



PHASE-SPACE STRUCTURES OF DARK MATTER HALOES

Michał MACIEJEWSKI

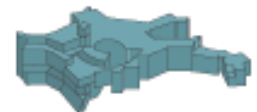
Stephane COLOMBI

Christophe ALARD

Francois BOUCHET

Simon D.M. WHITE

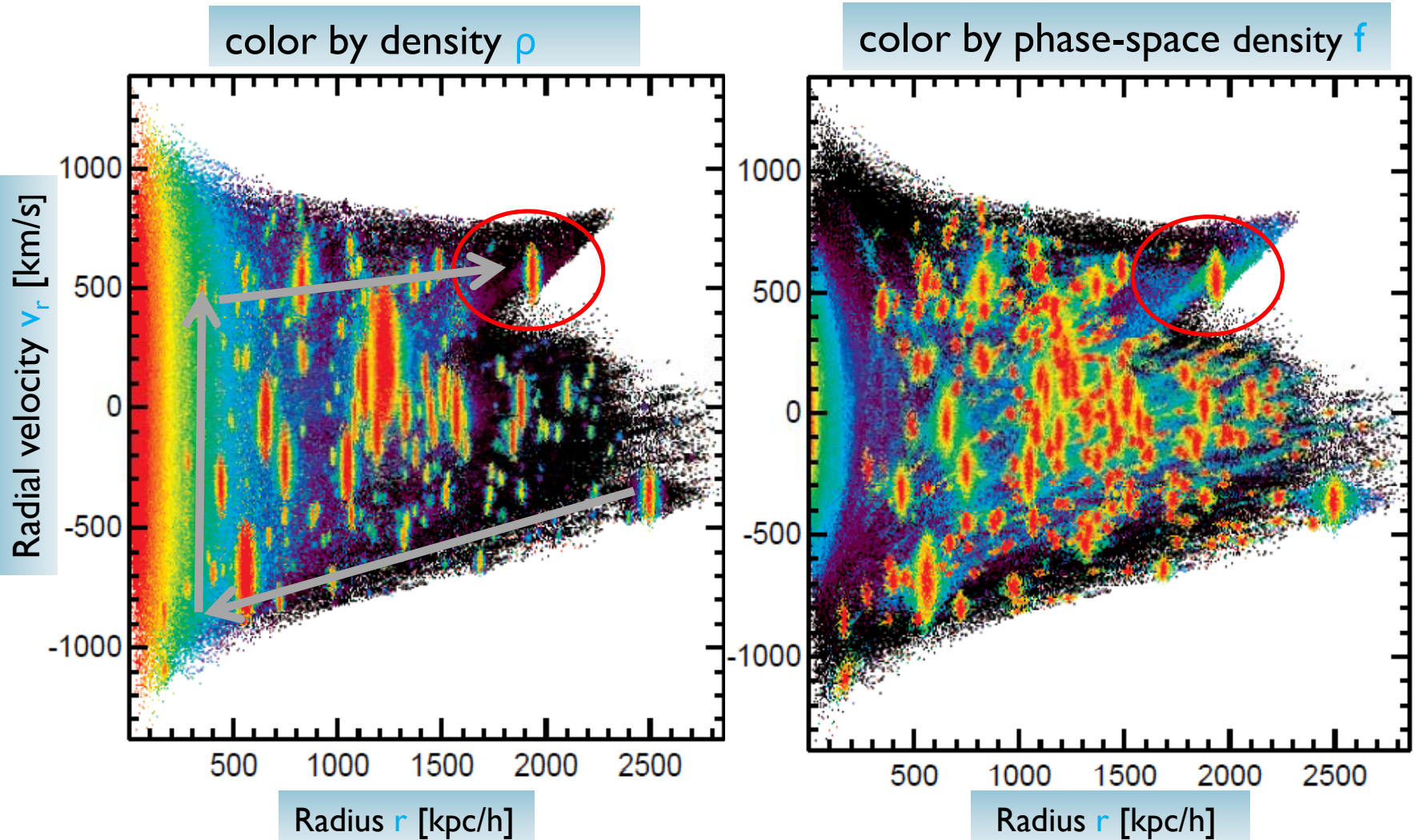
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Phase-space structures

2

- Can we see more structures in phase-space?

