The University of Nottingham

UNITED KINGDOM · CHINA · MALAYSIA

Subhaloes going Notts

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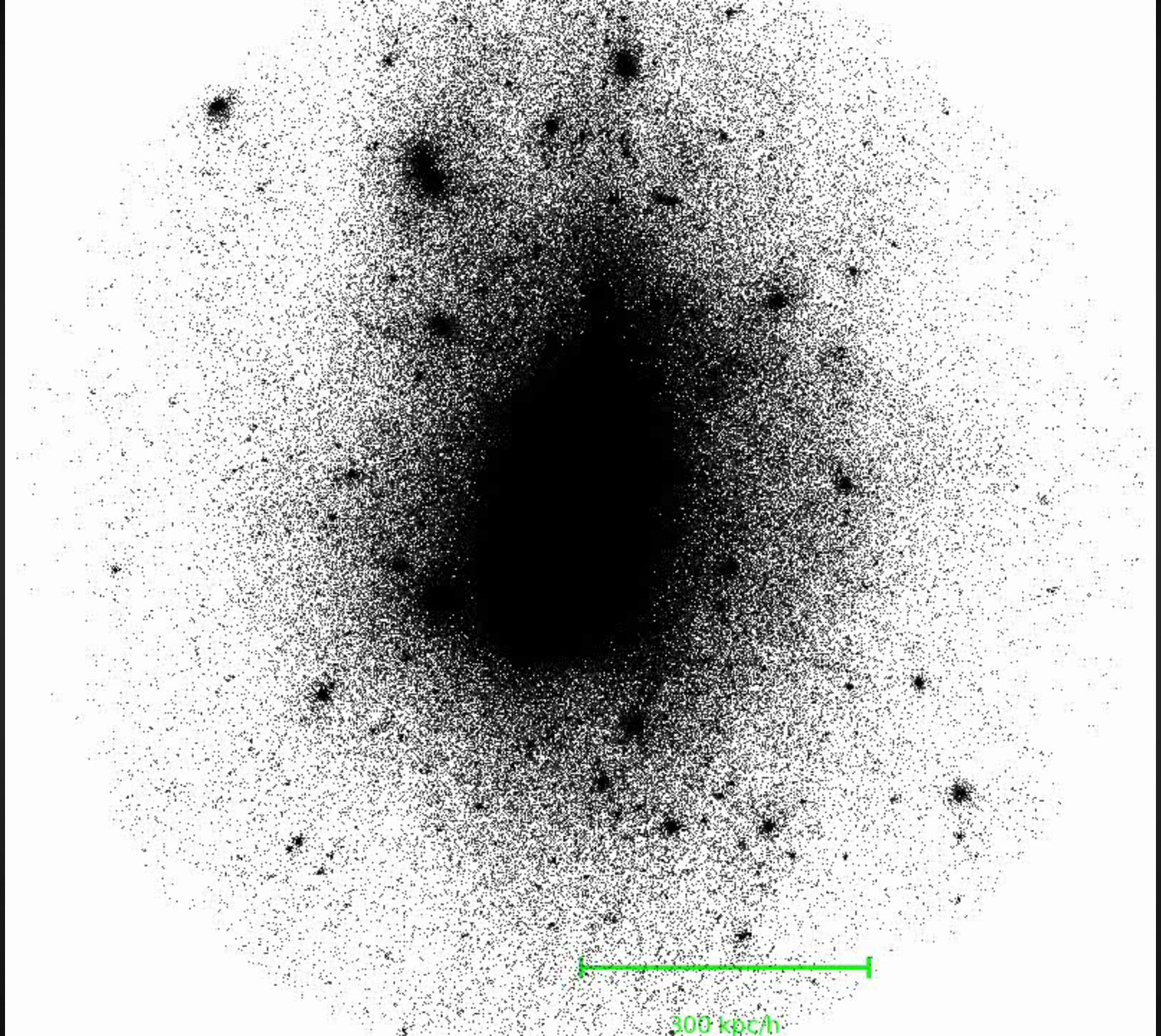
With Frazer Pearce, Alex Knebe, Stuart Muldrew, Hanni Lux, Steffen Knollmann, et al.

What is it?

- Comparison of substructure detection in a Milky Way sized object.
- Follow on from “Haloes going Mad”.

Why do it?

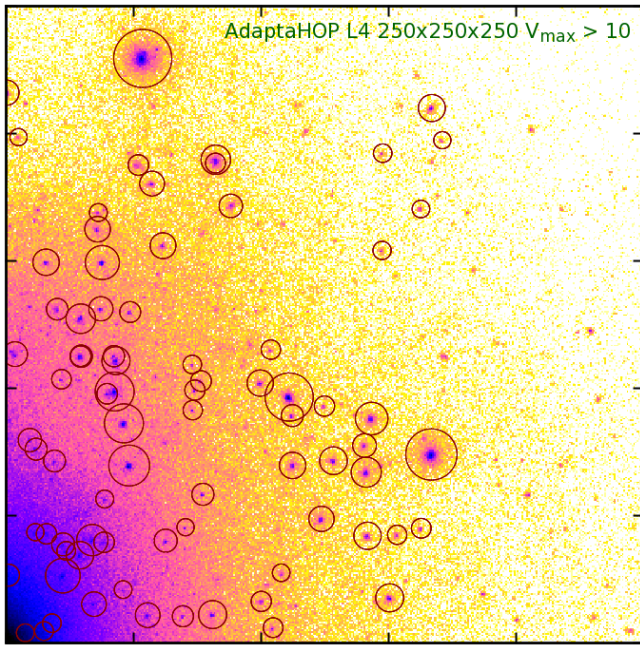
- Dark matter detection via annihilation.
- Lensing via substructure.
- Many large, single halo simulations each with own subhalo detector: are these comparable?

