The Place of the Local Group in the Cosmic Web

in collaboration with
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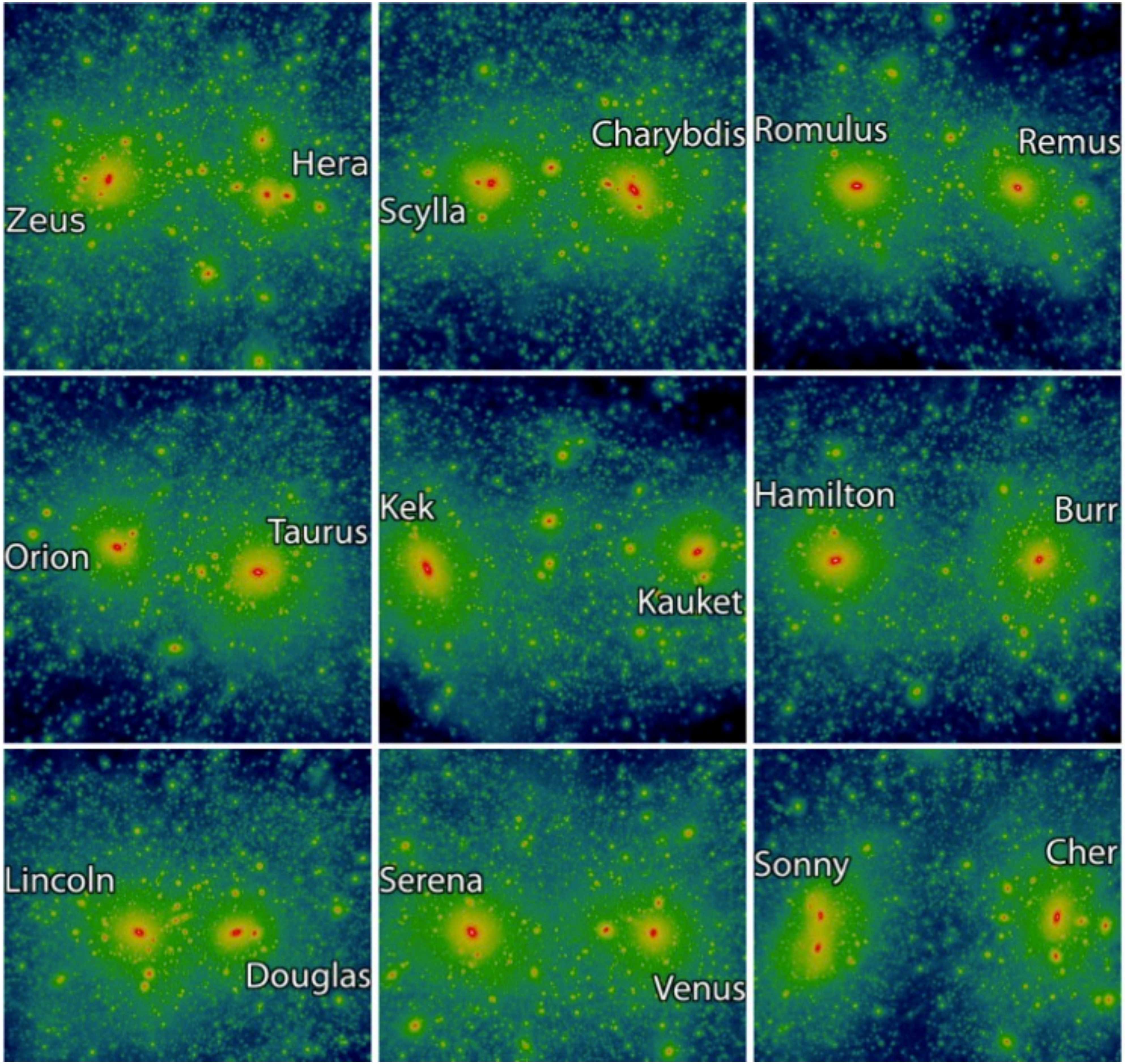
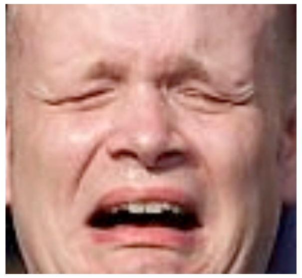


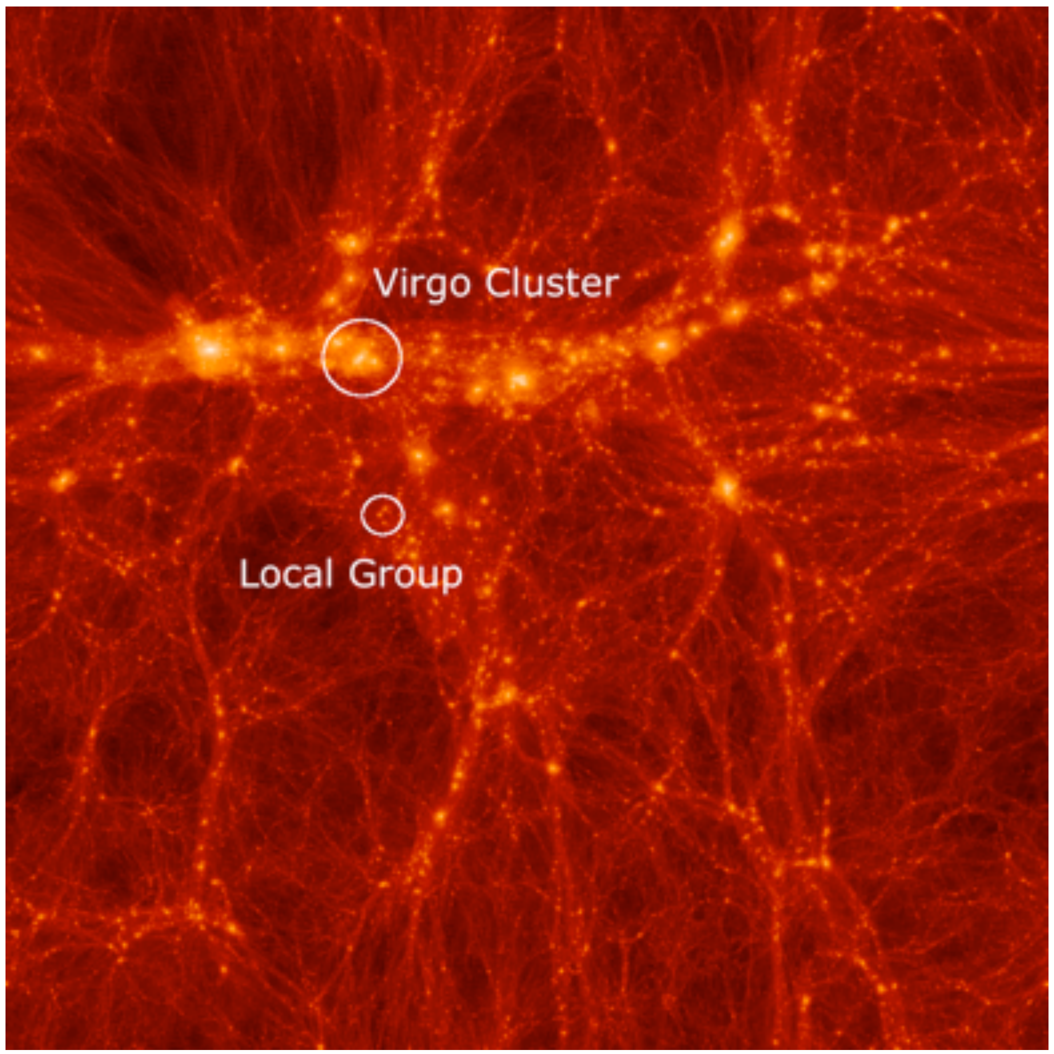
Garrison-Kimmel et al., 2013

Why getting into that trouble?



Because context is important

(CLUES - Constrained Local UniversE Simulations)

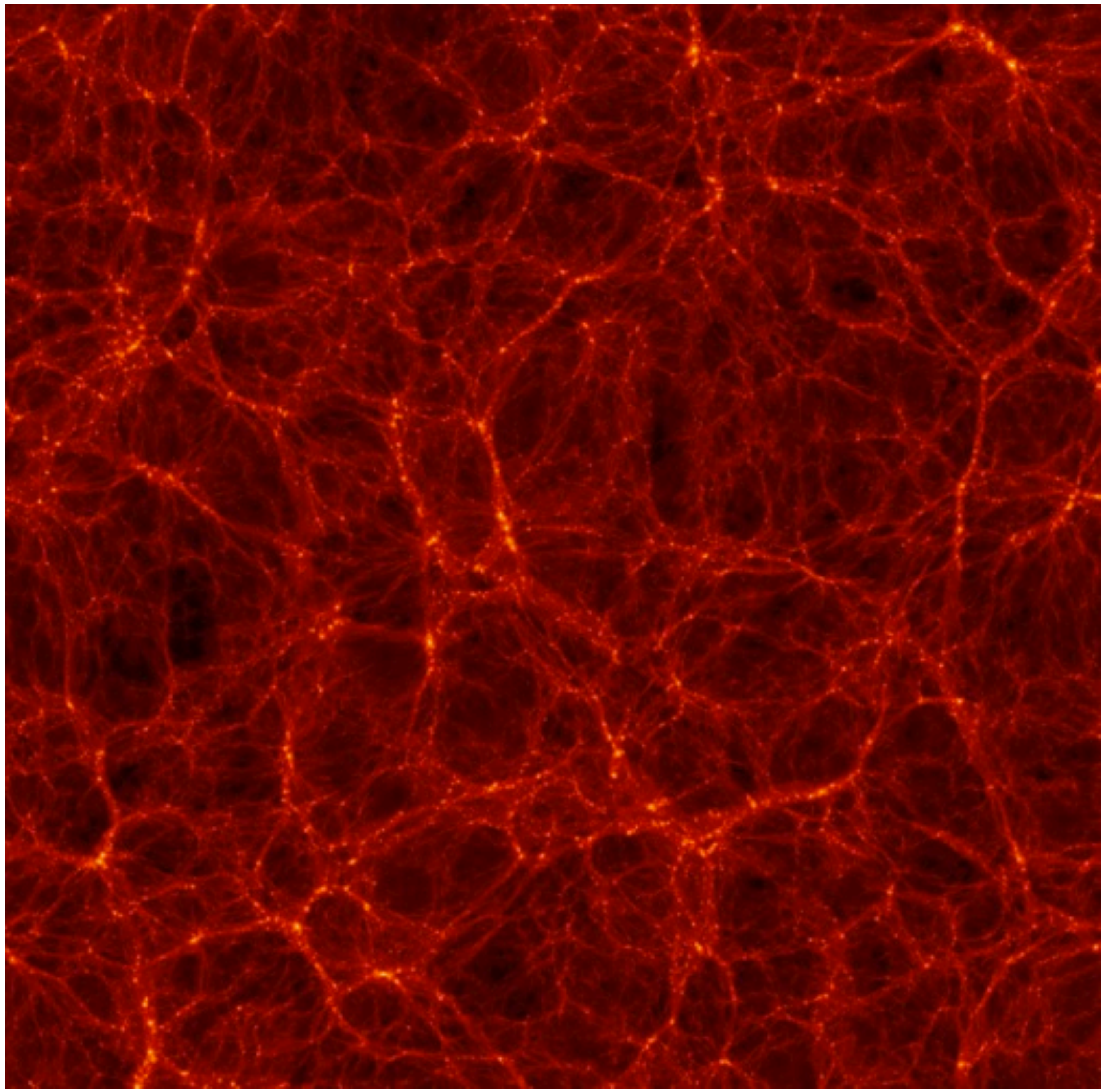


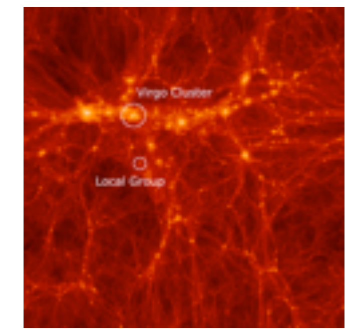
Gottloeber, Hoffman, Yepes 1005.2687

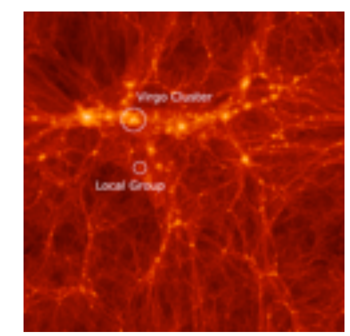
- Large Scales (5-7 Mpc) are fixed
- Small scales are random.
- 200 low res realizations until a LG is found.
- LG defined by mass and negative radial velocity).