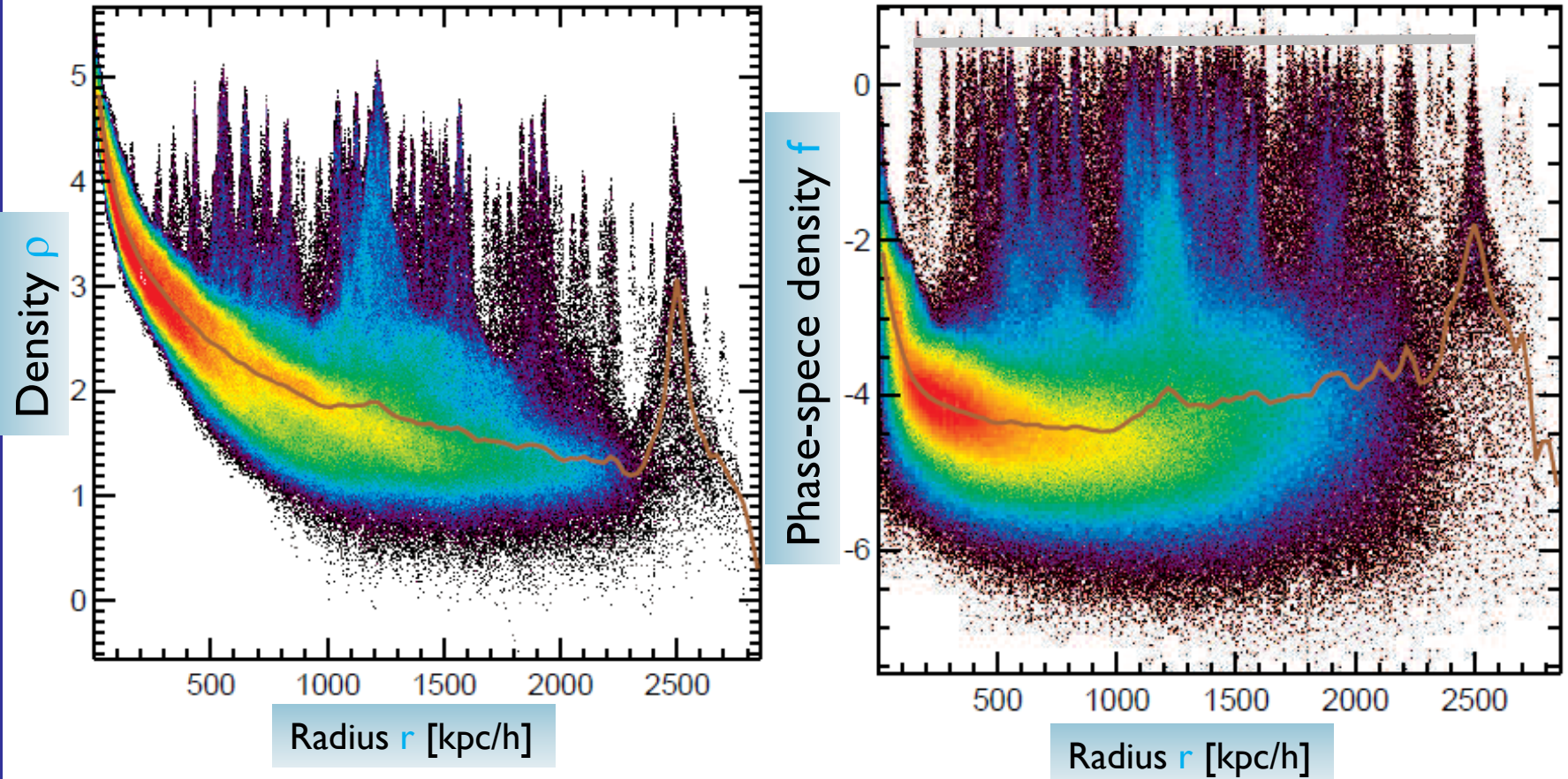


- ▶ Yes, we see additional streams

Density estimation

3

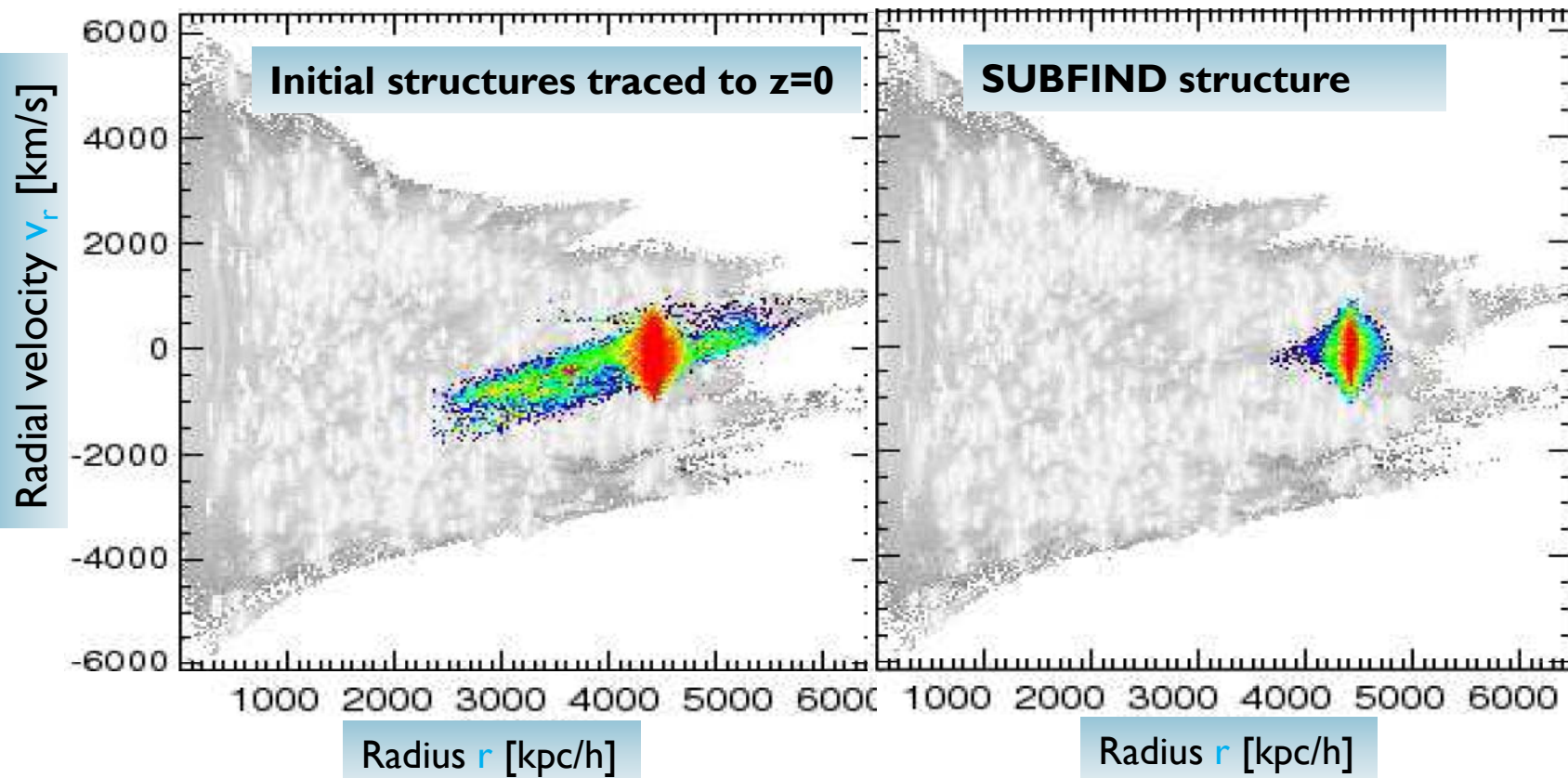
- Can we see more structures in phase-space?



- ▶ Yes, peaks are more contrasted

Hierarchical structure finder 4

- Can phase-space can be used to study the structures history?

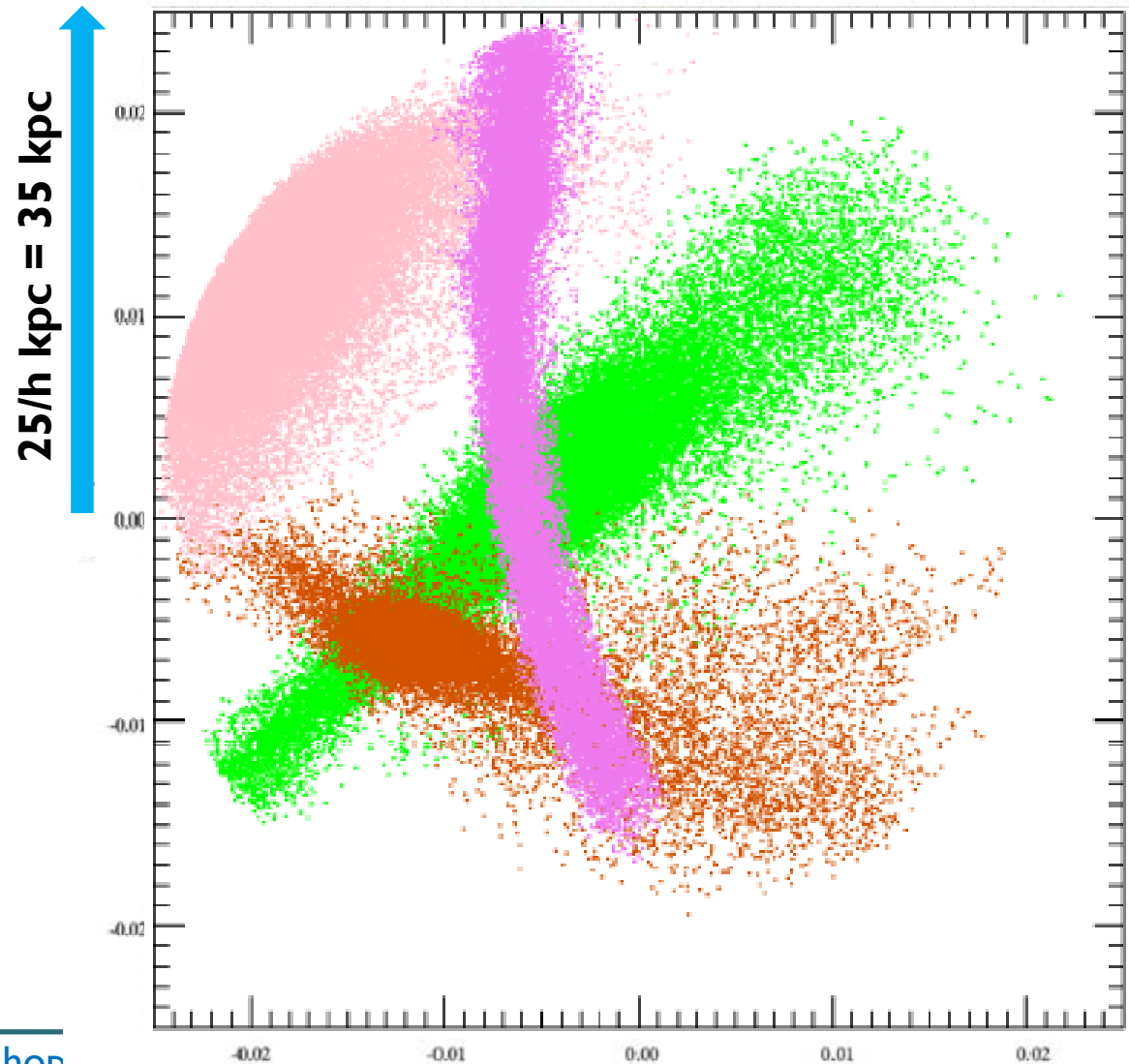


- ▶ Yes, for many structures ([Maciejewski et al. 2008](#))