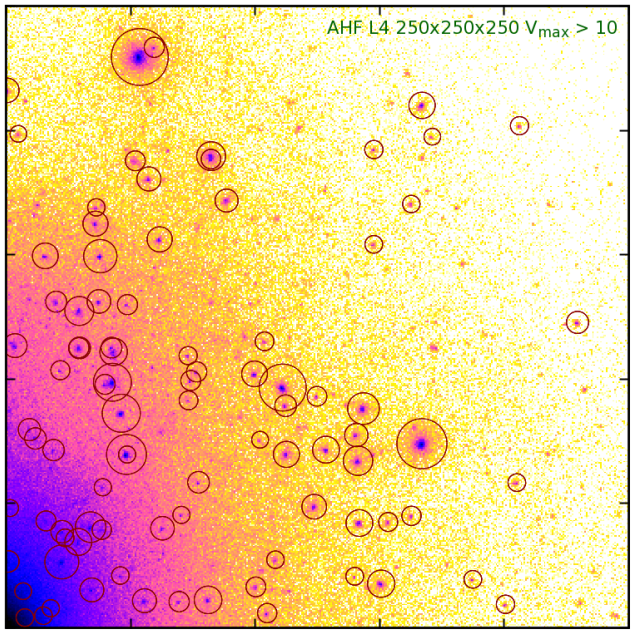

300 kpc/h

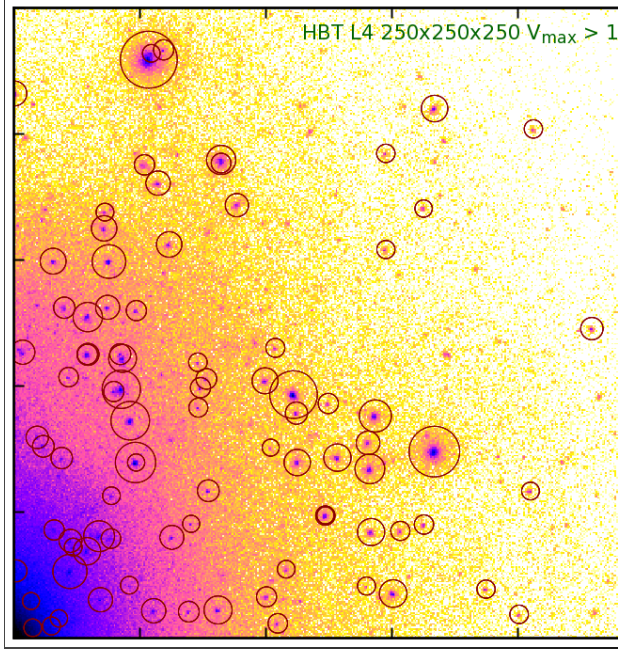
Finder	Contact	Method	Level
Adaptahop	Dylan Tweed	3-space particle	4
AHF	Alex Knebe	Adaptive mesh	1
HBT	Jiaxin Han	3-space+tracker	2
HOT3D	Yago Ascasibar	3-space particle	4
HOT6D	Yago Ascasibar	Phase space	4
HSF	Michal Maciejewski	Phase space	2
Mendieta	Andres Ruiz	3-space particle	3
Rockstar	Peter Behroozi	Phase space	1
STF	Pascal Elahi	Velocity/Phase space	3
Subfind	Volker Springel	3-space particle	1
Voboz	Mark Neyrinck	Voronoi	3

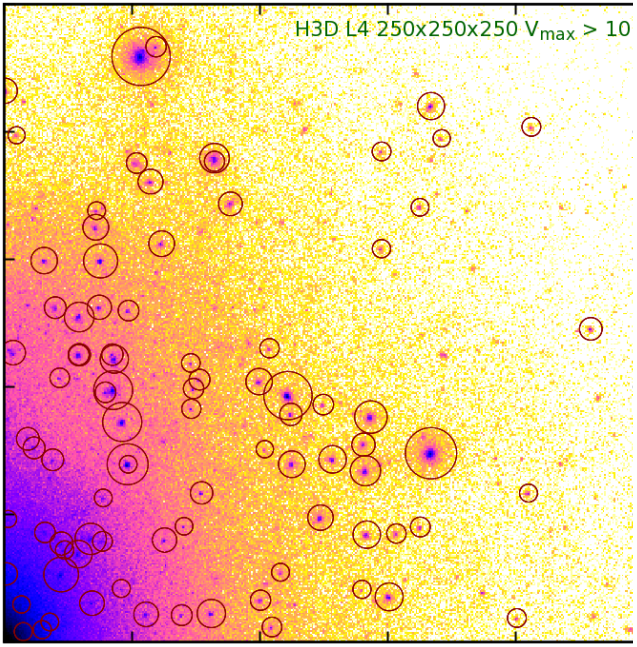
Common Processing

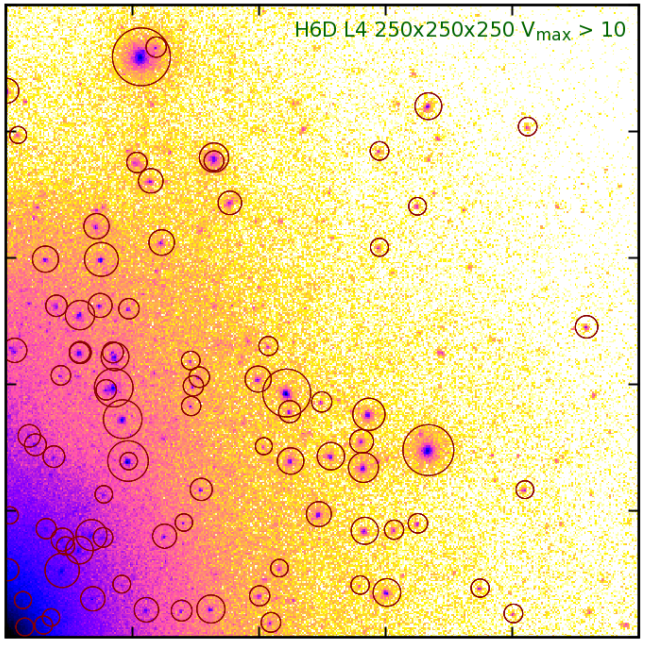
- Pipeline
  - Assign duplicates to smallest halo
  - refine centre of mass iteratively based on 50%
  - Process up to M_{200}
  - Calculate statistics