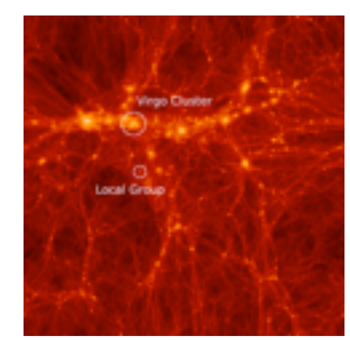
Random & Constrained Simulations

BOLSHOI
&.
CLUES





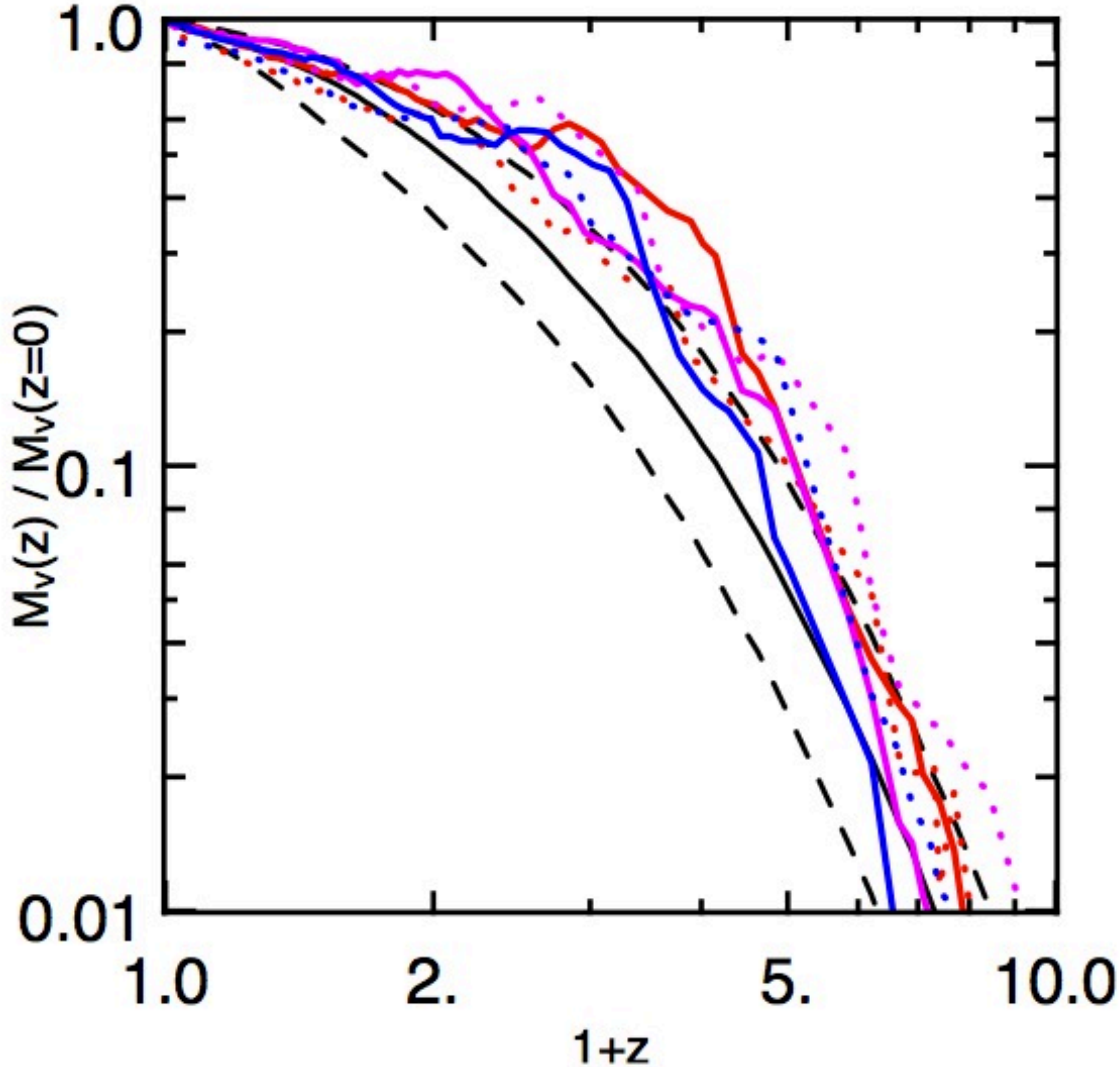




5 conditions to define Isolated Pairs

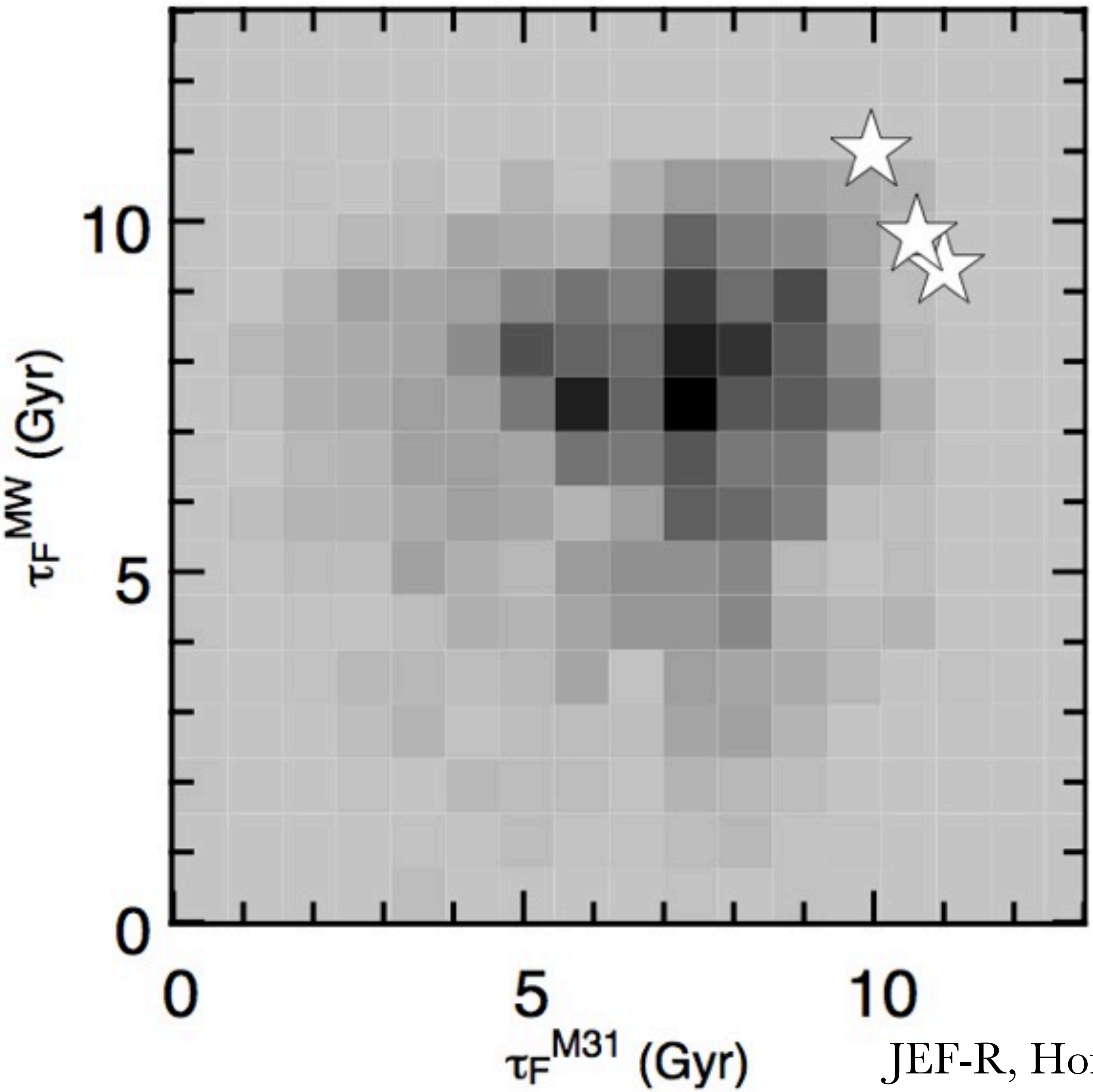
- Each halo has a mass between 5 10^{11} M_{sun} and 5 10^{12} M_{sun}.
- The distance between centers of the halos is smaller than 1.0 Mpc (Ribas et al. 2005)
- The relative radial velocity is negative.
- Absence of massive halos inside 3Mpc around each halo (Tikhonov & Klypin 2009)
- Absence of massive halos (>5 10^{13} M_{sol}) around 7Mpc (Karachentsev et al. 2004)