PHASE-SPACE STRUCTURES 5

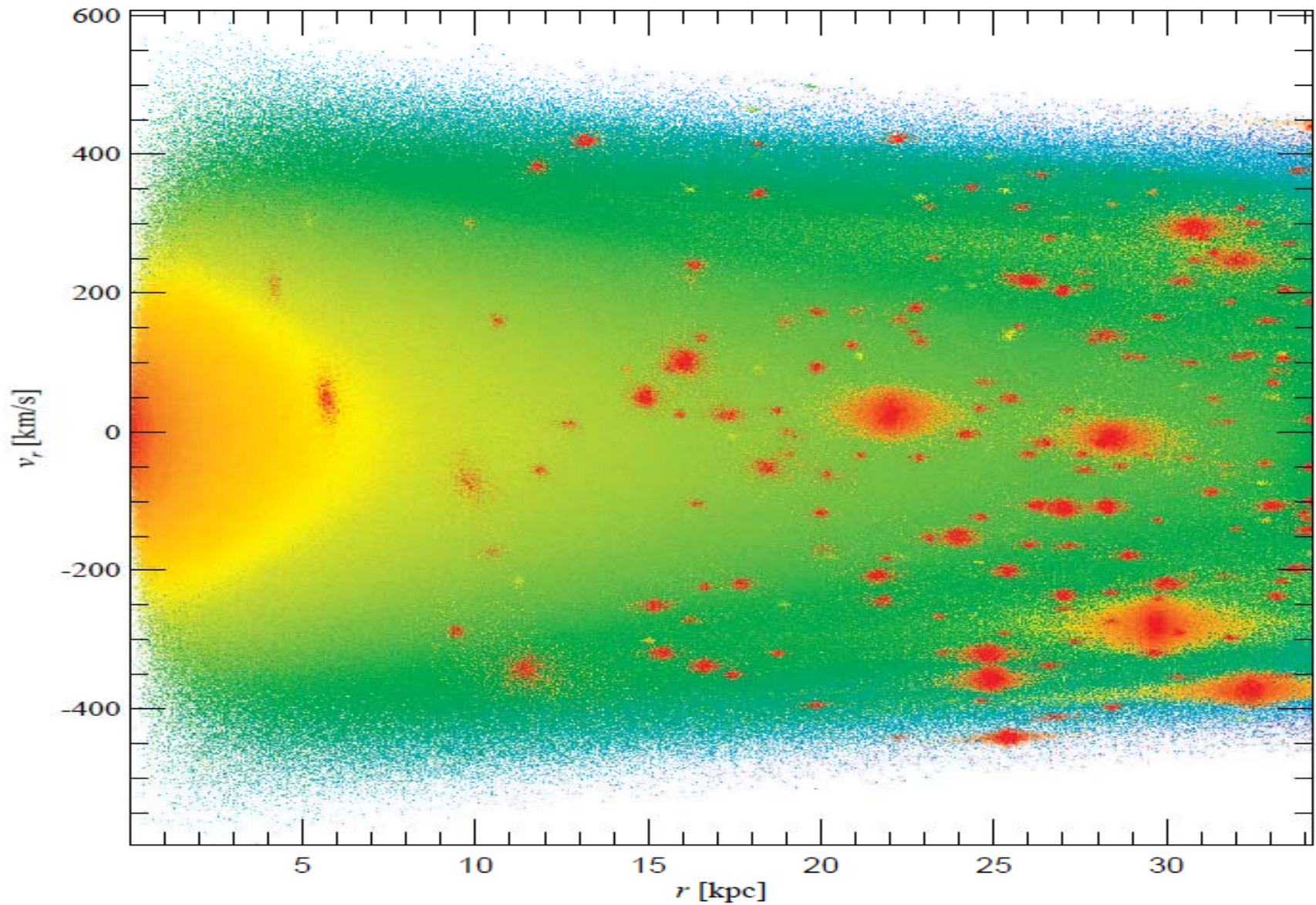
- AQUARIUS project – study properties of dark matter in our galaxy (White, Springel, Vogelsberger)

- ▶ Particle mass equal 1712 Solar Mass
- ▶ 35 kpc slice
- ▶ 200 million particles
- ▶ 0.05 % of mass in bound structures
- ▶ trace of dark matter streams near the Sun
- ▶ 0.5 % of mass in all structures found by HSF