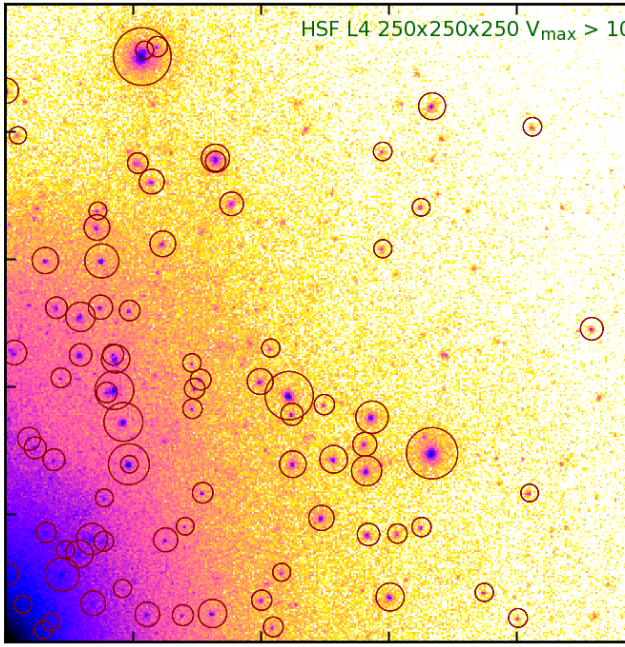

AdaptaHOP L4 250x250x250 V_{max} > 10

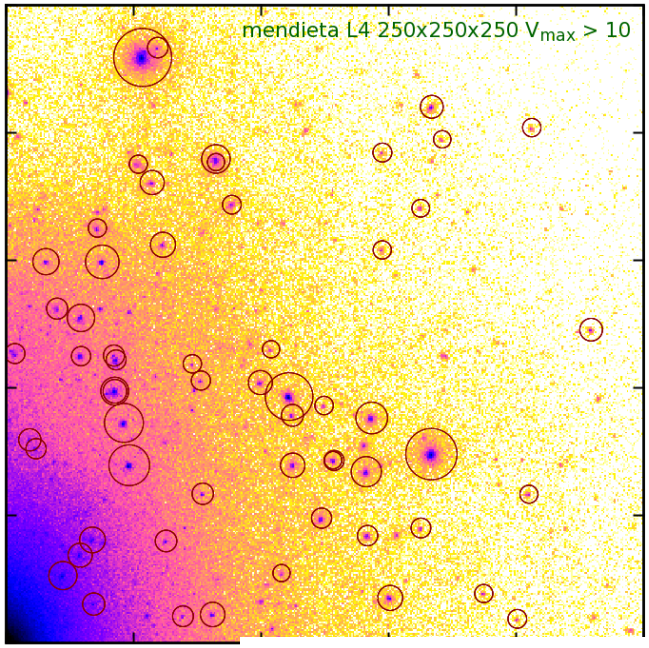

AHF L4 250x250x250 V_{max} > 10

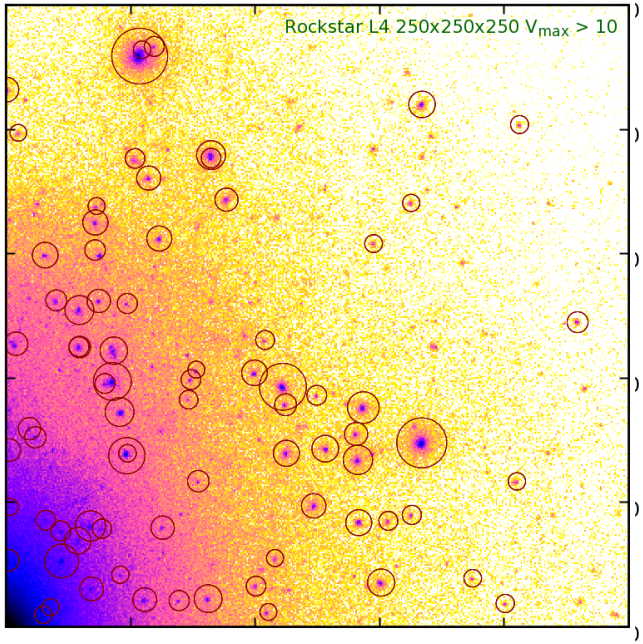

HBT L4 250x250x250 V_{max} > 1

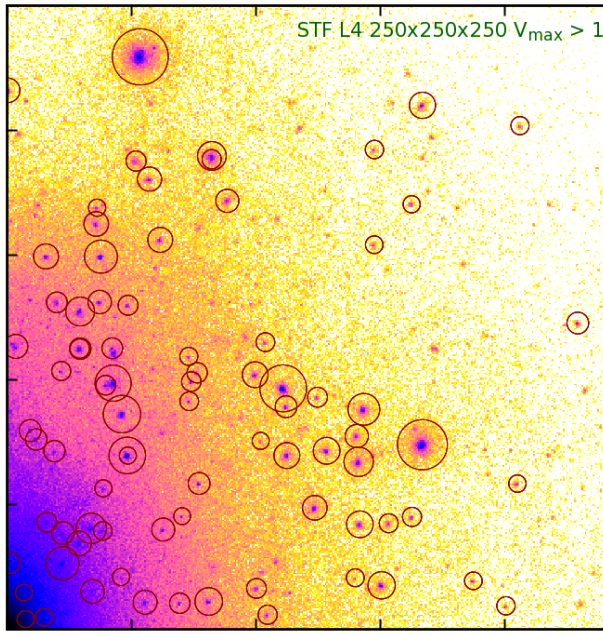

H3D L4 250x250x250 V_{max} > 10

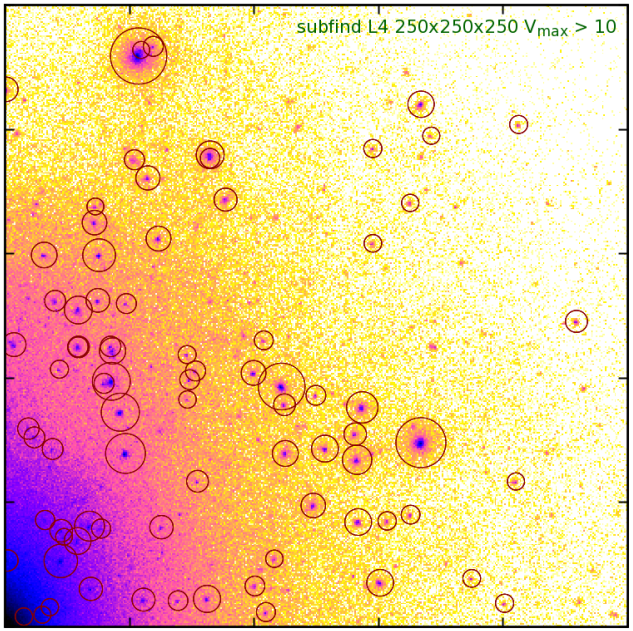

H6D L4 250x250x250 V_{max} > 10