biased LG assembly in constrained simulations



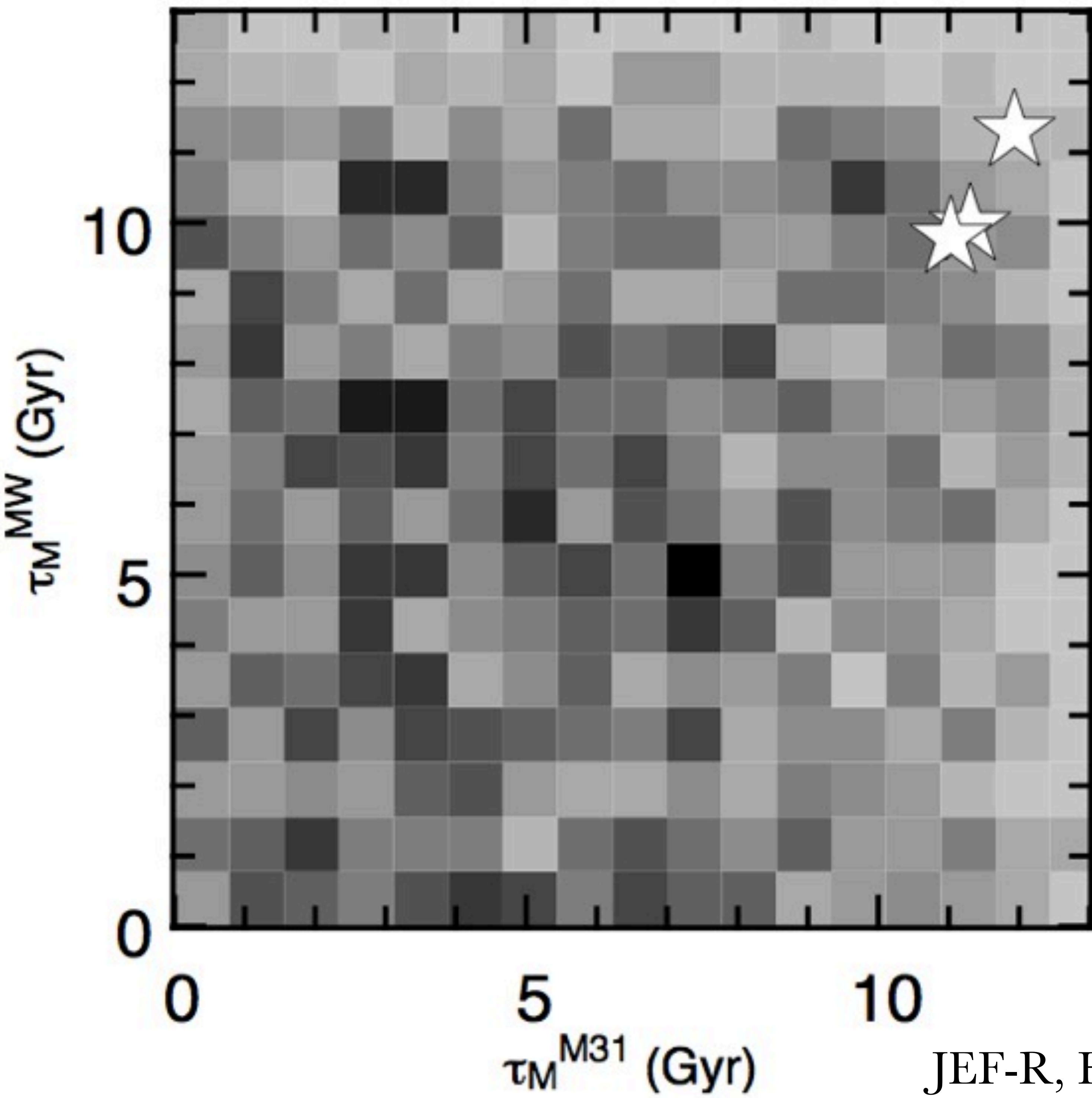
JEF-R, Hoffman, Yepes, Gottloeber, Piontek, Klypin, Steinmetz, 1107.0017

biased LG assembly in constrained simulations (formation time)



JEF-R, Hoffman, Yepes, Gottloeber, Piontek, Klypin, Steinmetz, 1107.0017

biased LG assembly in constrained simulations (last major merger)

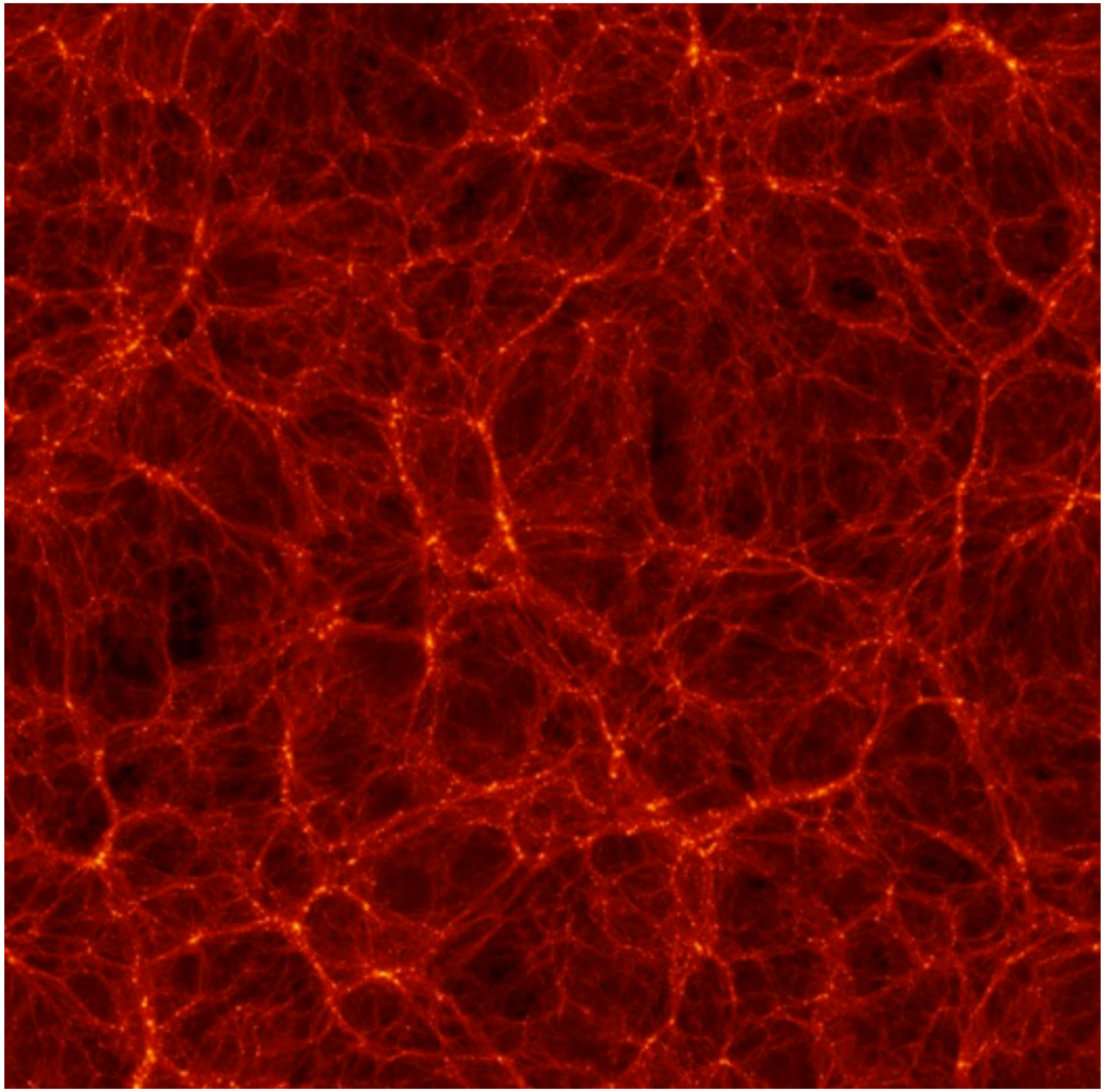


JEF-R, Hoffman, Yepes, Gottloeber, Piontek, Klypin, Steinmetz, 1107.0017

Conclusion #1

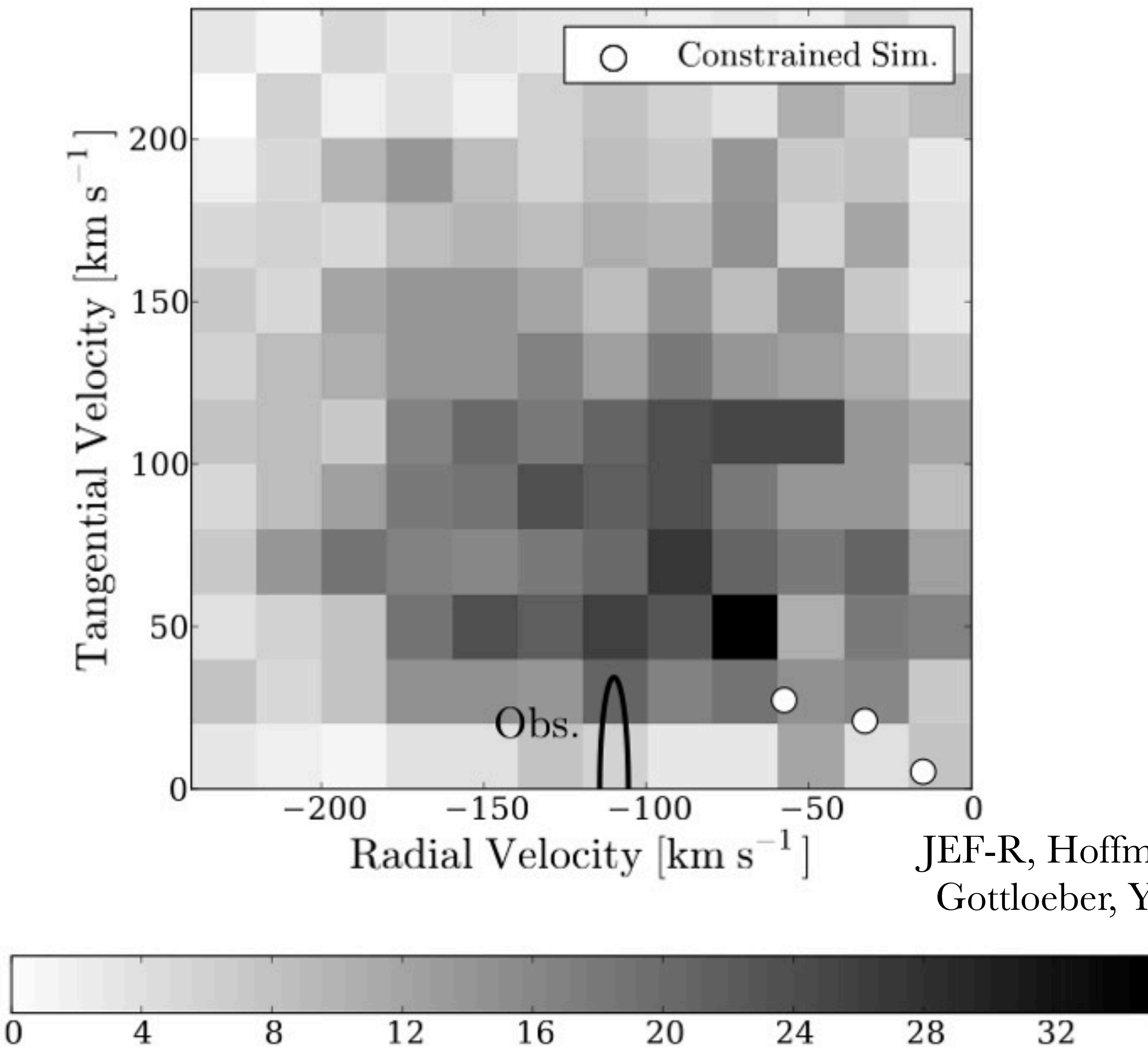
Constraints (large scales + meso scales) produce special Local Groups

Use Bolshoi to study in detail the Isolated Pairs



1st step: kinematics (Sohn, Anderson & van der Marel 2012)

the not-so-common LG kinematics in LCDM



JEF-R, Hoffman, Bustamante, Gottloeber, Yepes 1312.2587

small numbers to construct a new LG sample

Physical property	(%) Pairs consistent with observations (1-σ) (full sample)
$v_{\rm r}$-$v_{\rm t}$	(0.4%) 8/1923
$e_{\rm tot}$-$l_{\rm orb}$	(15%)298/1923
$\log_{10}\lambda$	(13%)257/1923
$r_{\rm t} = v_{\rm t}/v_{\rm r}$	(12%)242/1923