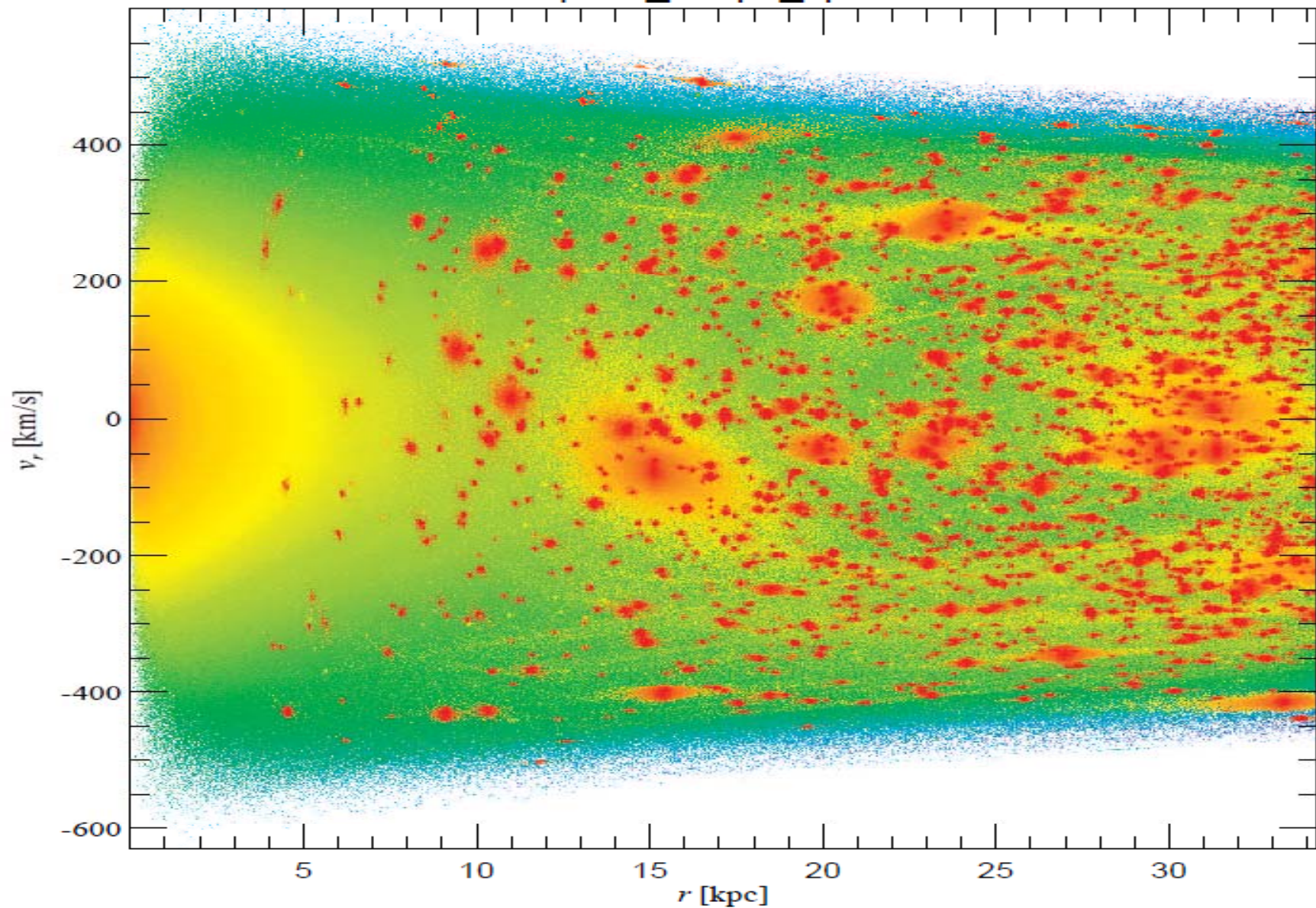
Phase-space diagram

6

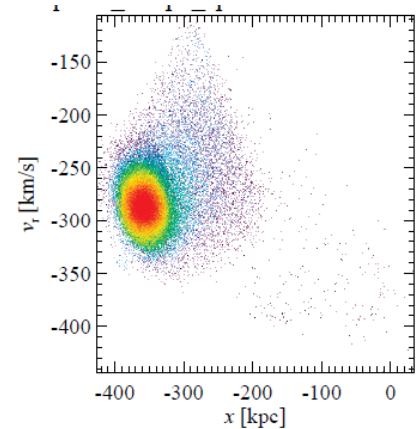
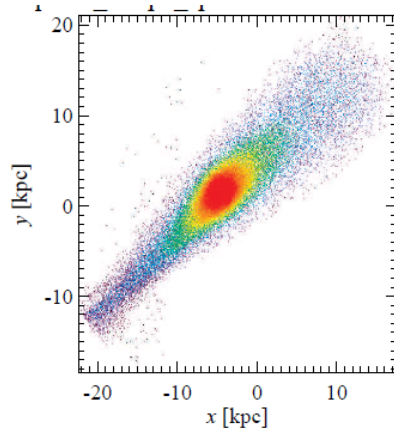
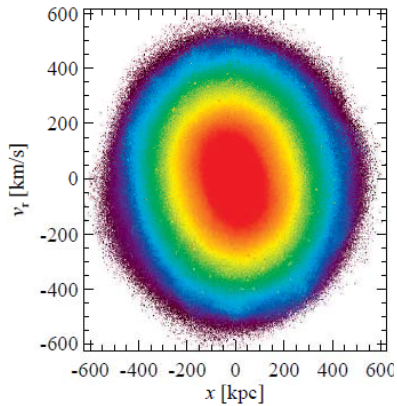
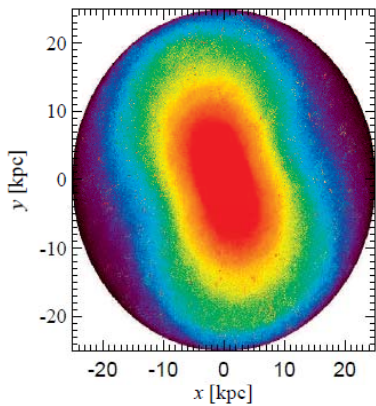
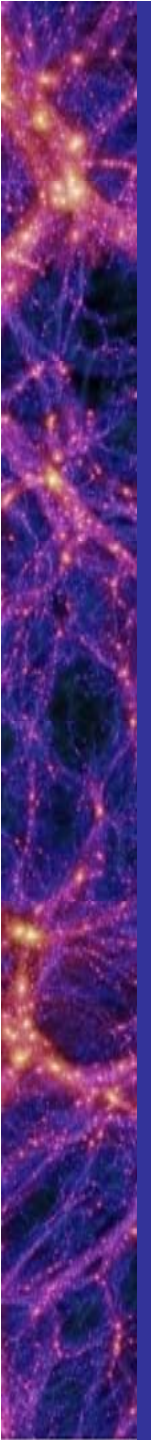


Phase-space diagram

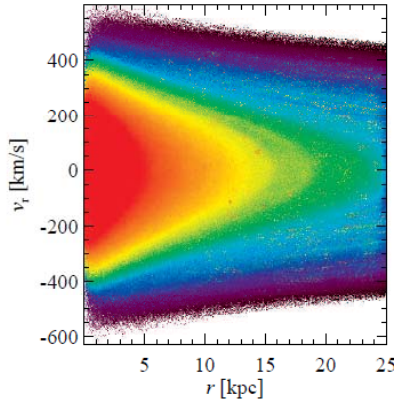
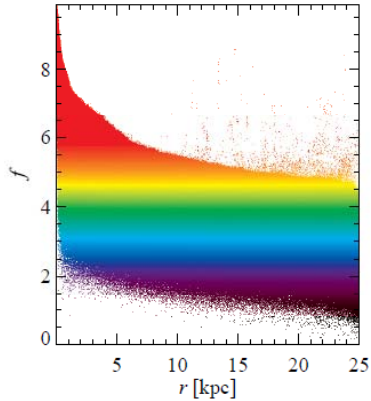
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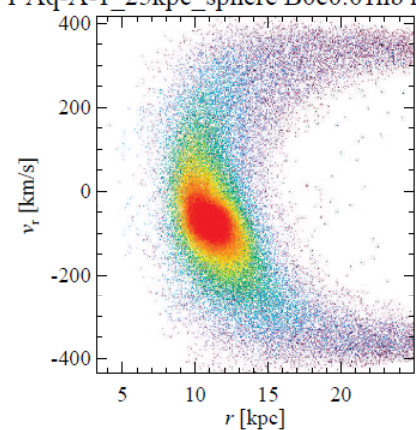
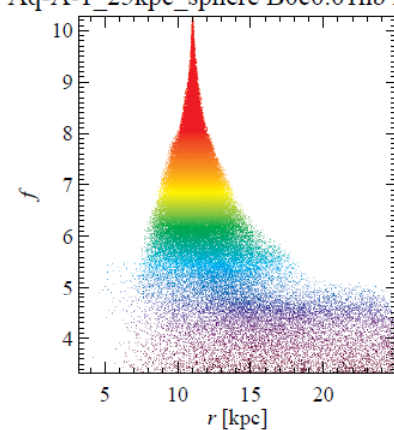
Phase-space diagram