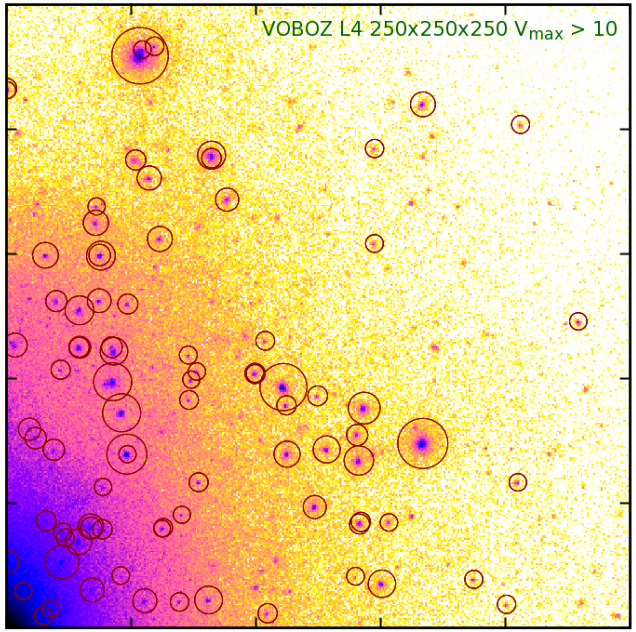

HSF L4 250x250x250 V_{max} > 10

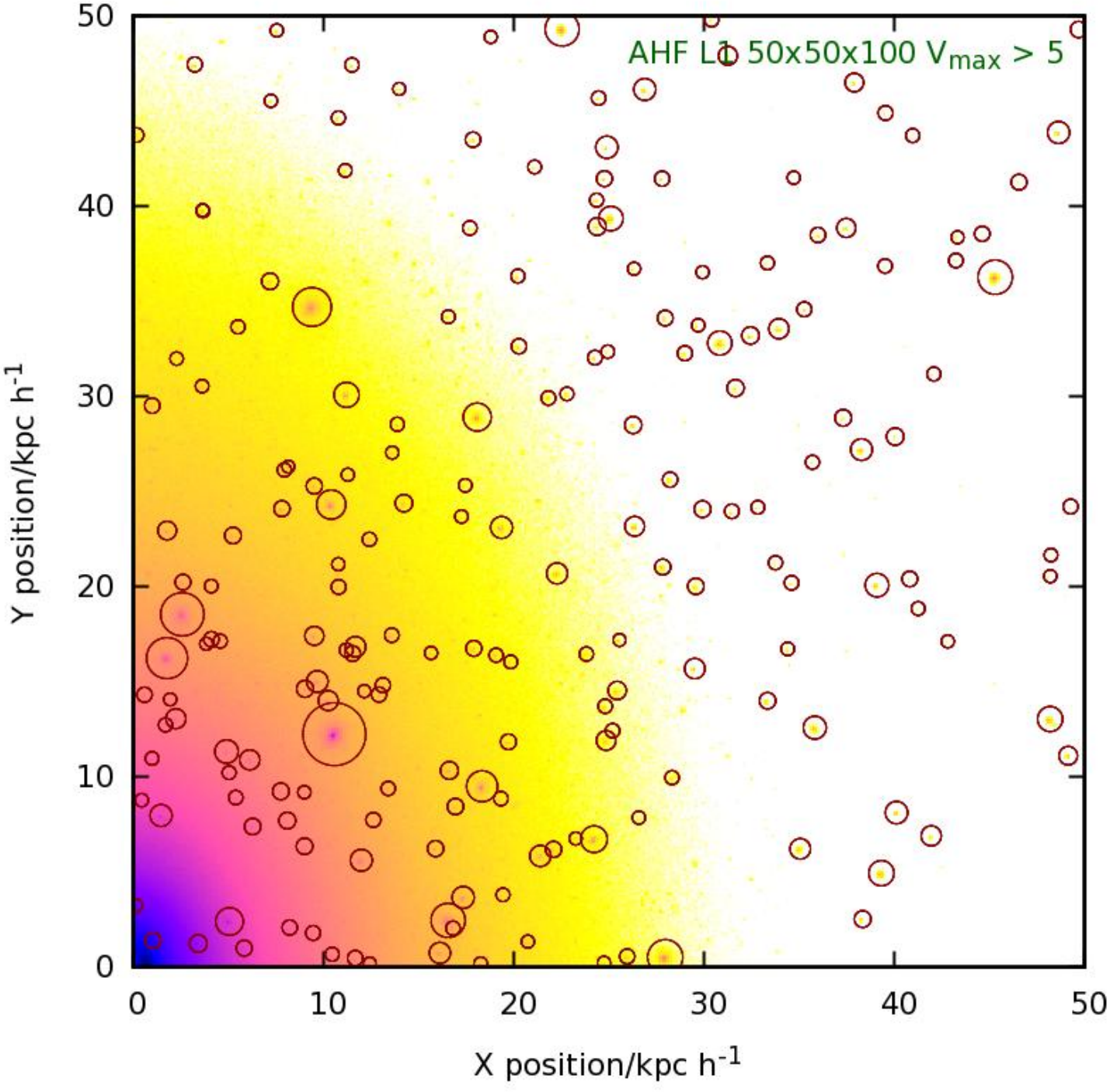

mendieta L4 250x250x250 V_{max} > 10

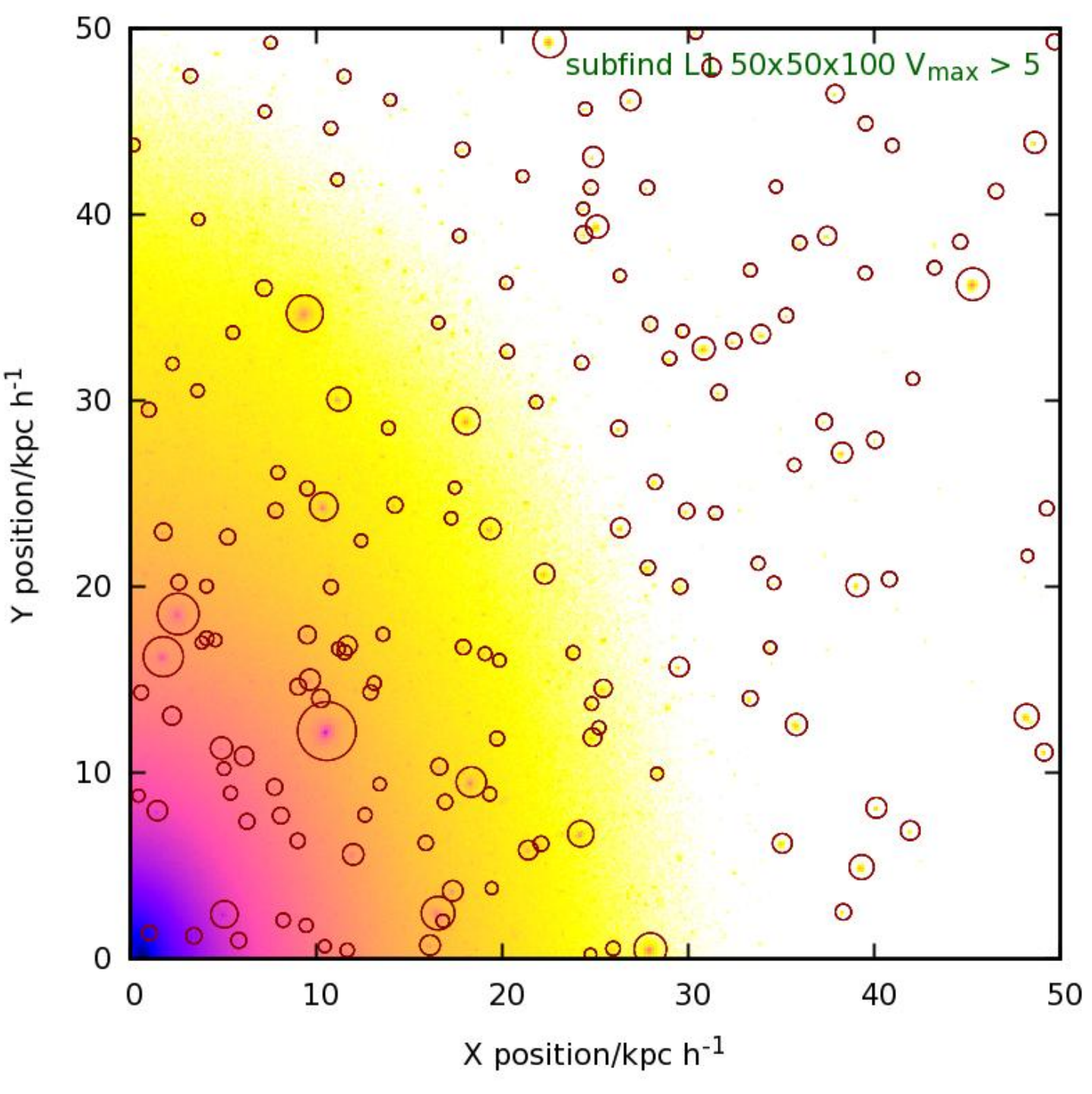

Rockstar L4 250x250x250 V_{max} > 10

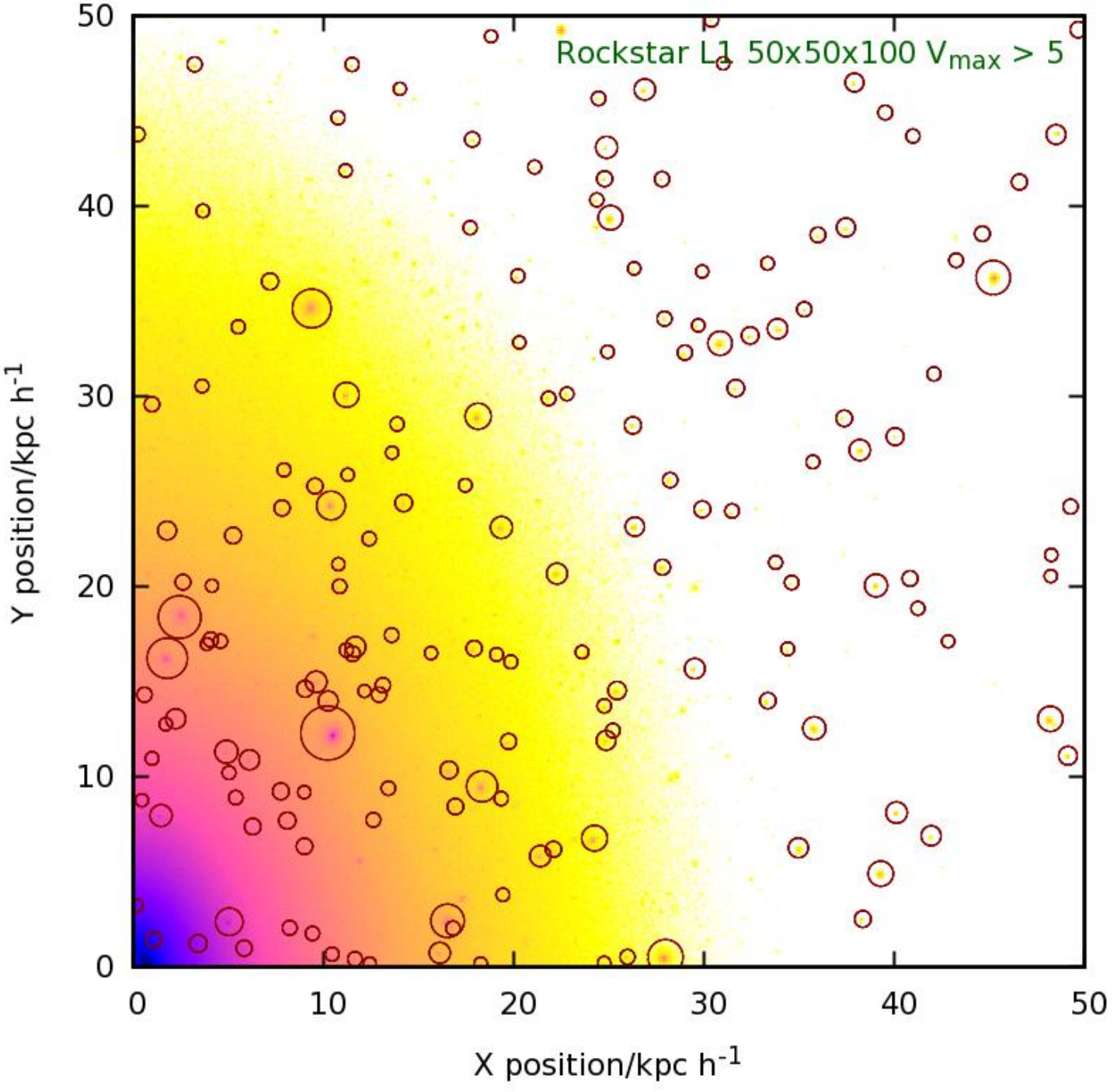

STF L4 250x250x250 V_{max} > 1

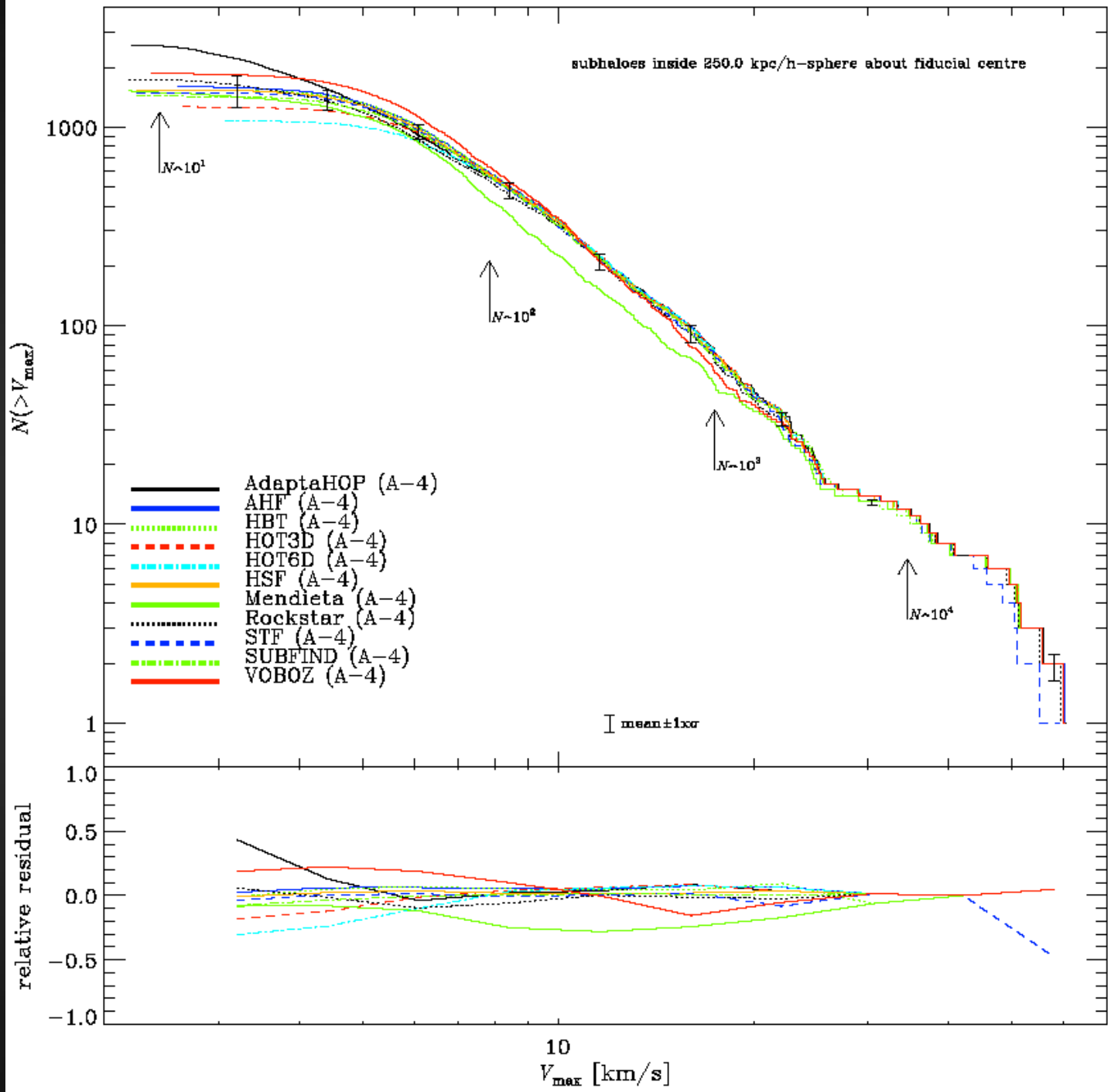