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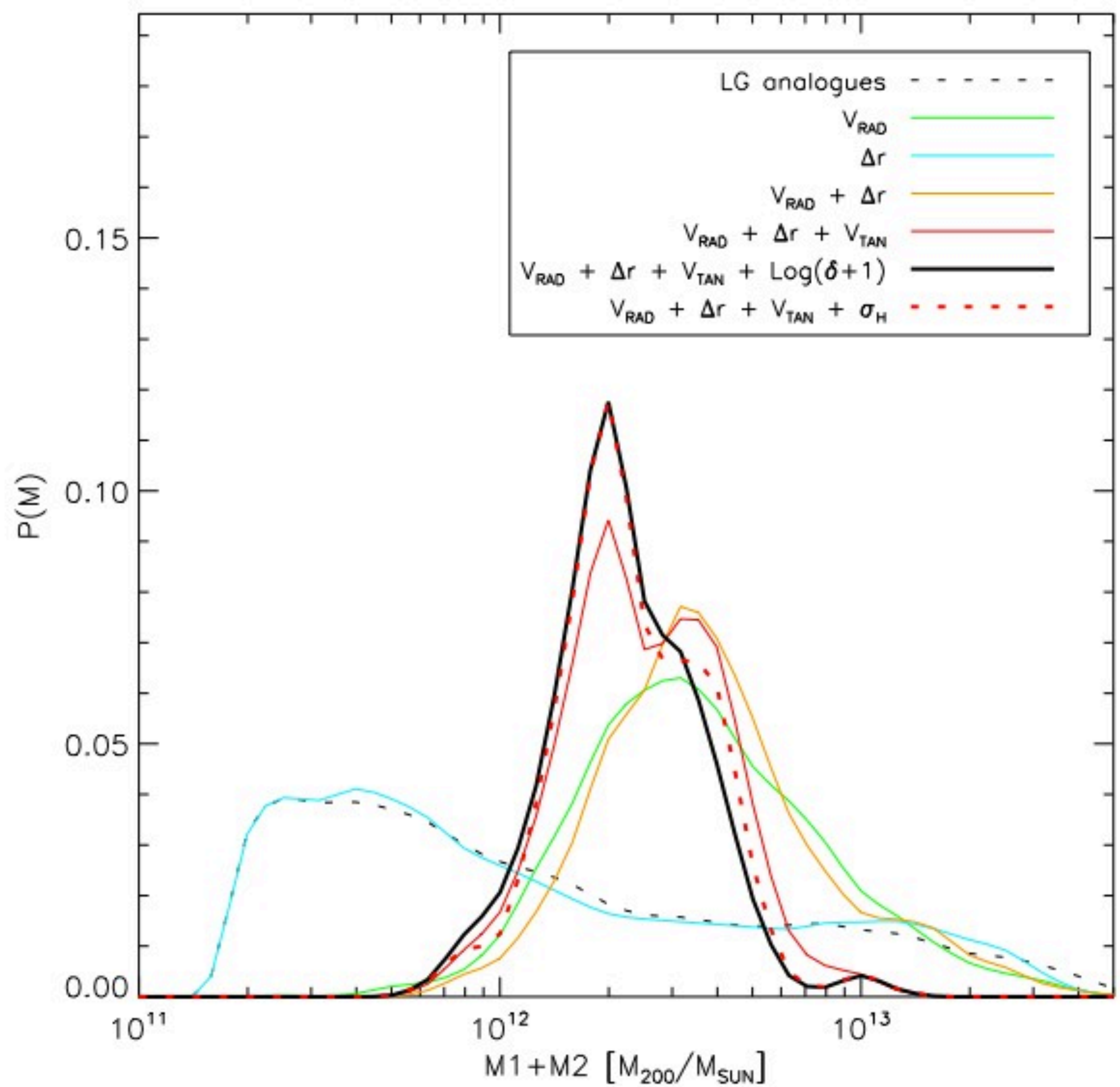
kinematics impose a strong mass selection effect



Gonzalez, Kravtsov, Gnedin 1312.2587

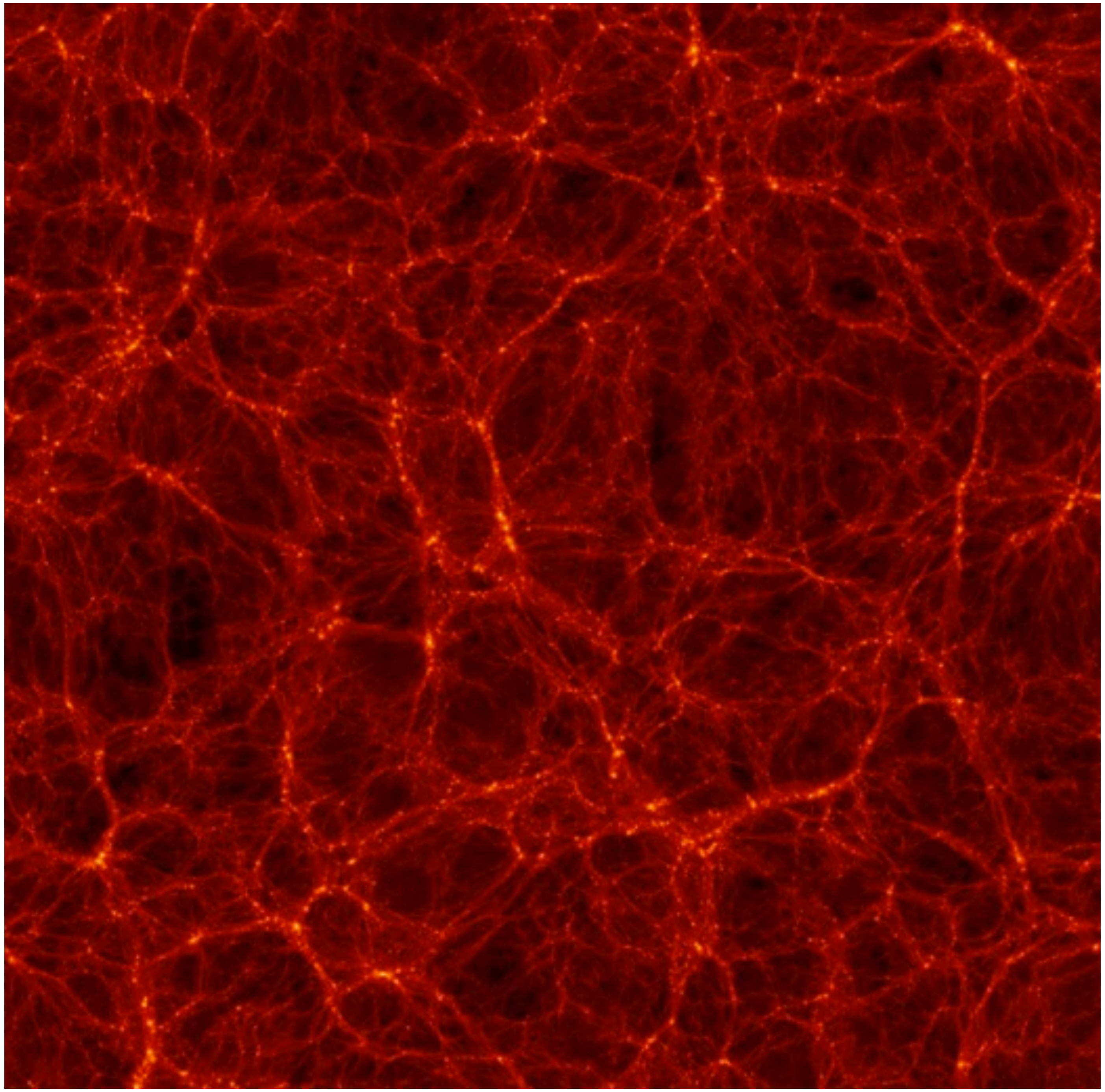
Conclusion #2

The LG kinematics are not common in LCDM.

Conclusion #3

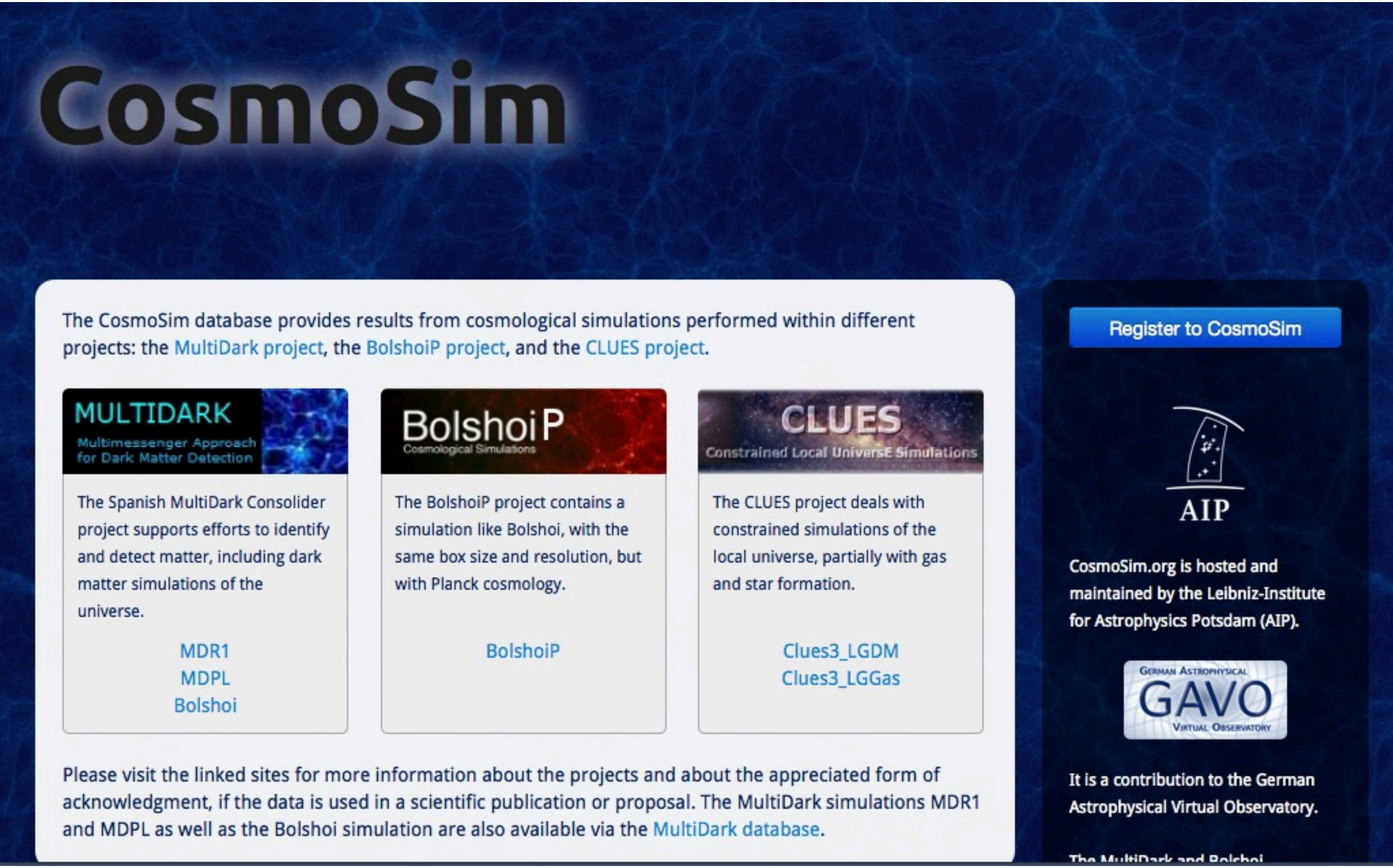
Requiring consistency with observations imposes a tight constraint on the LG mass.