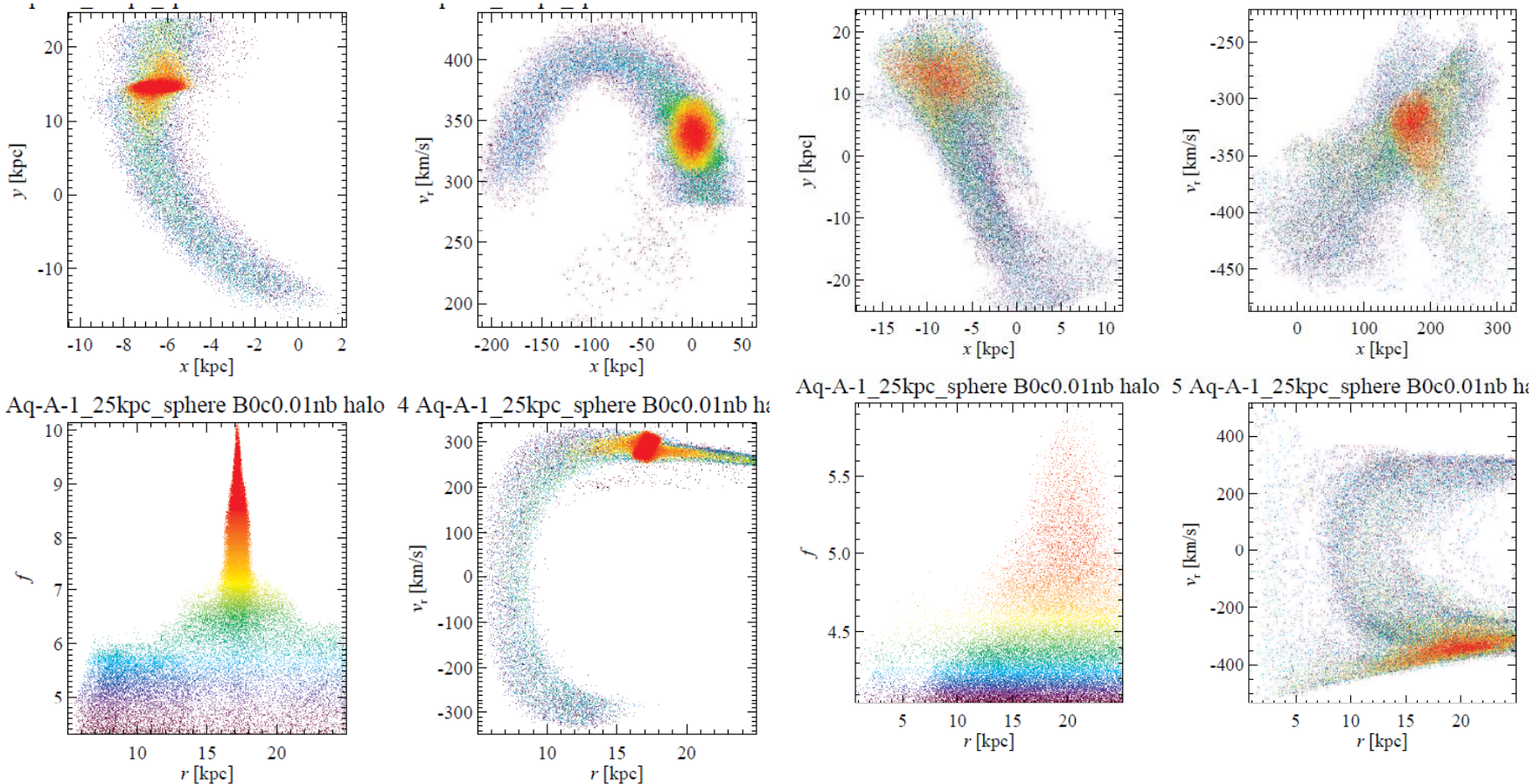
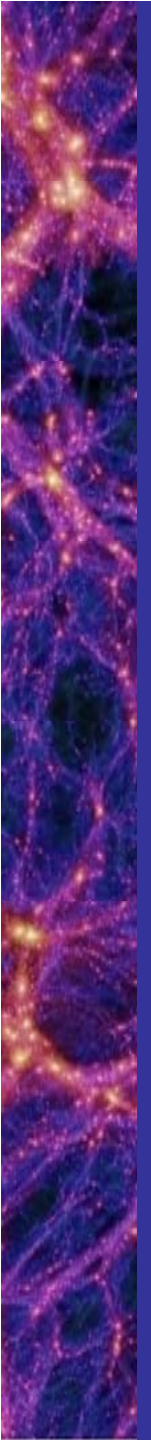
Aq-A-1_25kpc_sphere B0c0.01nb halo 0 Aq-A-1_25kpc_sphere B0c0.01nb h



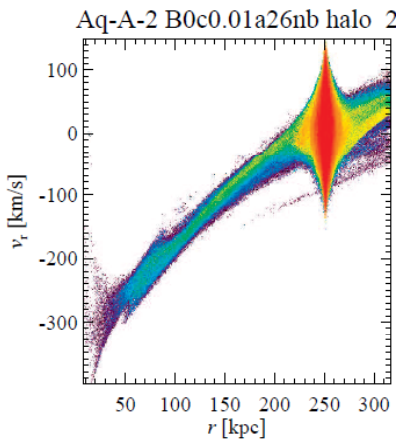
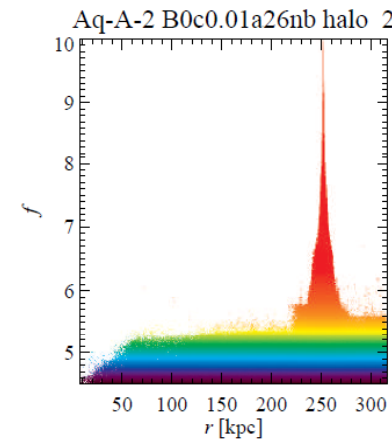
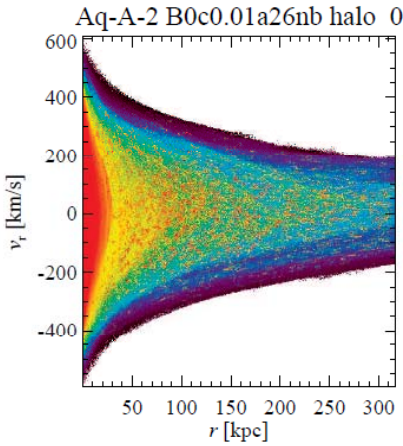
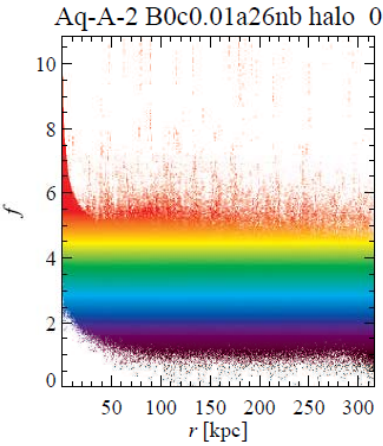
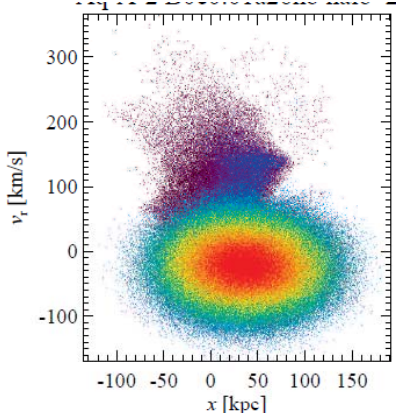
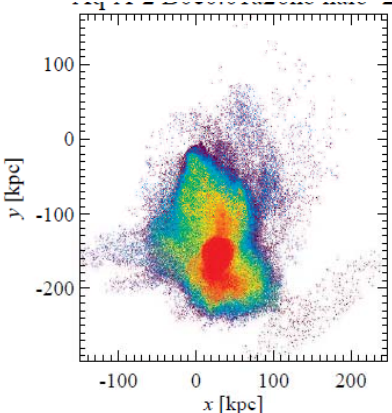
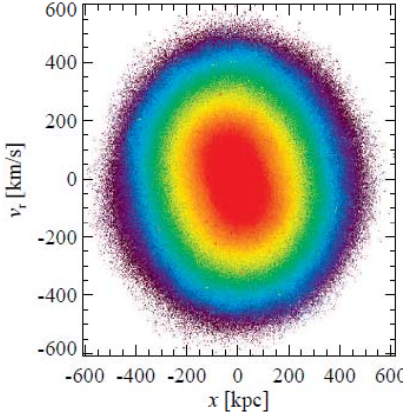
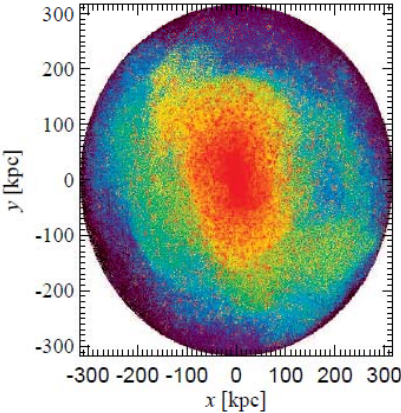
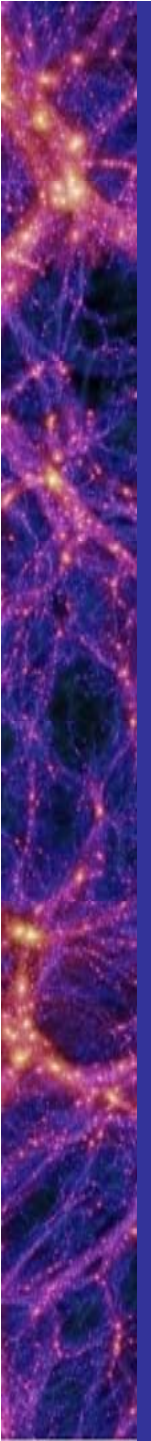
Aq-A-1_25kpc_sphere B0c0.01nb halo 1 Aq-A-1_25kpc_sphere B0c0.01nb halo