subfind L4 250x250x250 V_{max} > 10

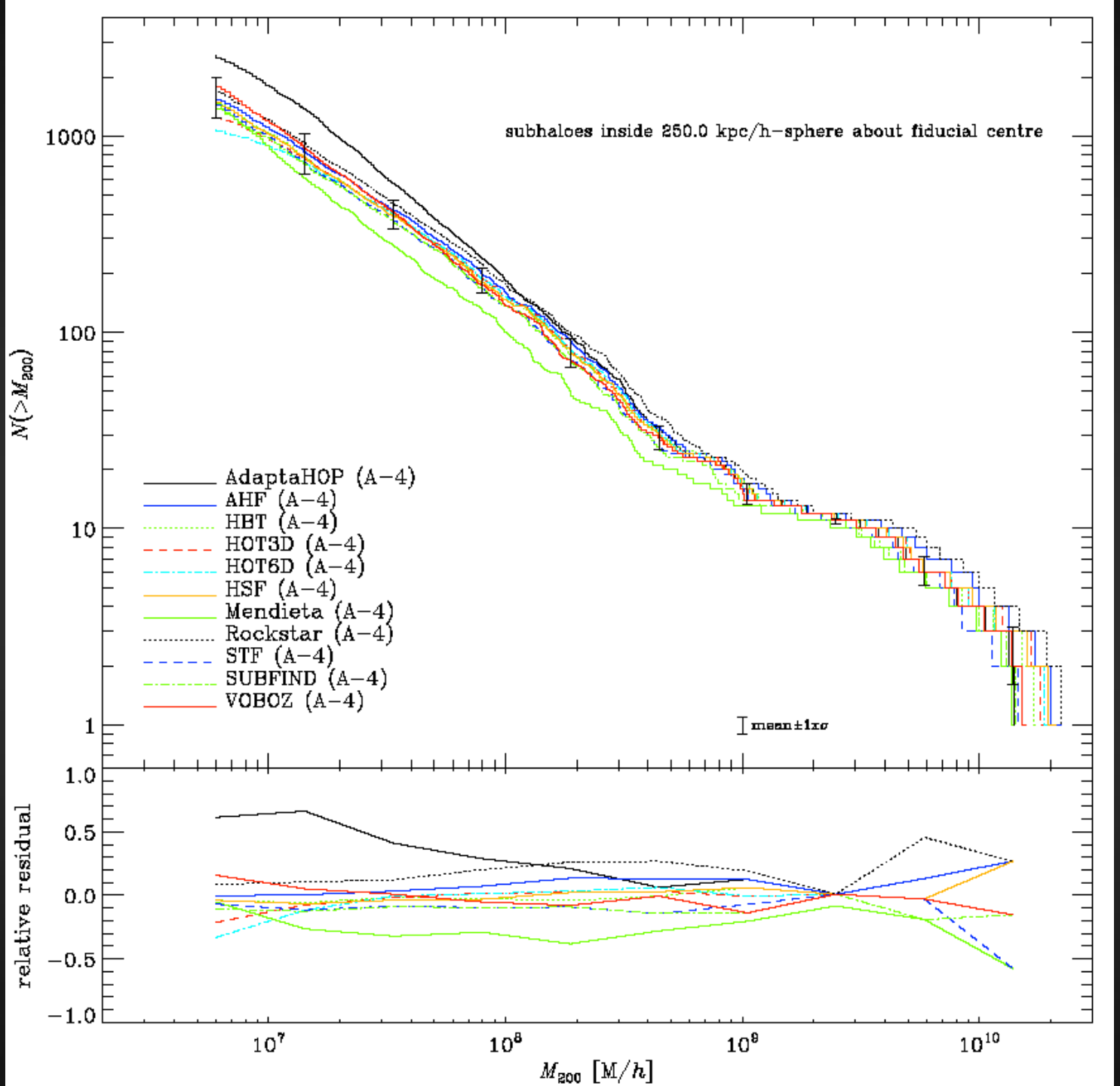

VOBOZ L4 250x250x250 V_{max} > 10


AHF L1 50x50x100 V_{max} > 5
Y position/kpc h^{-1}
X position/kpc h^{-1}
0
10
20
30
40
50


subfind L1 50x50x100 V_{max} > 5
Y position/kpc h^{-1}
X position/kpc h^{-1}
0
10
20
30
40
50


Rockstar L1 50x50x100 V_{max} > 5
Y position/kpc h^{-1}
X position/kpc h^{-1}
