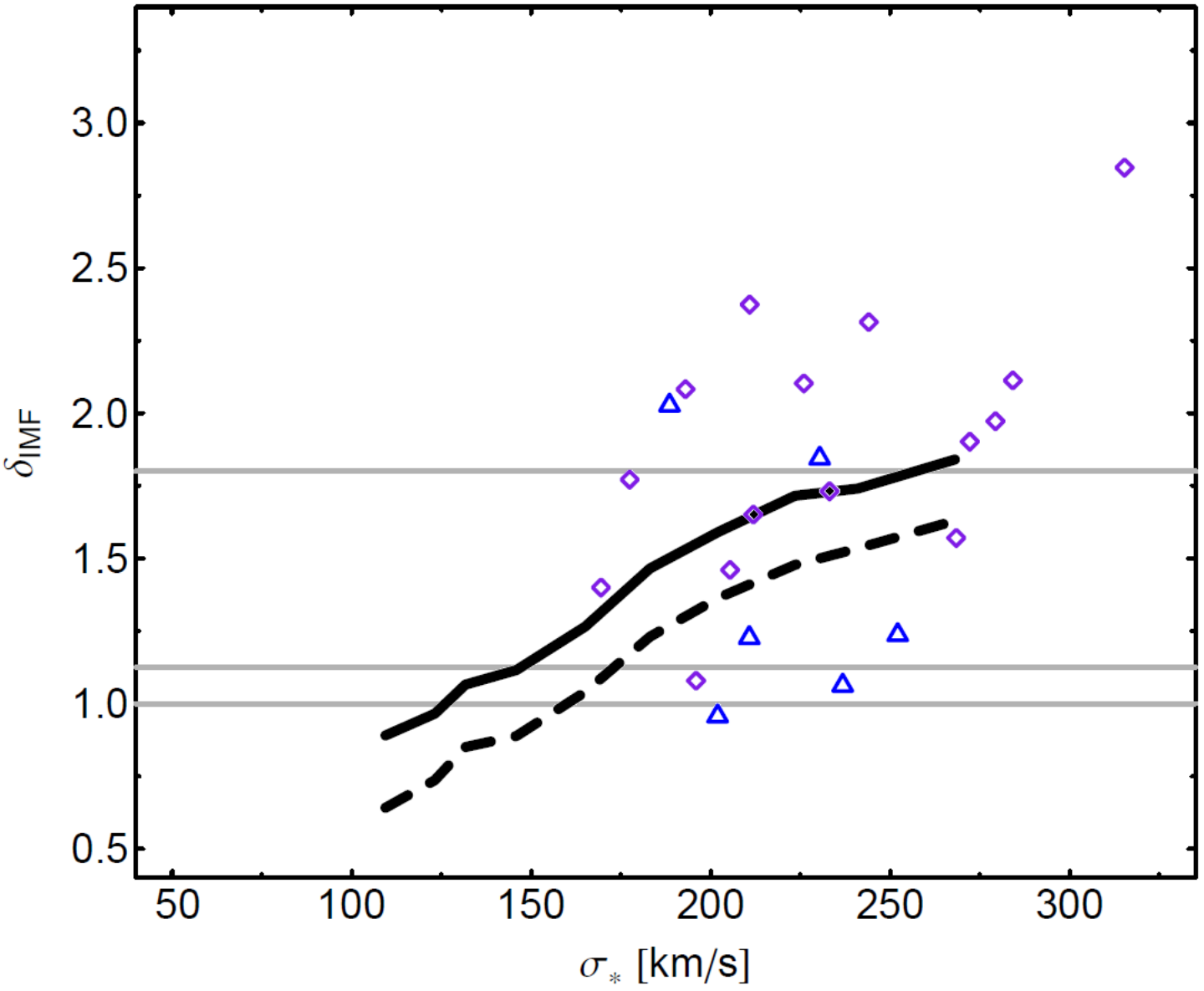


Dutton et al. 2012



Dutton et al. 2012

Cappellari et al. 2013



Dutton et al. 2012

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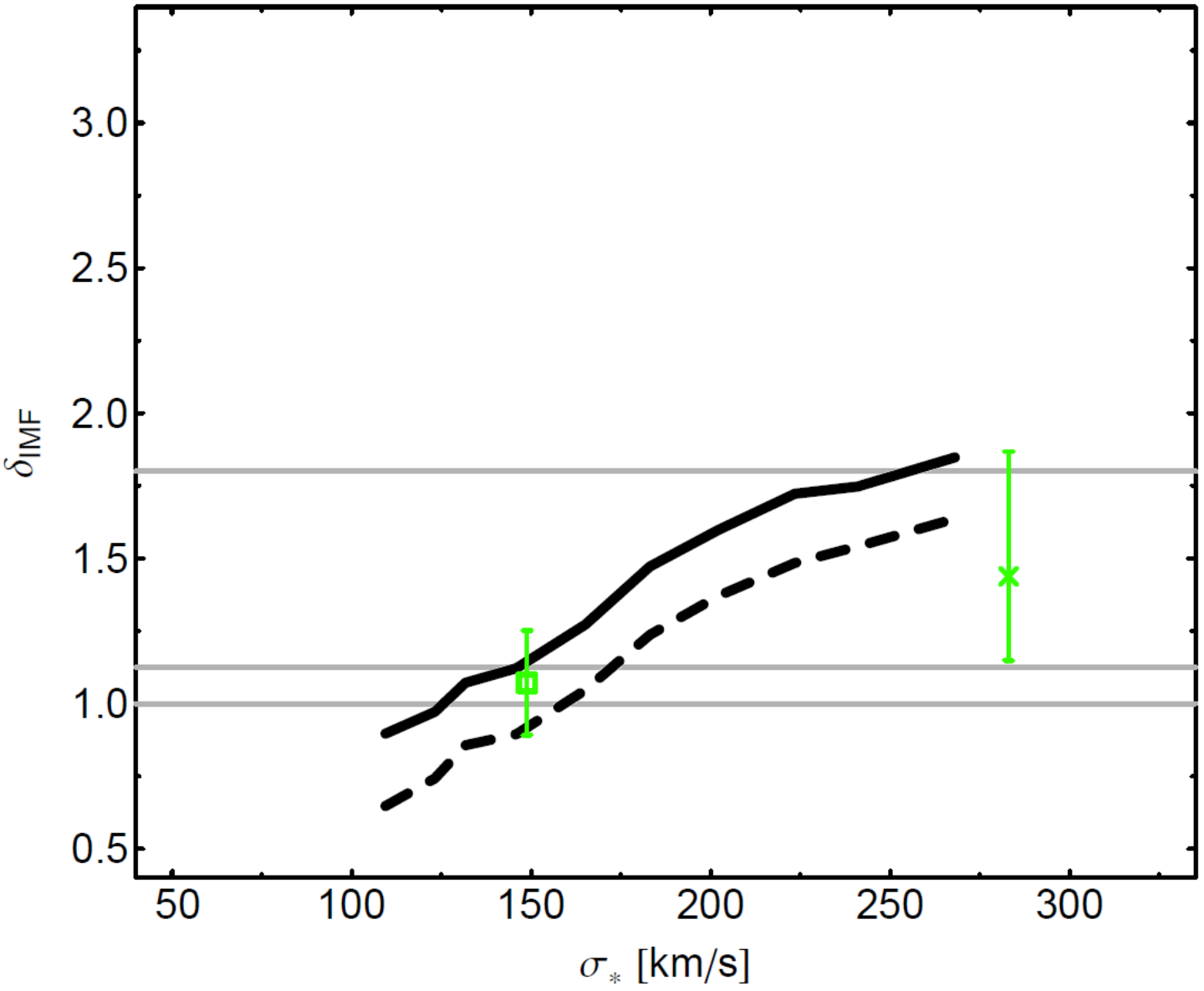
Thomas et al. 2011