Use Bolshoi to study in detail the Isolated Pairs



2nd step: environment (Forero-Romero et al. 2009)

Data publicly available



what is the environment of these LG pairs?

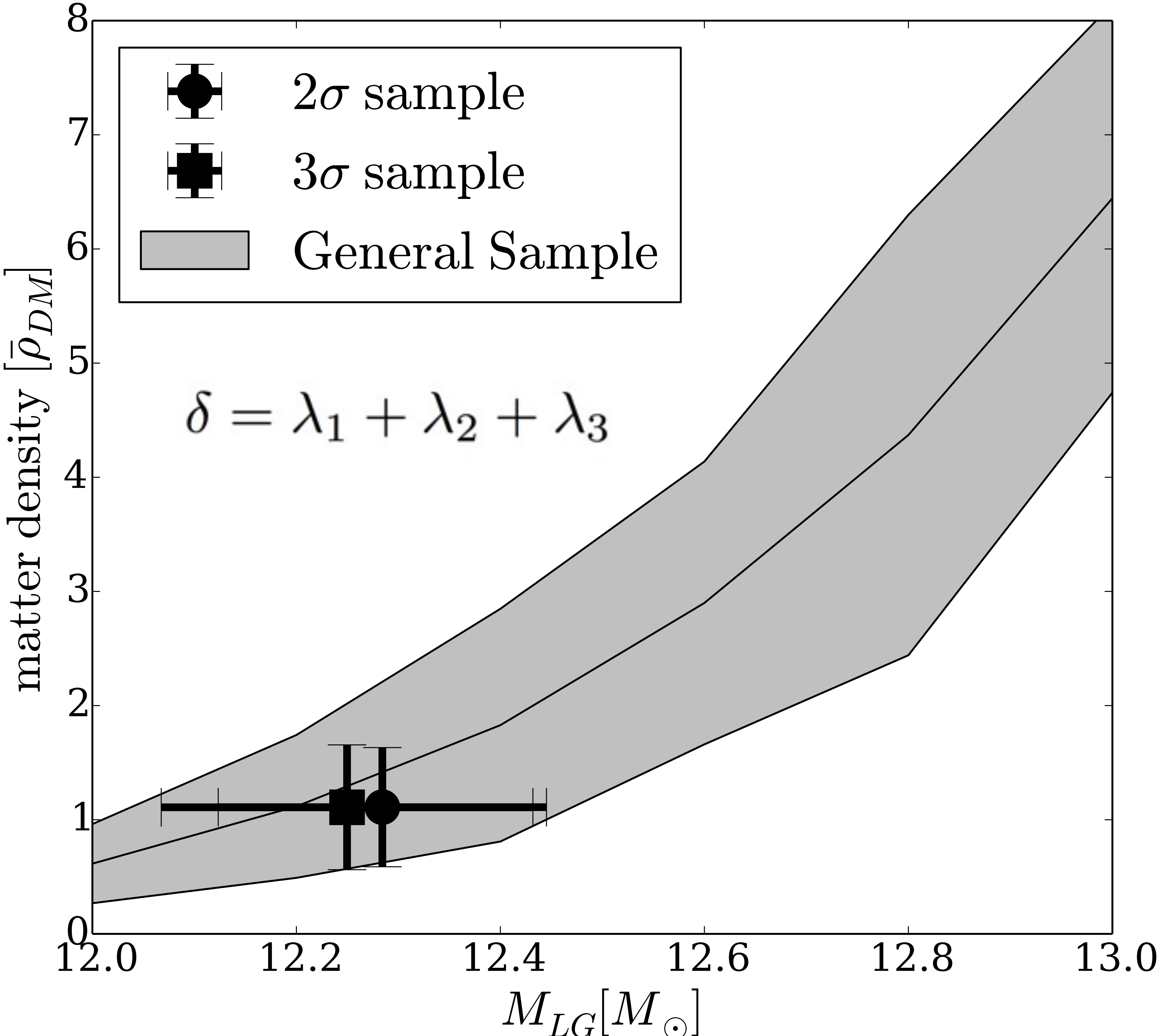
$$T_{ij} = \frac{\partial^2 \phi}{\partial r_i \partial r_j}$$

$$\delta = \lambda_1 + \lambda_2 + \lambda_3$$

$$e = \frac{\lambda_3 - \lambda_1}{2(\lambda_1 + \lambda_2 + \lambda_3)} \qquad p = \frac{\lambda_1 + \lambda_3 - 2\lambda_2}{2(\lambda_1 + \lambda_2 + \lambda_3)}$$

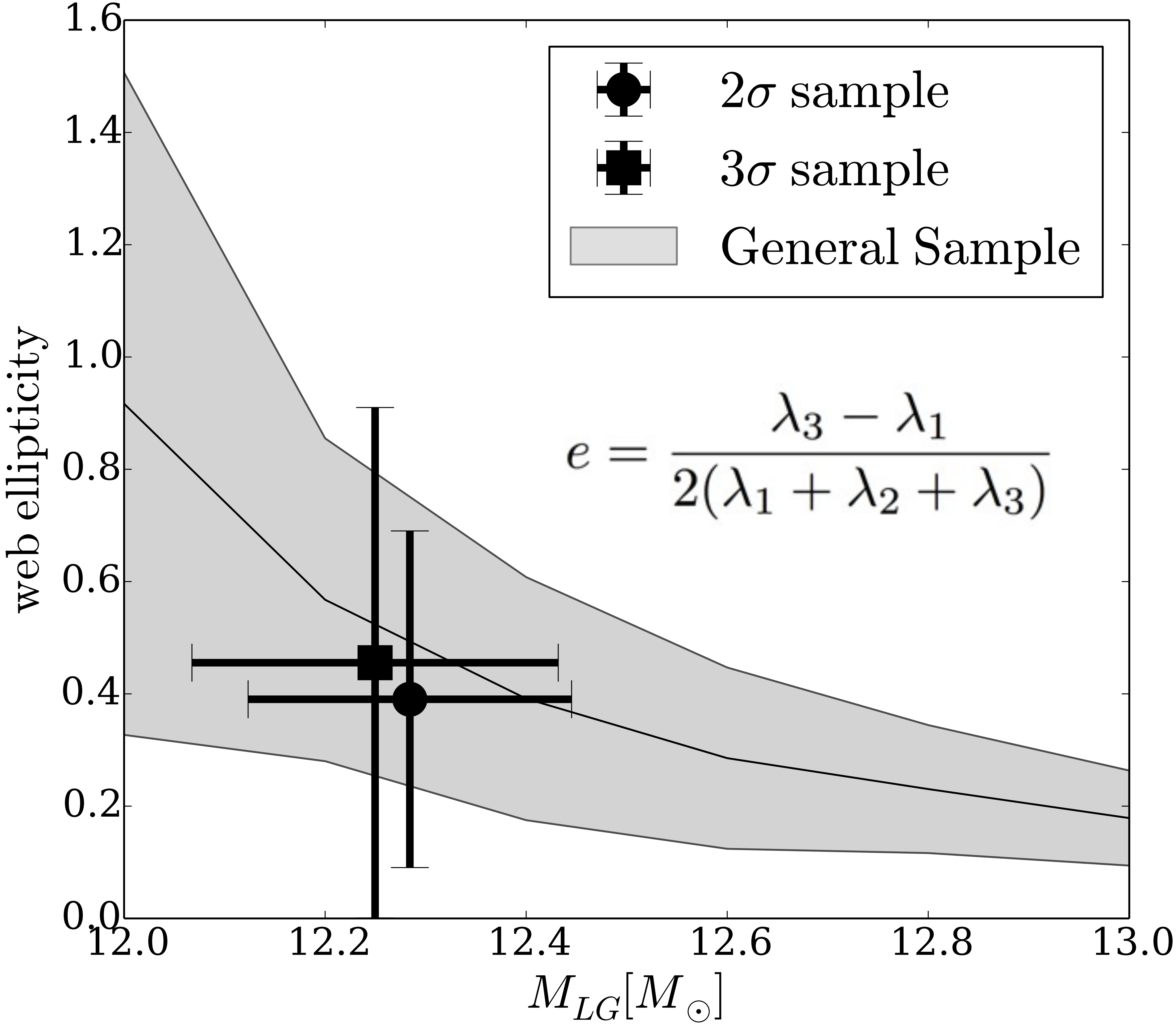
defined over a grid of 1Mpc/h + 1Mpc/h gaussian smoothing

local matter over-density around pairs



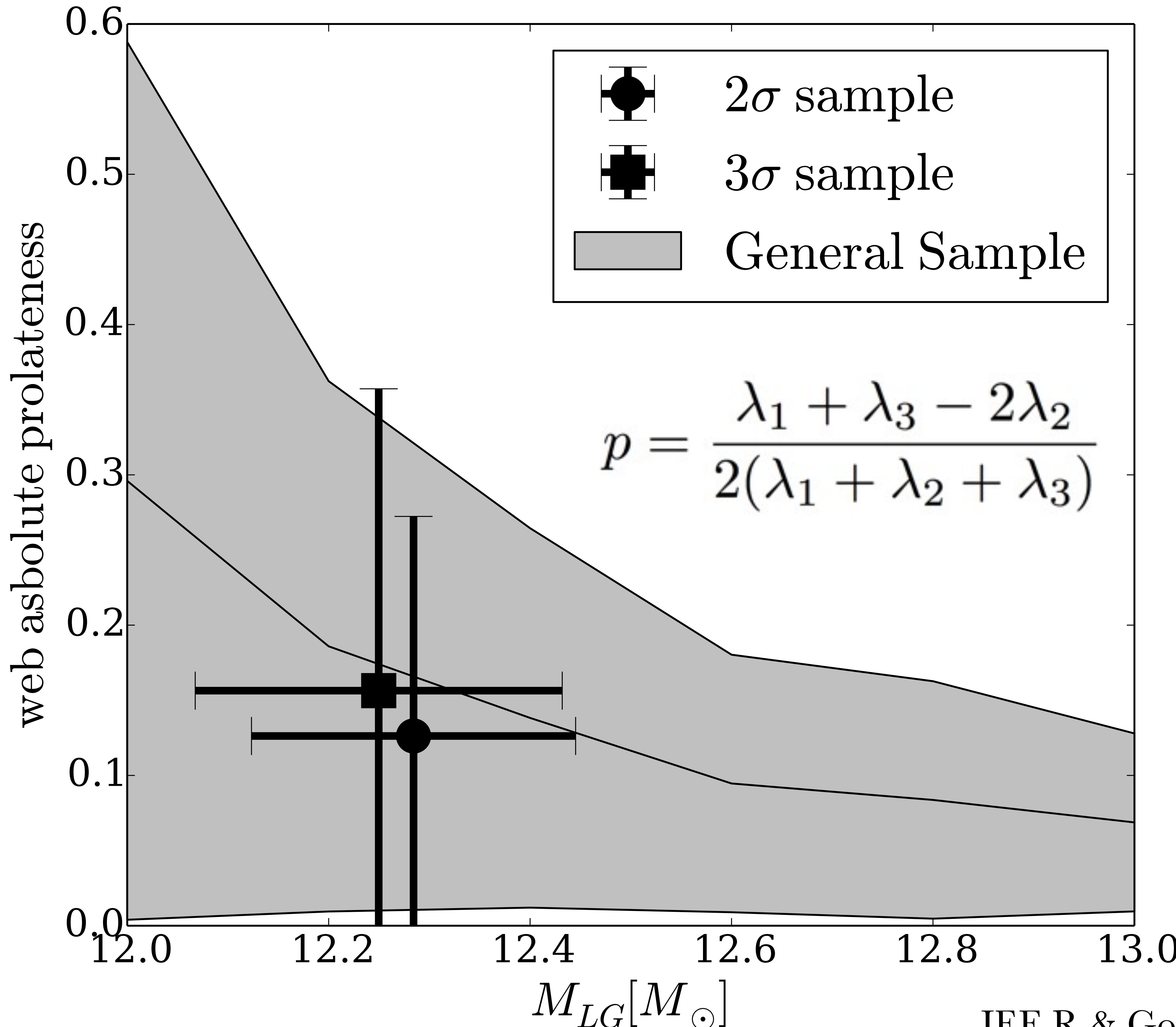
JEF-R & Gonzalez, in prep.