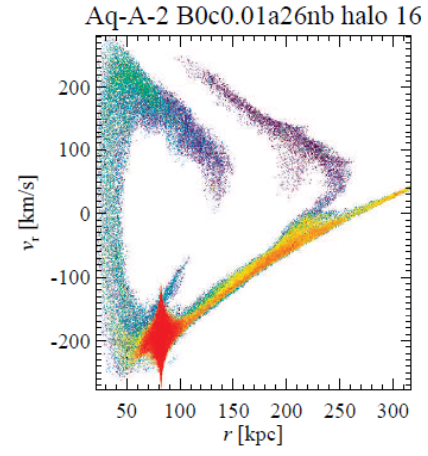
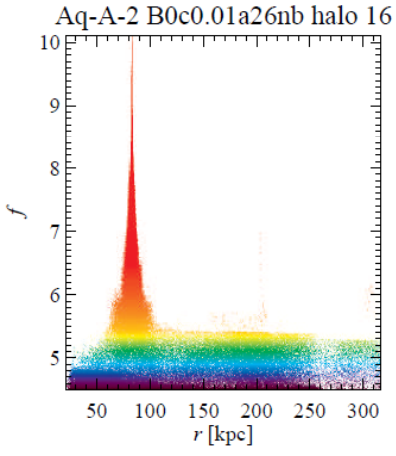
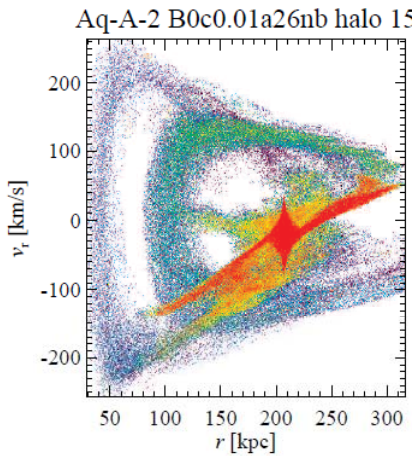
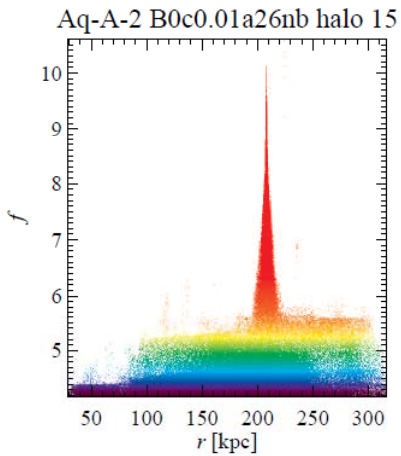
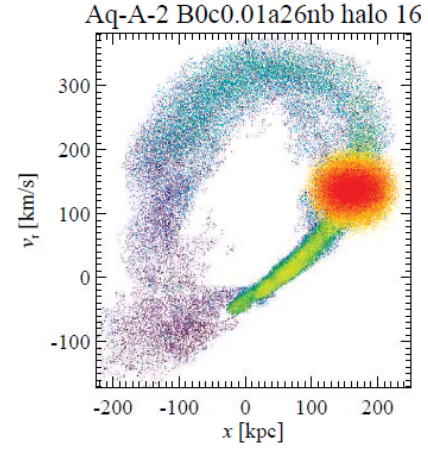
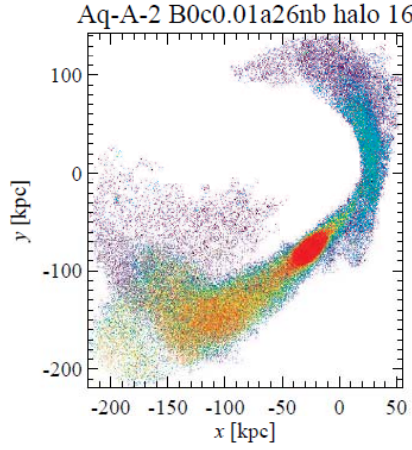
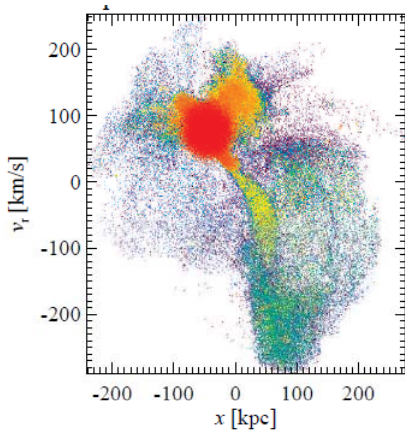
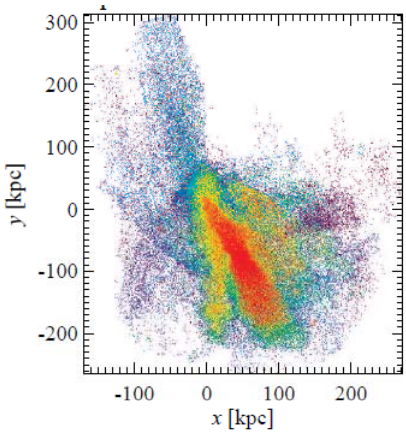
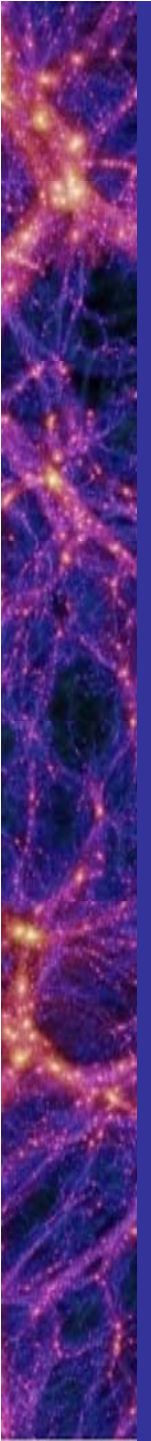
Phase-space diagram