Wegner et al. 2012



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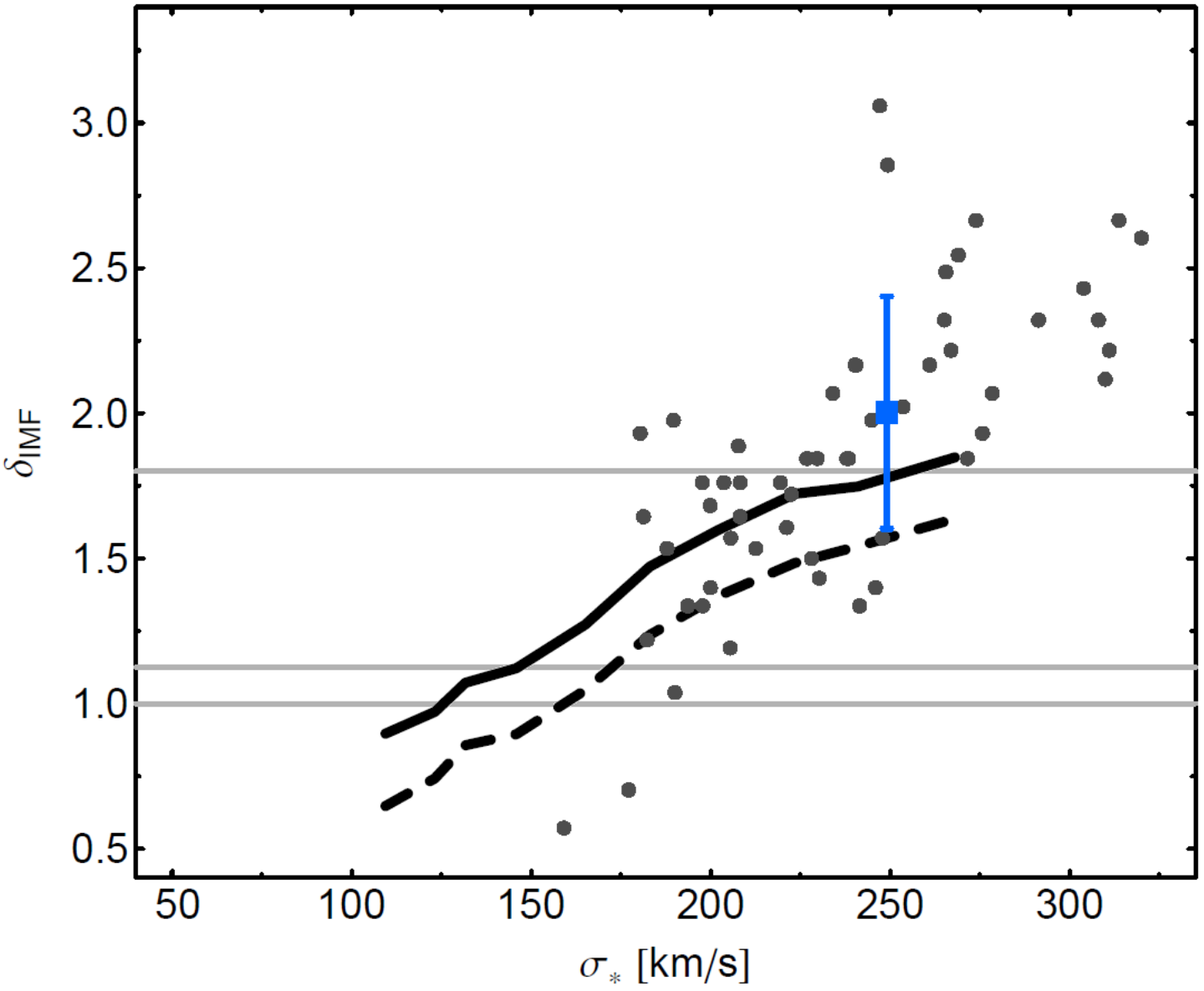