T-web ellipticity around pairs

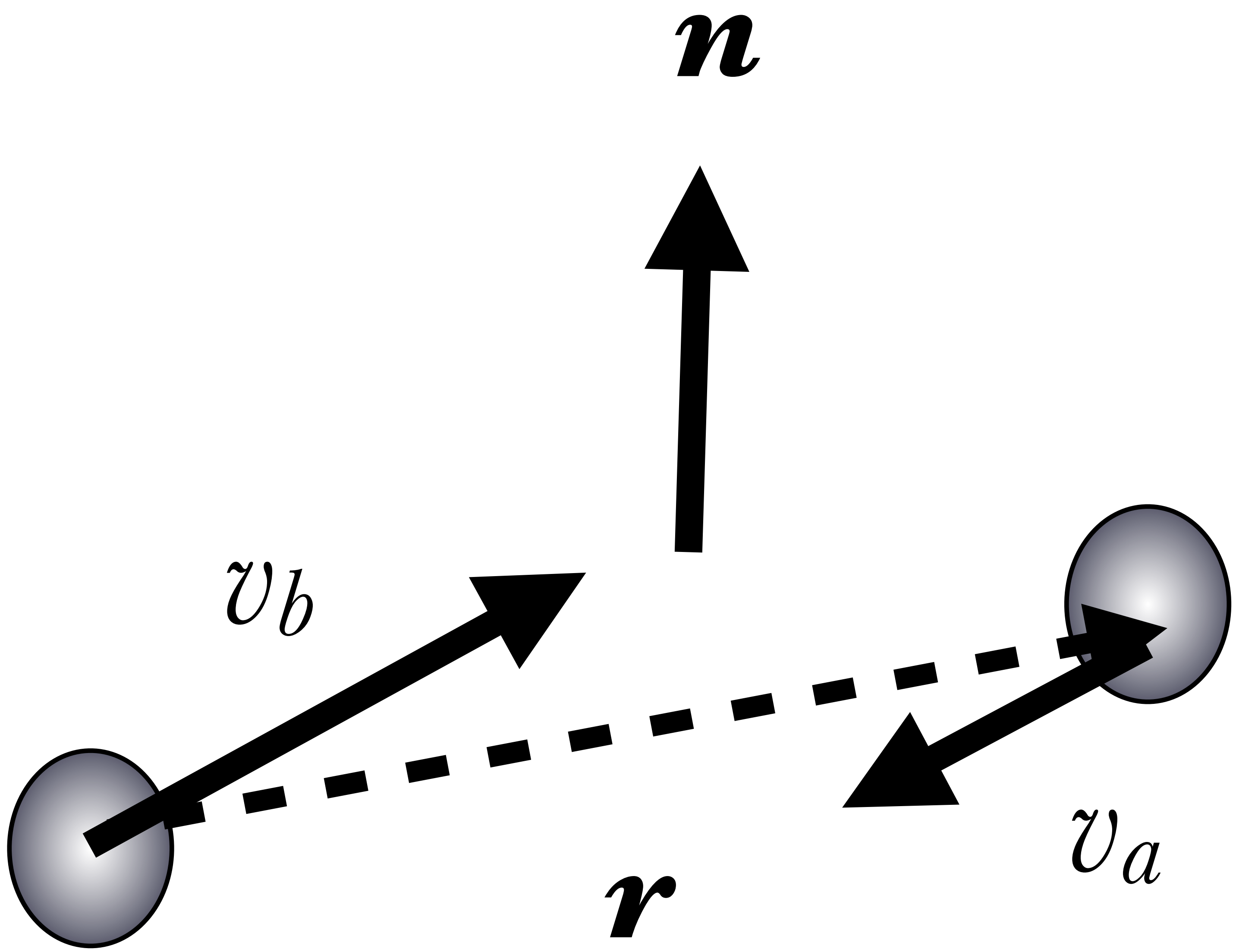


JEF-R & Gonzalez, in prep.

T-web prolateness around pairs

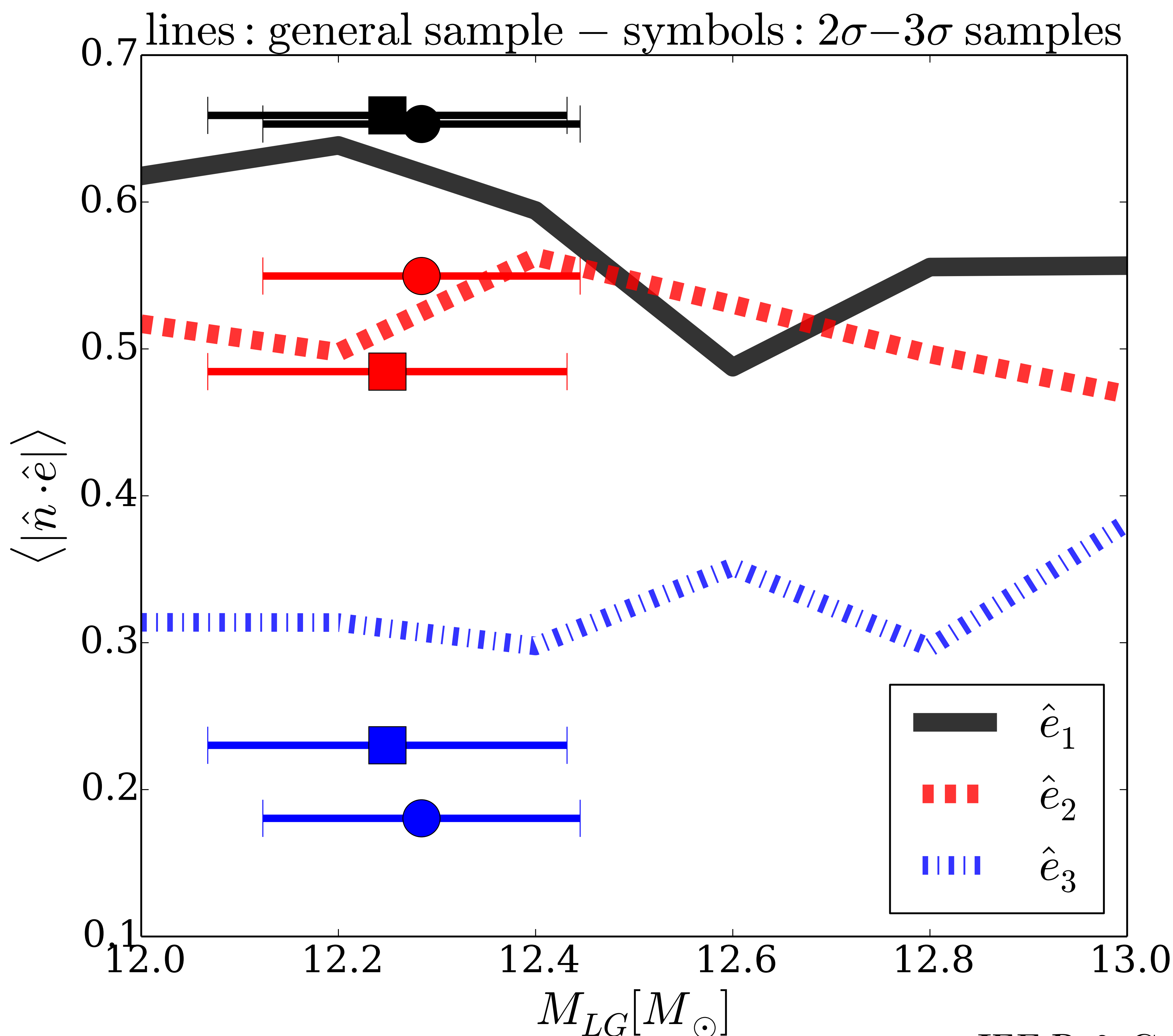


JEF-R & Gonzalez, in prep.