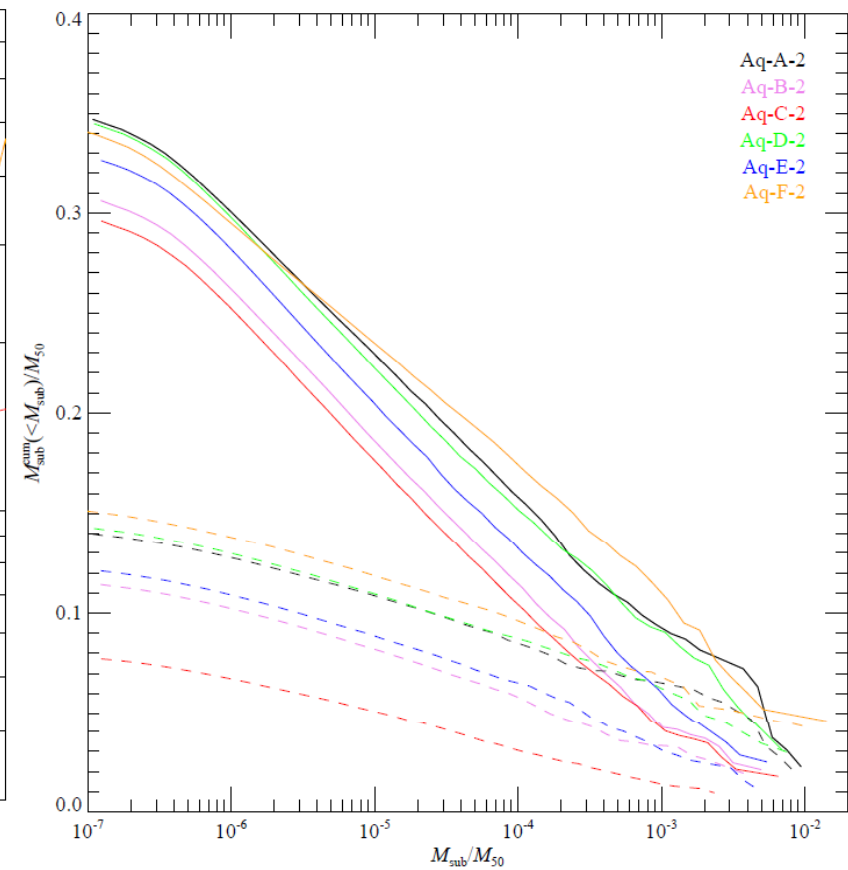
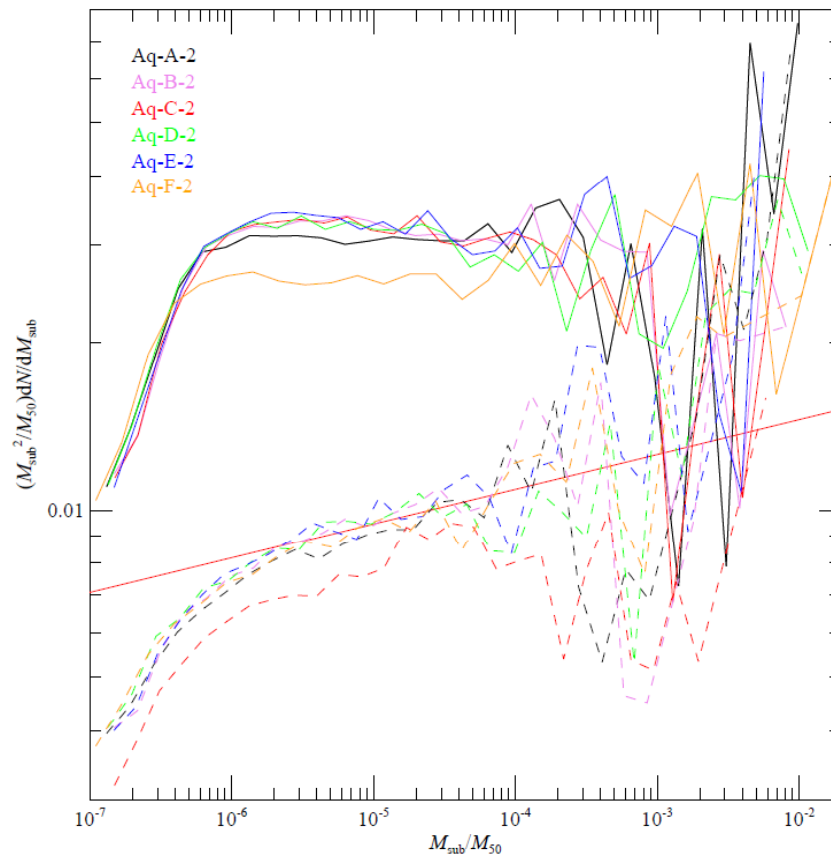
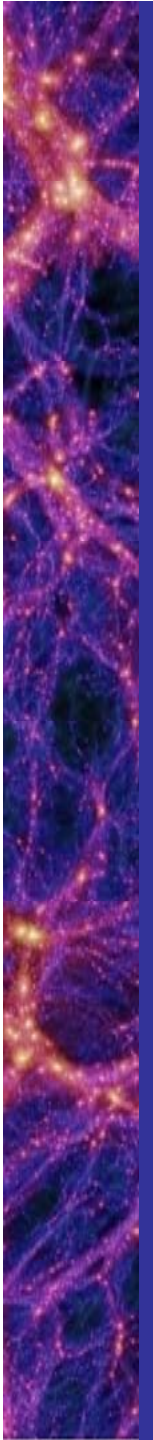
Phase-space diagram