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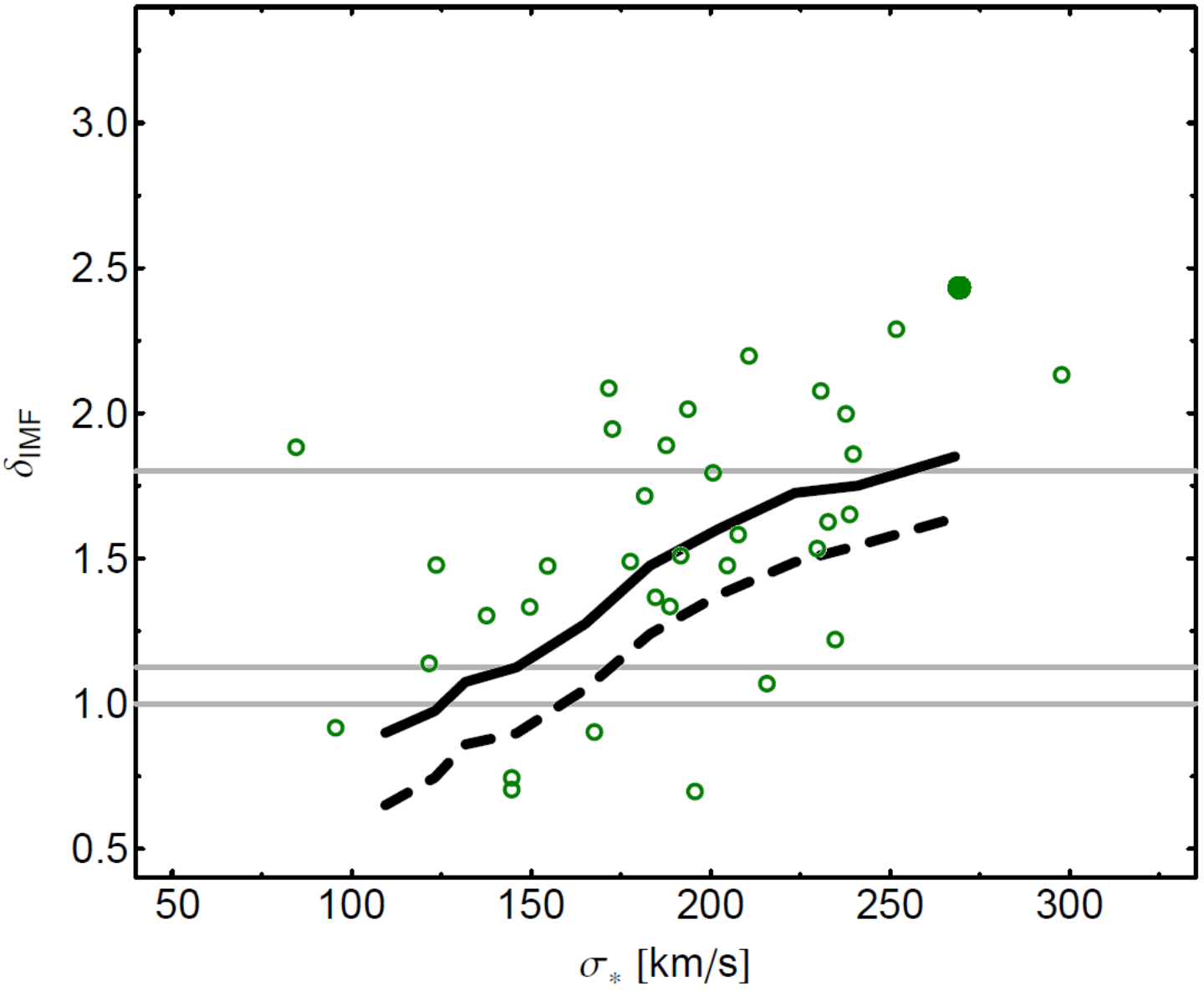
Treu et al. 2010

Sonnenfeld et al. 2012