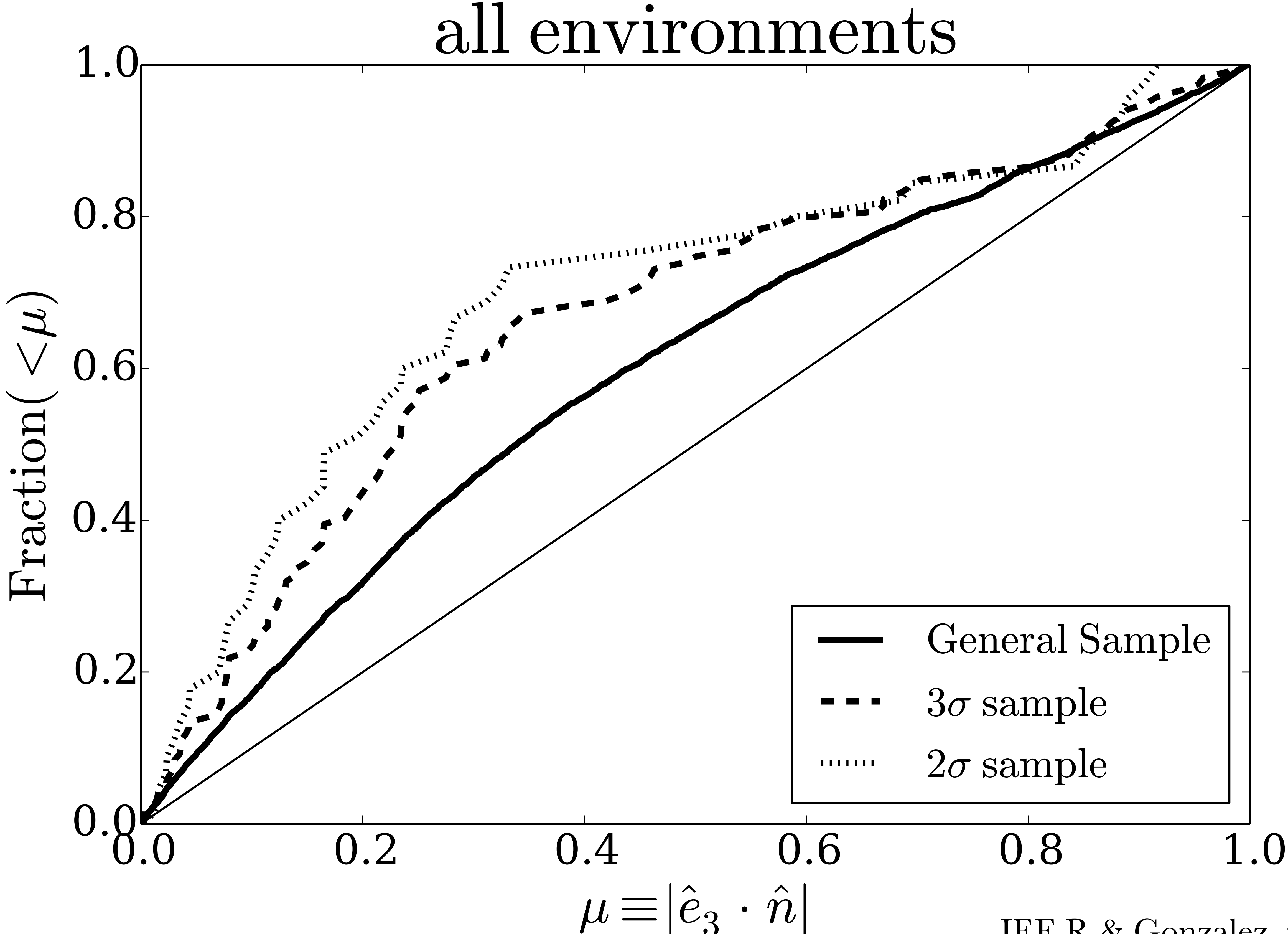
CM Frame

strong T-web alignments for pairs



JEF-R & Gonzalez, in prep.

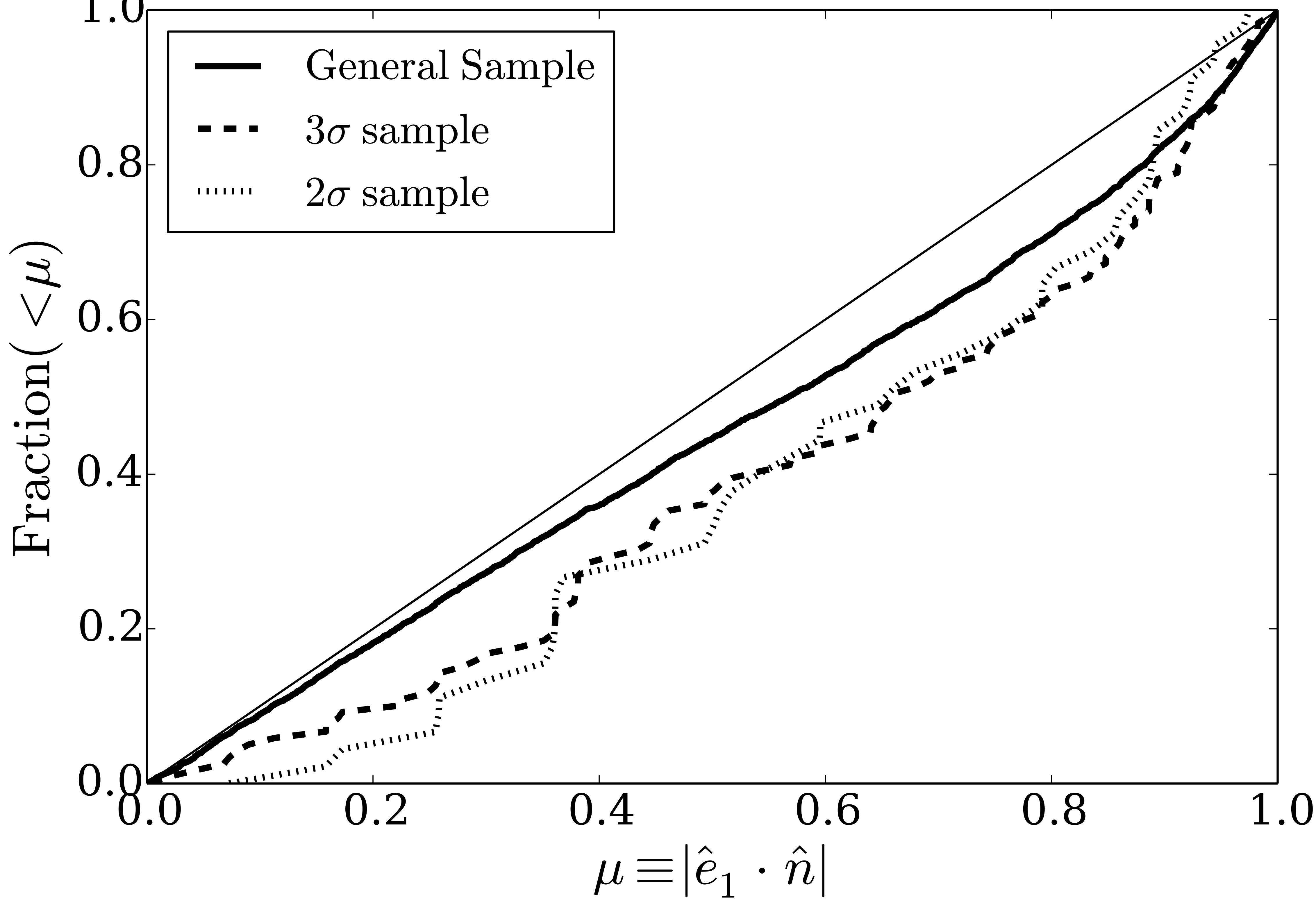
strong anti-alignment of **n** with e_3



JEF-R & Gonzalez, in prep.

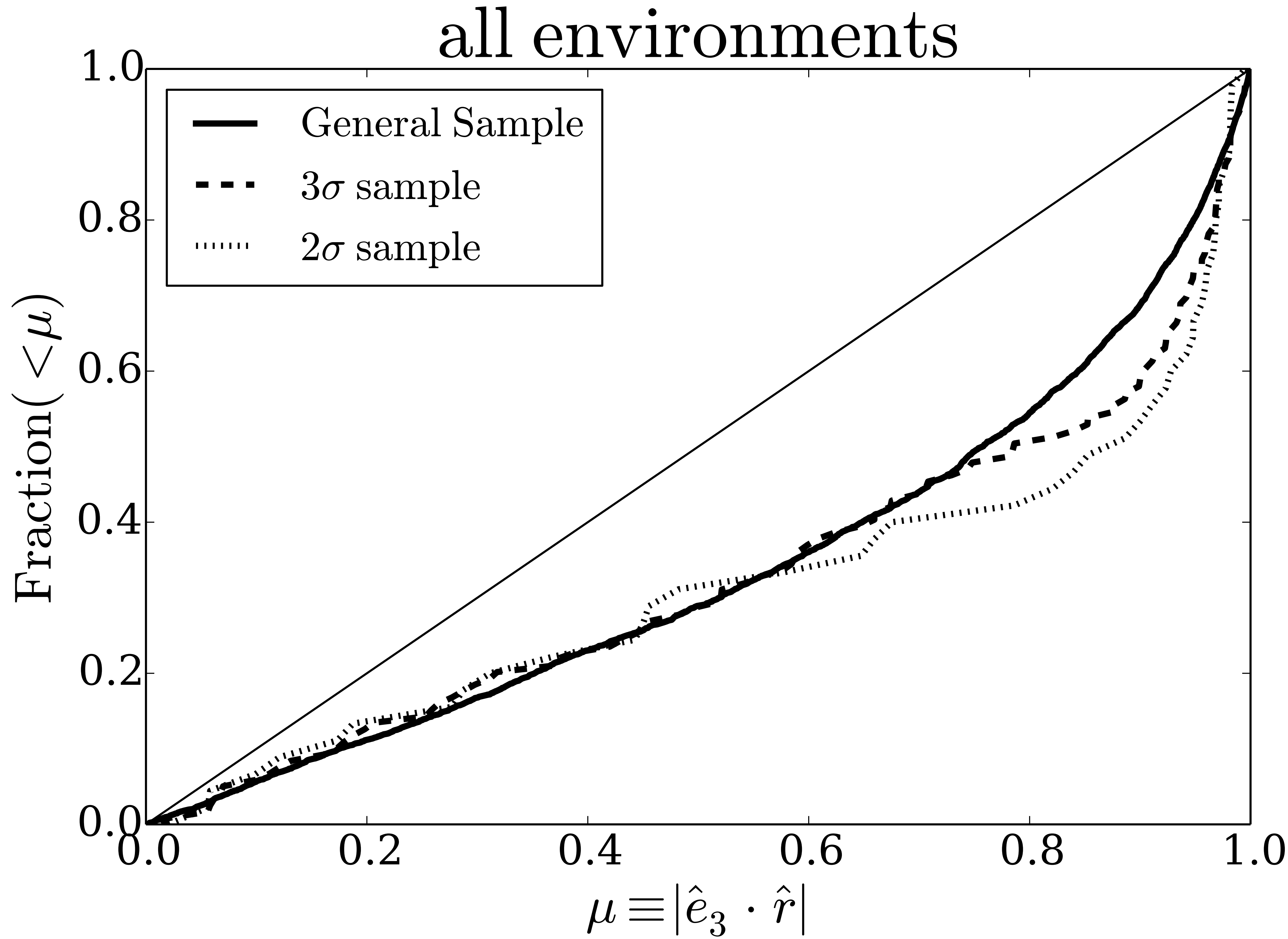
weak alignment of **n** with $\mathbf{e}_1$

all environments



JEF-R & Gonzalez, in prep.