0
10
20
30
40
50


subhaloes inside 250.0 kpc/h−sphere about fiducial centre
1000
100
10
1
$N(>V_{max})$
$N\sim10^1$
$N\sim10^2$
$N\sim10^3$
$N\sim10^4$
AdaptaHOP (A−4)
AHF (A−4)
HBT (A−4)
HOT3D (A−4)
HOT6D (A−4)
HSF (A−4)
Mendieta (A−4)
Rockstar (A−4)
STF (A−4)
SUBFIND (A−4)
VOBOZ (A−4)
mean±1xσ
1.0
0.5
0.0
−0.5
−1.0
relative residual
10
V_{max} [km/s]


subhaloes inside 250.0 kpc/h−sphere about fiducial centre
AdaptaHOP (A−4)
AHF (A−4)
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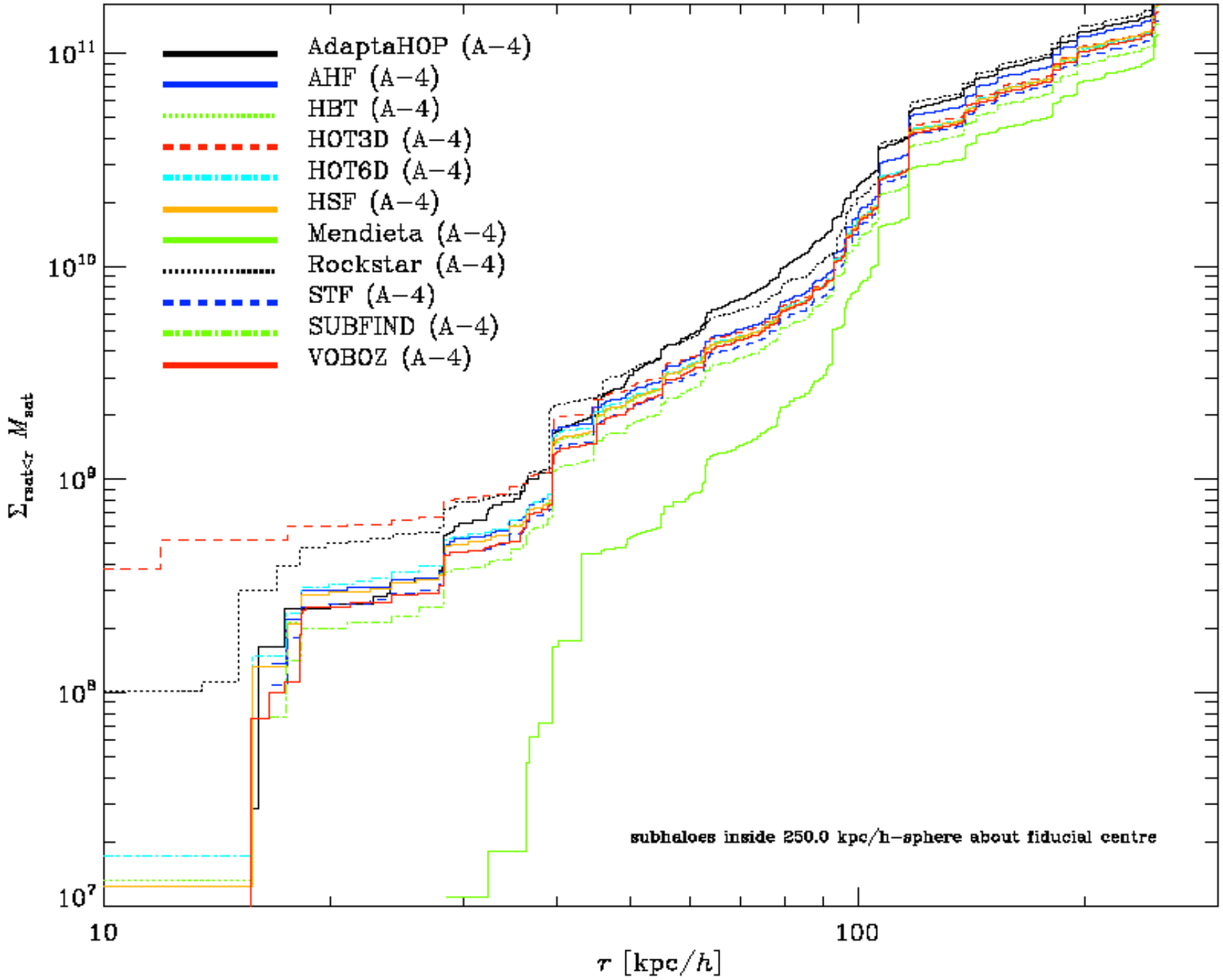
HOT3D (A−4)
HOT6D (A−4)
HSF (A−4)
Mendieta (A−4)
Rockstar (A−4)
STF (A−4)
SUBFIND (A−4)
VOBOZ (A−4)
mean±1xσ
N(>M200)
1000
100
10
1
relative residual
1.0
0.5
0.0
−0.5
−1.0
10^7
10^8
10^9
10^10
M200 [M/h]