Dutton et al. 2012

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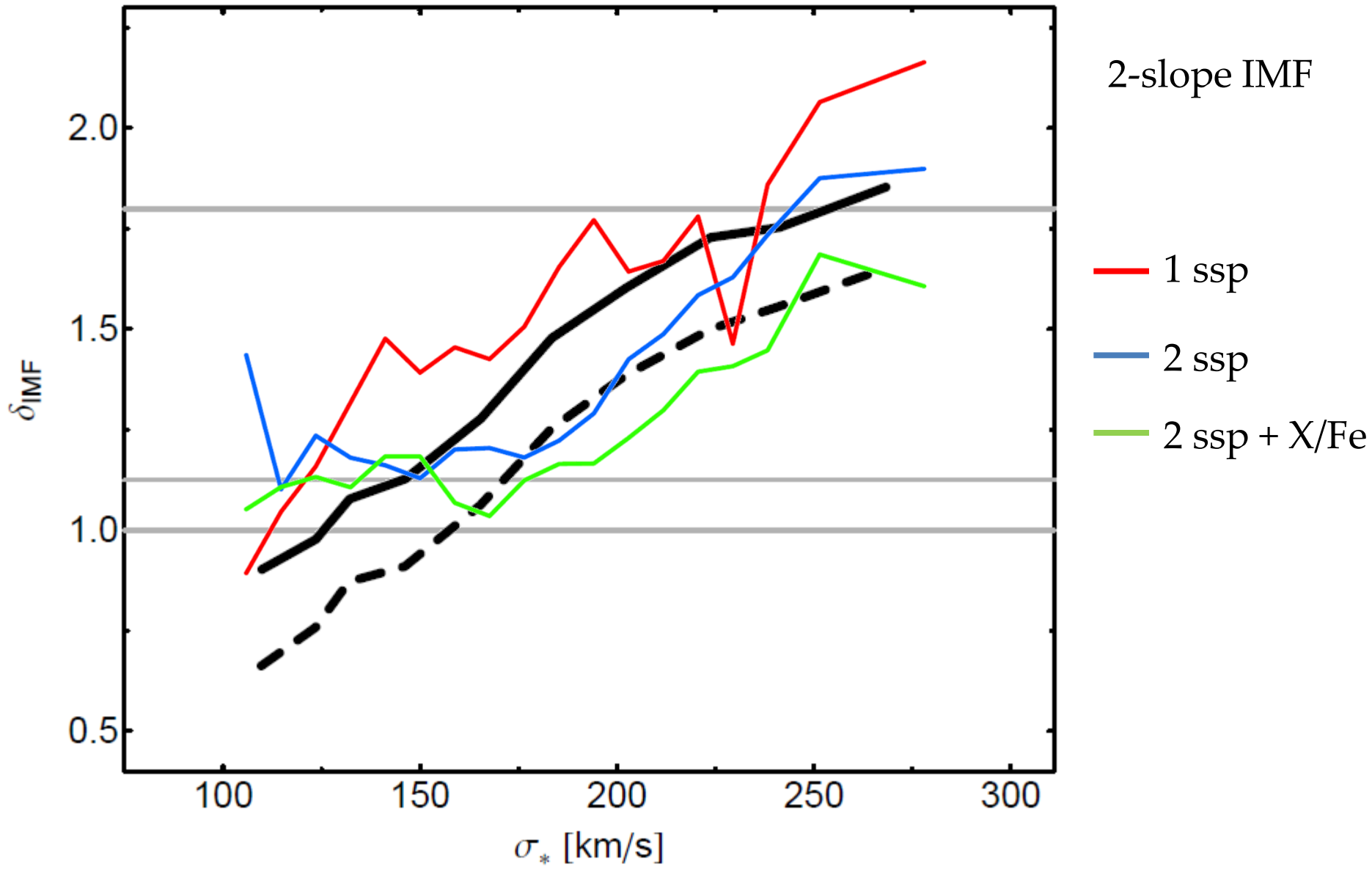
Treu et al. 2010