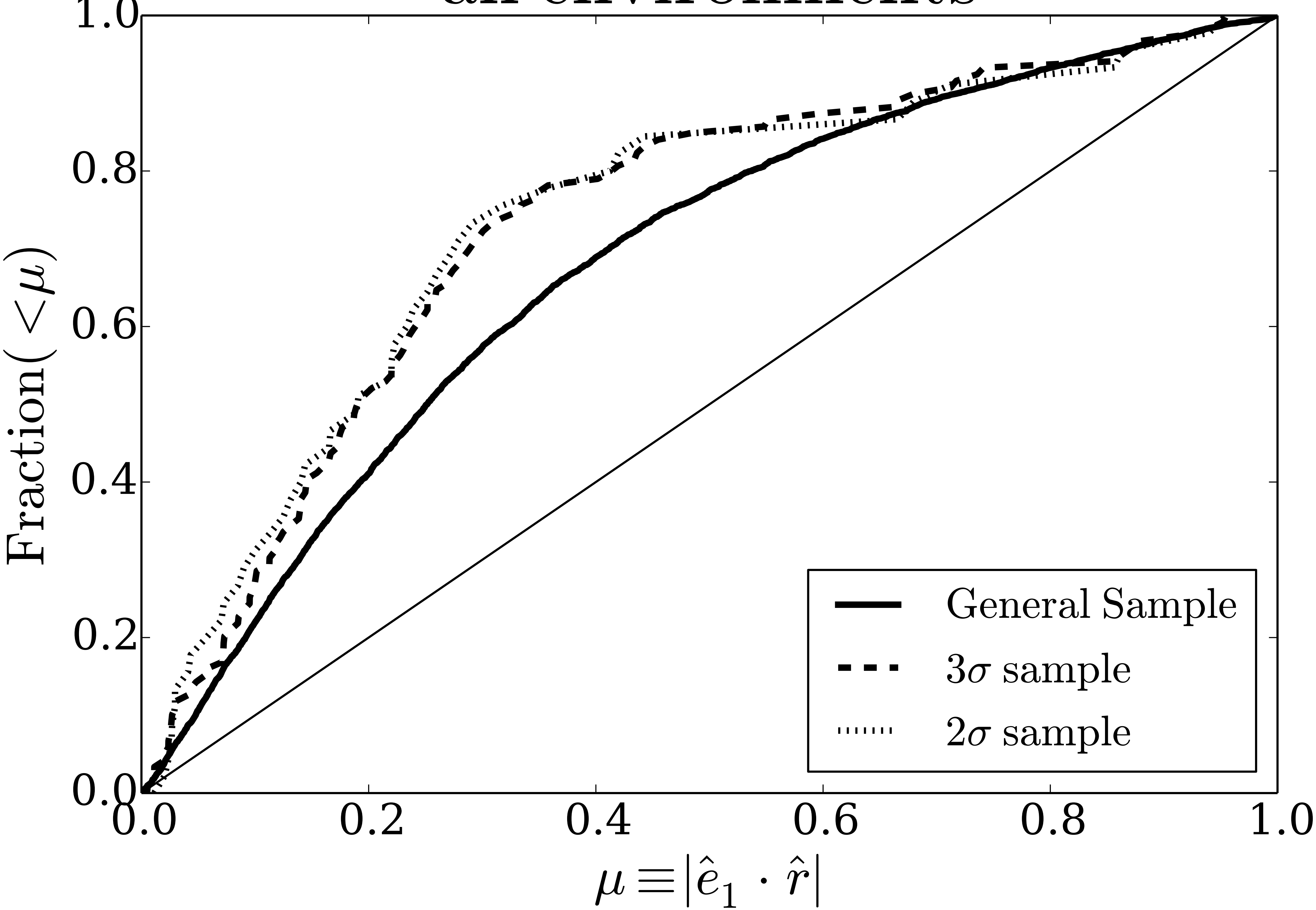
strong alignment of **r** with **e**₃



JEF-R & Gonzalez, in prep.

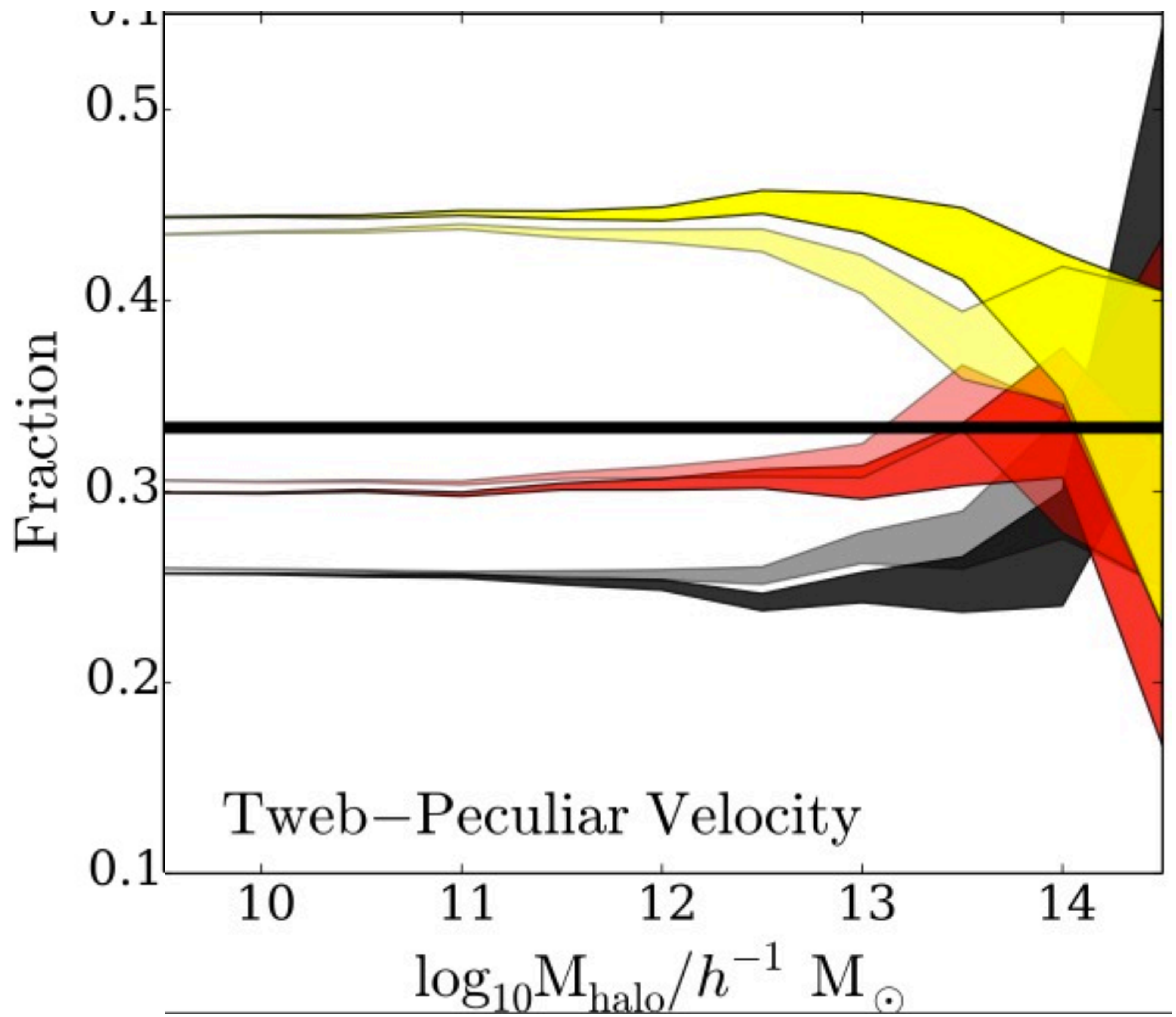
strong anti-alignment of **r** with **e**$_1$

all environments



JEF-R & Gonzalez, in prep.

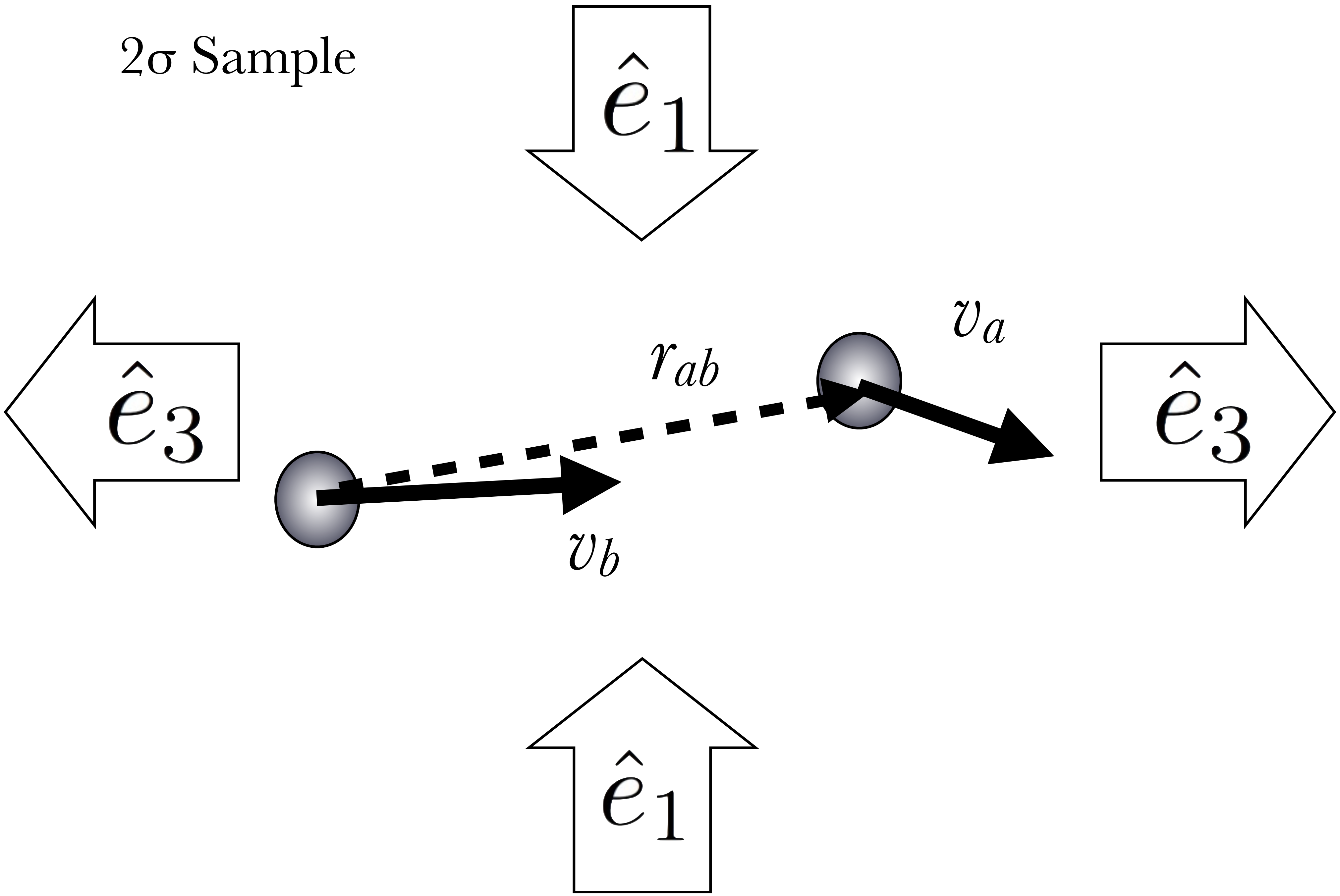
alignment of peculiar velocities with e_3



JEF-R, Contreras, Padilla, MNRAS accepted

Conclusion #4

2σ Sample



JEF-R & Gonzalez, in prep.

Conclusions

- Density field constraints (large scales + meso scales) produce special Local Groups.
- The LG kinematics are not common in LCDM
- LG kinematics impose a tight constraint on the LG mass.
- In the T-web context, LG is most probably located in a filament with the **r** vector along the direction defined by $\mathbf{e}_3$.

Sample	Peak	Filament	Sheet	Void
	n (%)	n (%)	n (%)	n (%)
2σ	4 (8.7)	24 (52.2)	17 (36.7)	1 (2.2)
3σ	10 (8.3)	58 (48.3)	47 (39.2)	5 (4.2)
General	1312 (23.9)	1472 (26.9)	1769 (32.3)	927 (16.9)