AdaptaHOP (A−4)
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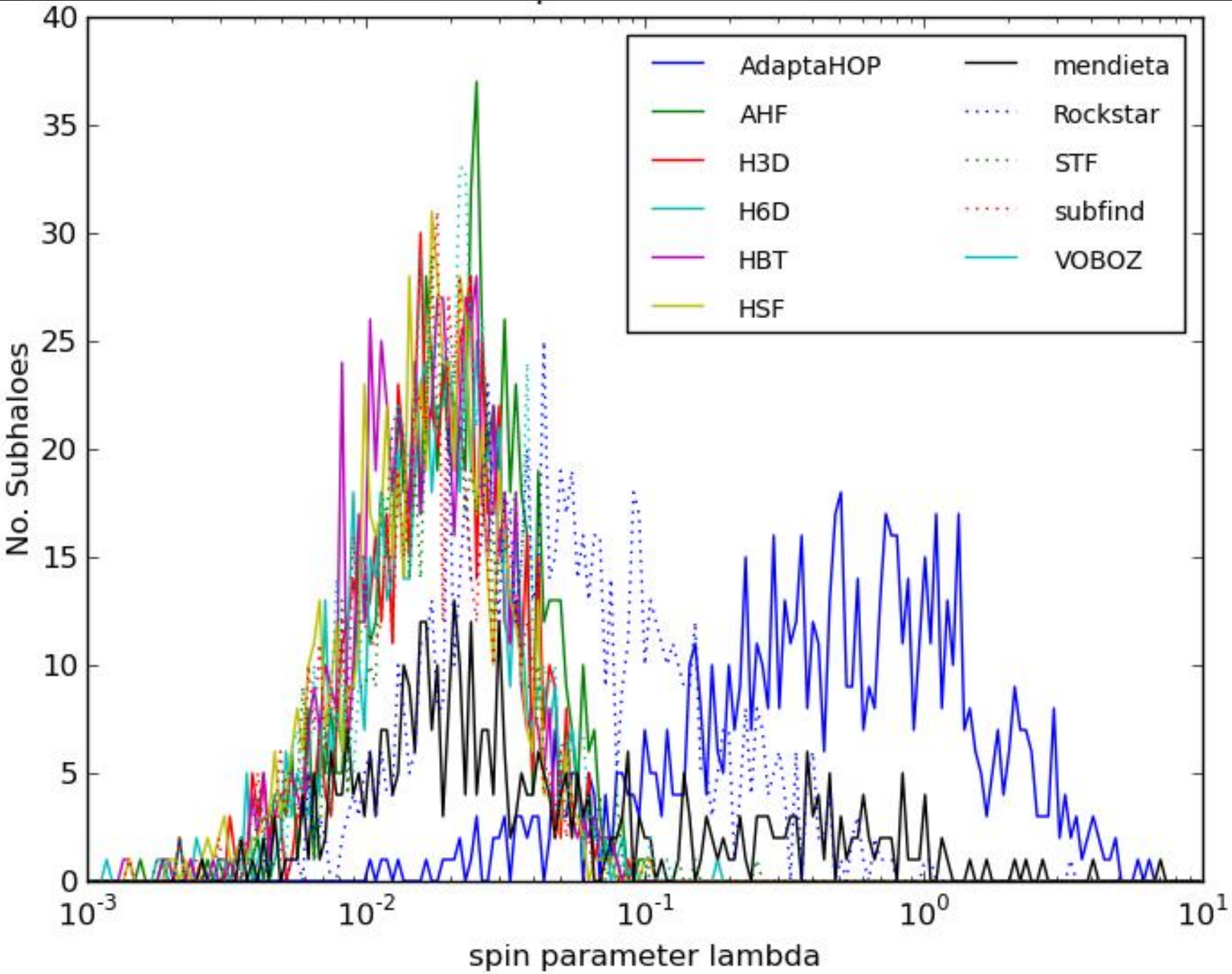
HOT3D (A−4)
HOT6D (A−4)
HSF (A−4)
Mendieta (A−4)
Rockstar (A−4)
STF (A−4)
SUBFIND (A−4)
VOBOZ (A−4)
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
$\Sigma_{\rm rad<r}\ M_{\rm sat}$
10
100
r [kpc/h]
subhaloes inside 250.0 kpc/h−sphere about fiducial centre


AdaptaHOP
AHF
H3D
H6D
HBT
HSF
mendieta
Rockstar
STF
subfind
VOBOZ
No. Subhaloes
spin parameter lambda
0
5
10
15
20
25
30
35
40
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}

Conclusions

- Several reliable, efficient subhalo finders exist
- For recovering surviving clumps, phase space finders indistinguishable from real space finders
- Important to use unbinding
- Good to about 10% accuracy.

To be done:

- Compare finders own subhalo properties
- Uniform subhalo definition?

SubHaloes Going Notts
14-18th May, 2012, Derbyshire