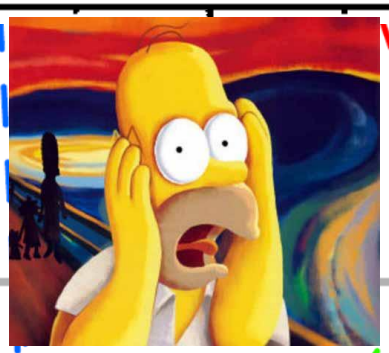
Sonnenfeld et al. 2012

Conroy & van Dokkum 2012

from La Barbera et al. 2013 (SPIDER VIII)



from La Barbera et al. 2013 (SPIDER VIII)



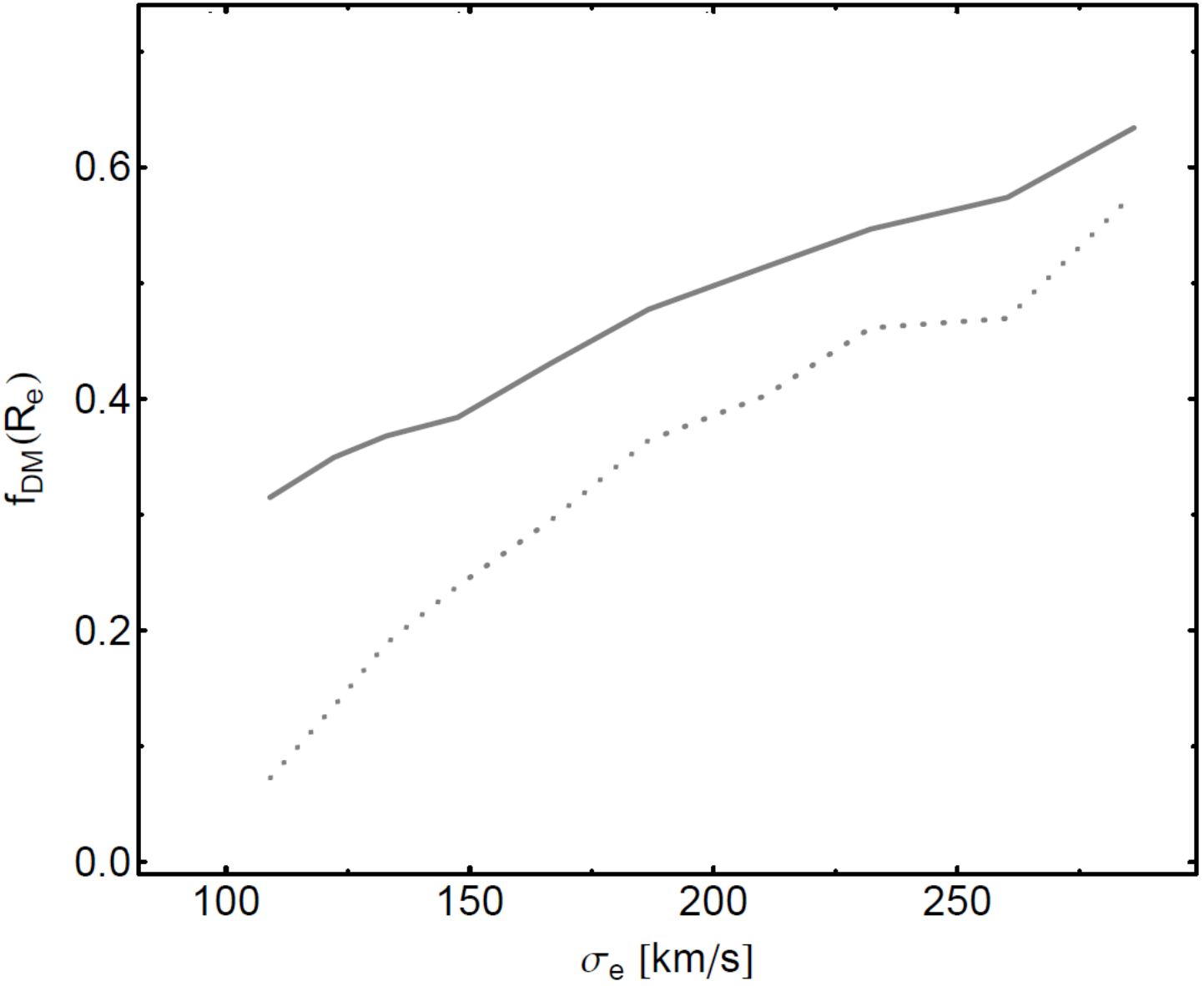
2-slope IMF

1 ssp

2 ssp

2 ssp + X/Fe

1-slope IMF

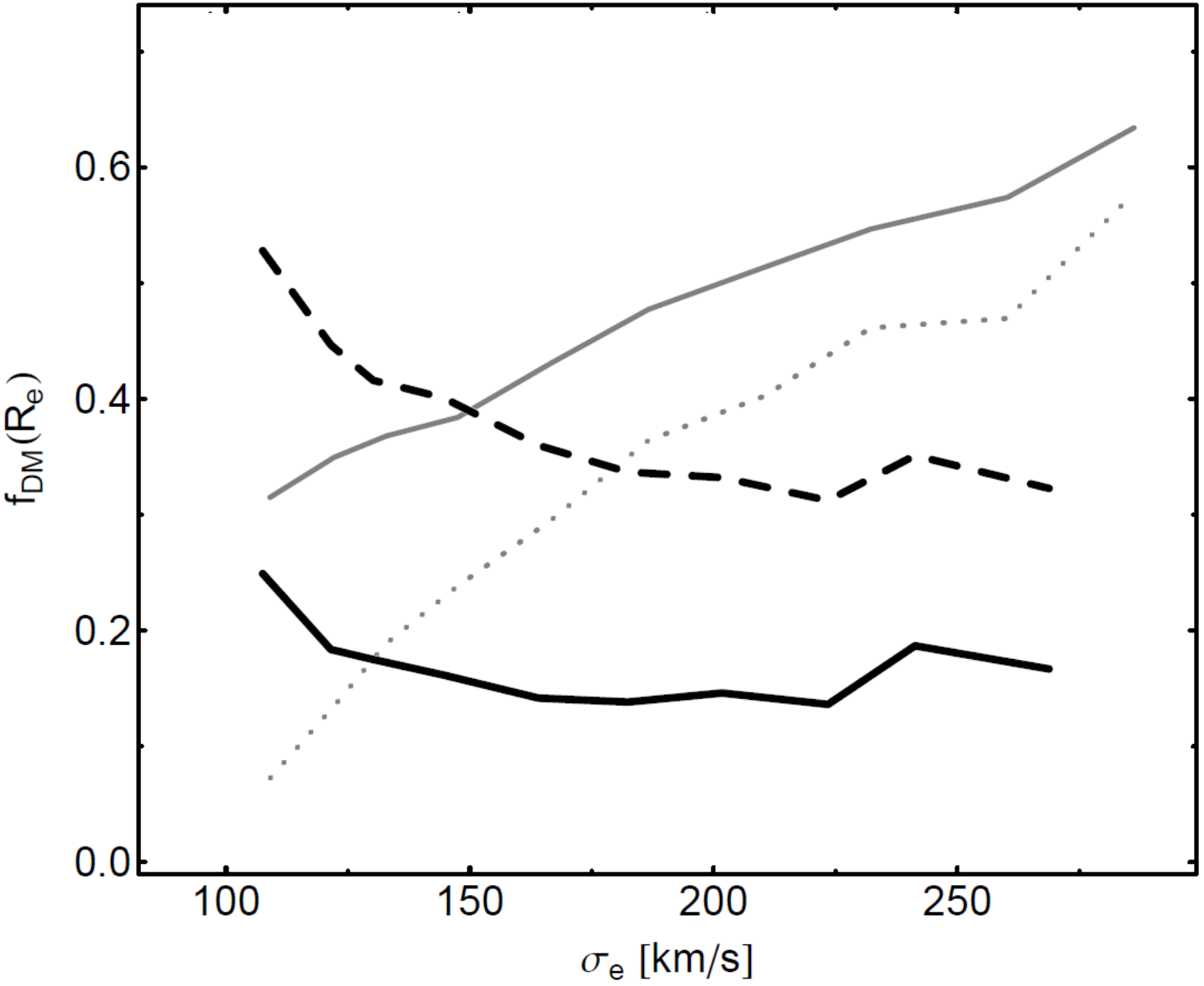


Chabrier IMF

SIS

Constant M/L

Tortora et al. 2012 (SPIDER VI)



Chabrier IMF

SIS

Constant M/L

Tortora et al. 2012 (SPIDER VI)

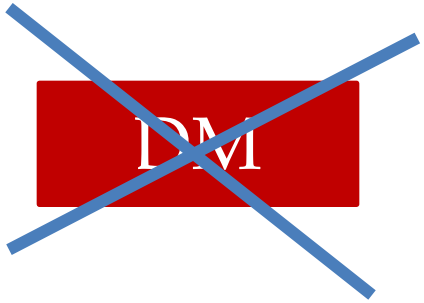
Variable IMF

NFW+light

NFW+AC+light

Tortora et al. 2013

Cappellari et al. 2013(ATLAS3D)



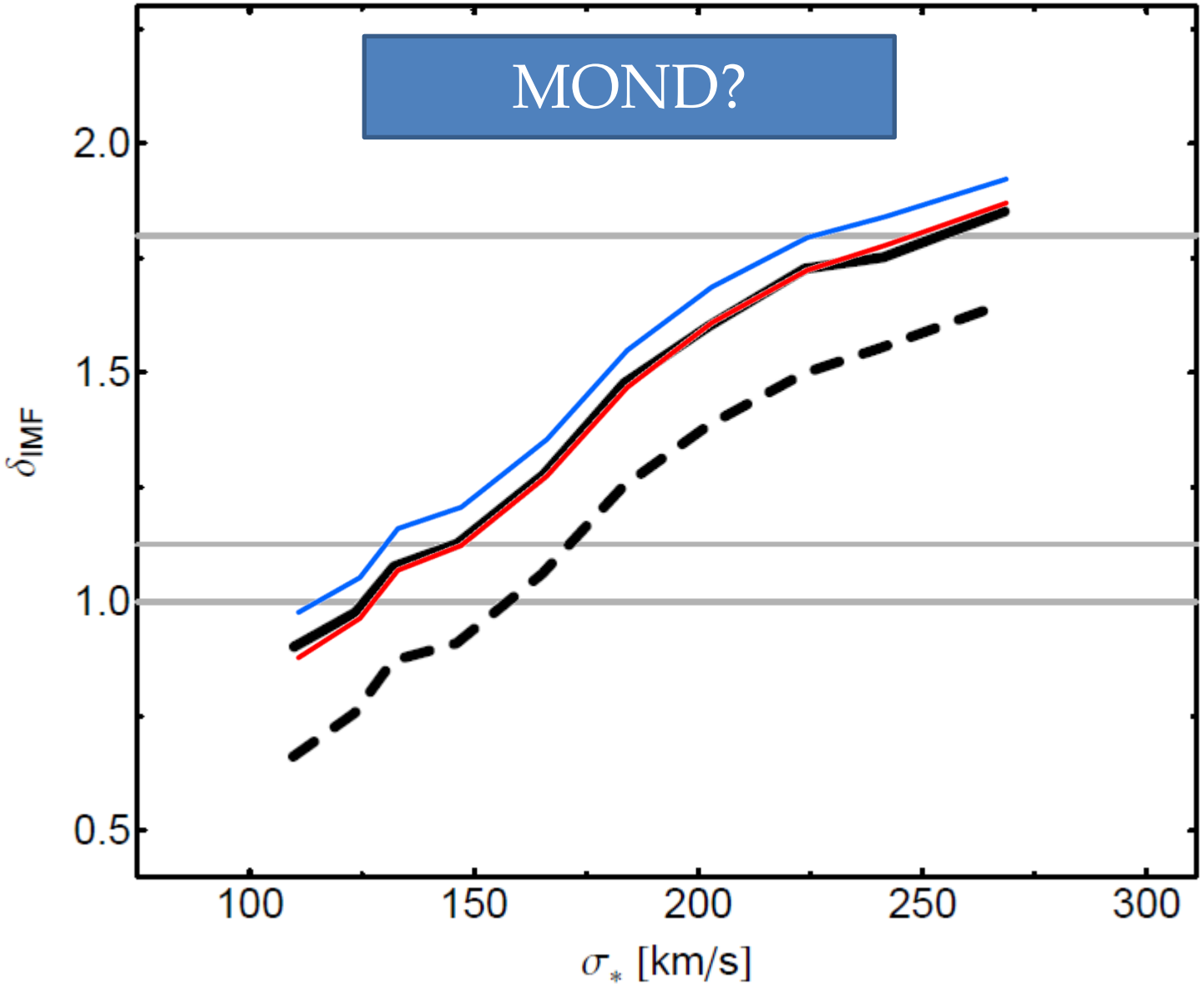
MOND?

MOND $g_M(r)$ → Newton $g_N(r)$

acceleration $g(r)$

$$g(r)\mu\left(\frac{g(r)}{a_0}\right) = g_N(r)$$

$$\mu_1(r) = \frac{g(r)}{a_0+g(r)} \qquad \mu_2(r) = \frac{g(r)}{\sqrt{a_0^2+g(r)^2}}$$

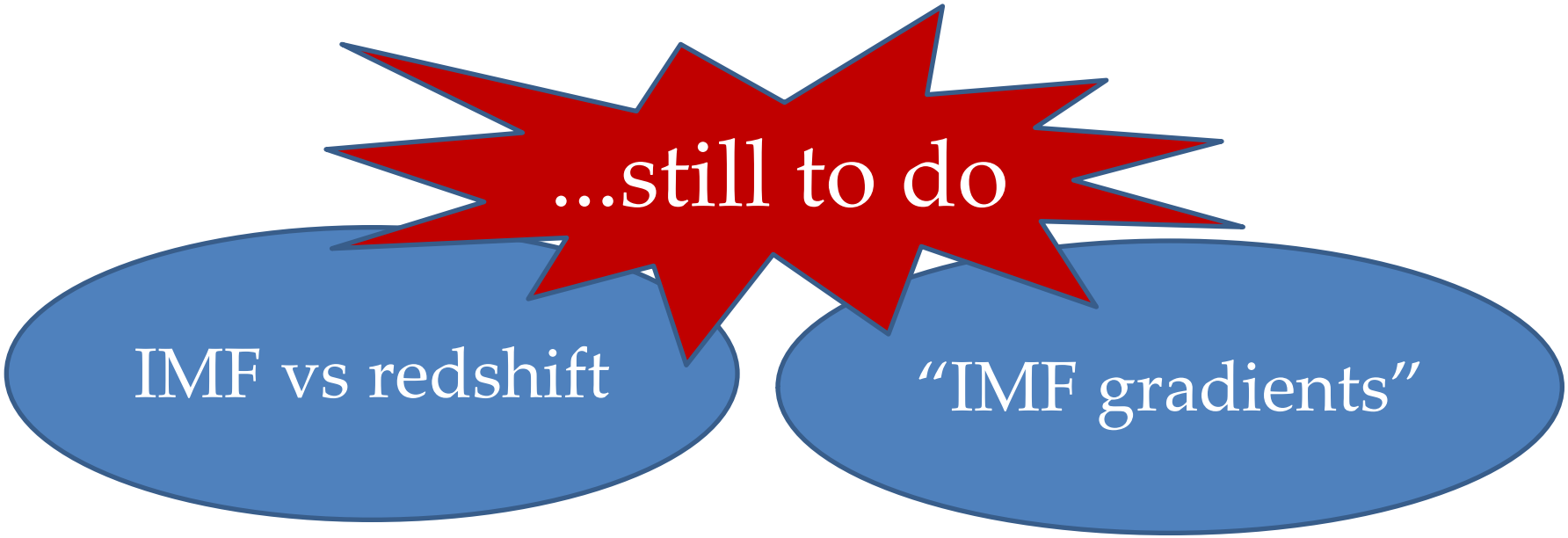


$$\mu_1(r) = \frac{g(r)}{a_0 + g(r)}$$

$$\mu_2(r) = \frac{g(r)}{\sqrt{a_0^2 + g(r)^2}}$$

Is the IMF universal?

Many lines of evidence cast doubt on its universality



Thank you for the attention