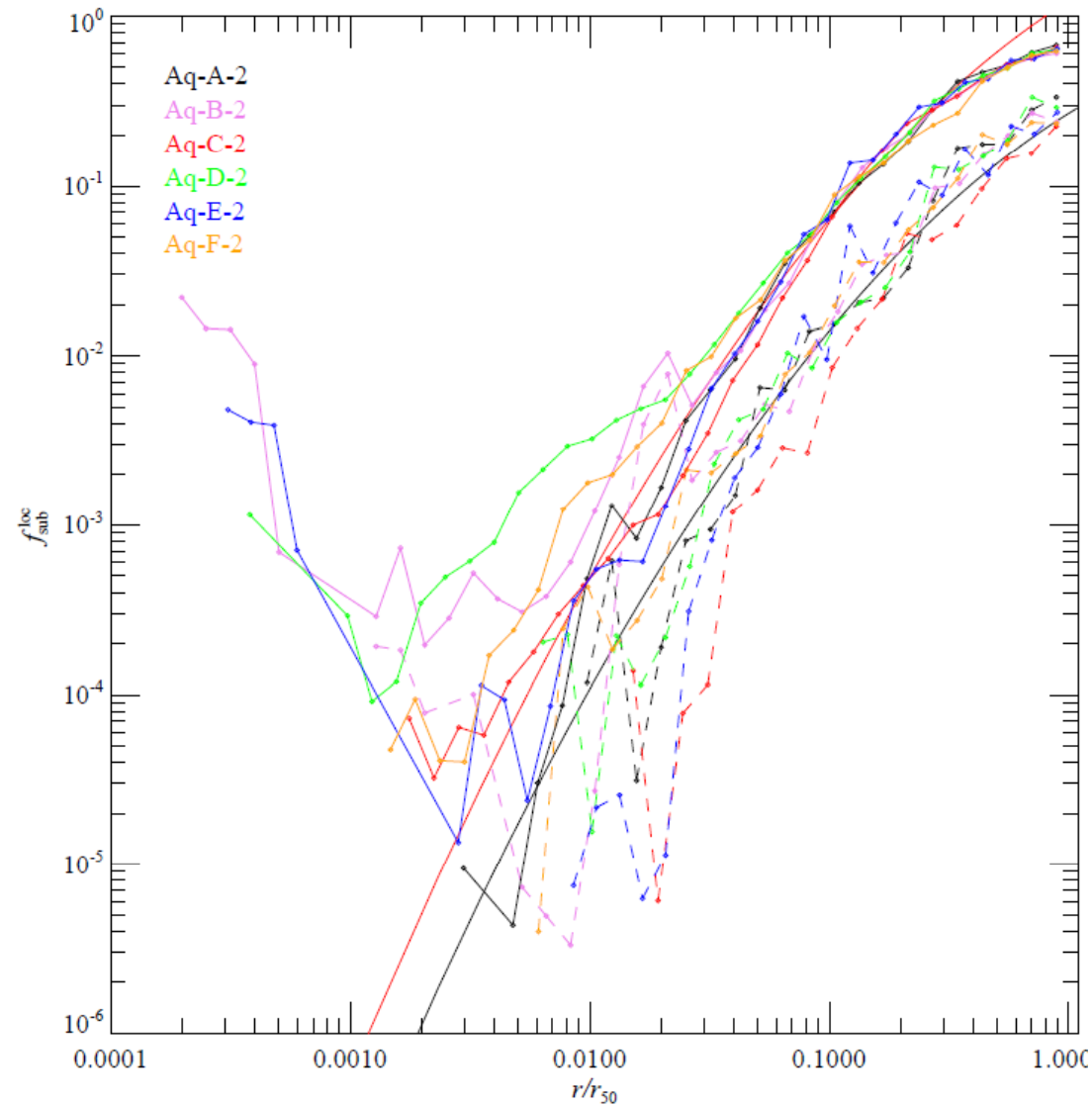
Phase-space diagram



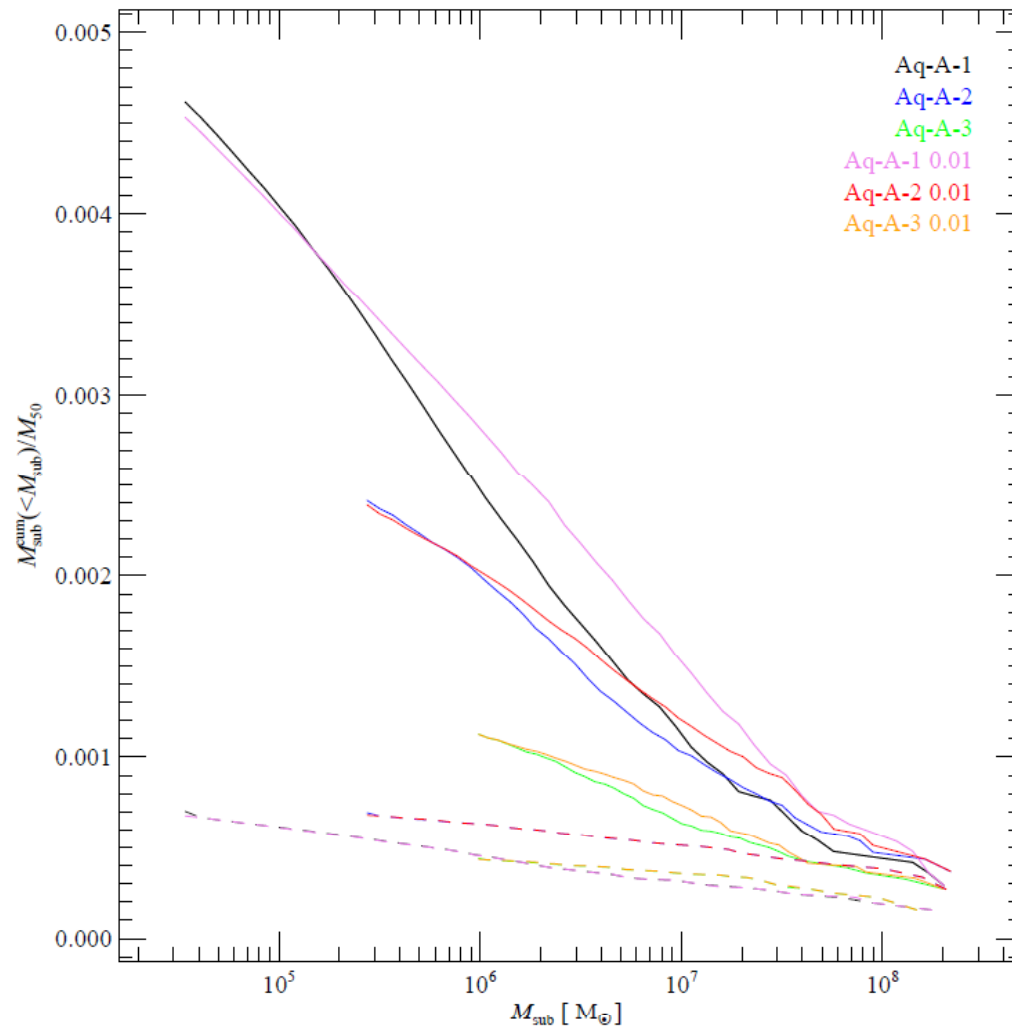
PHASE-SPACE STRUCTURES 12



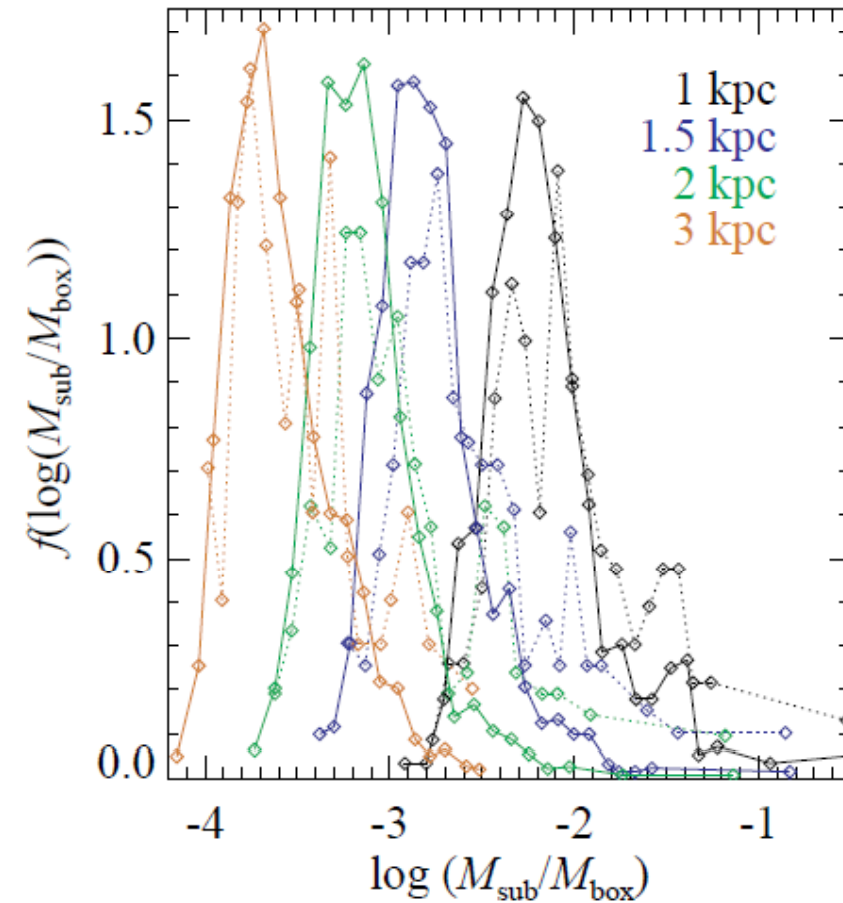
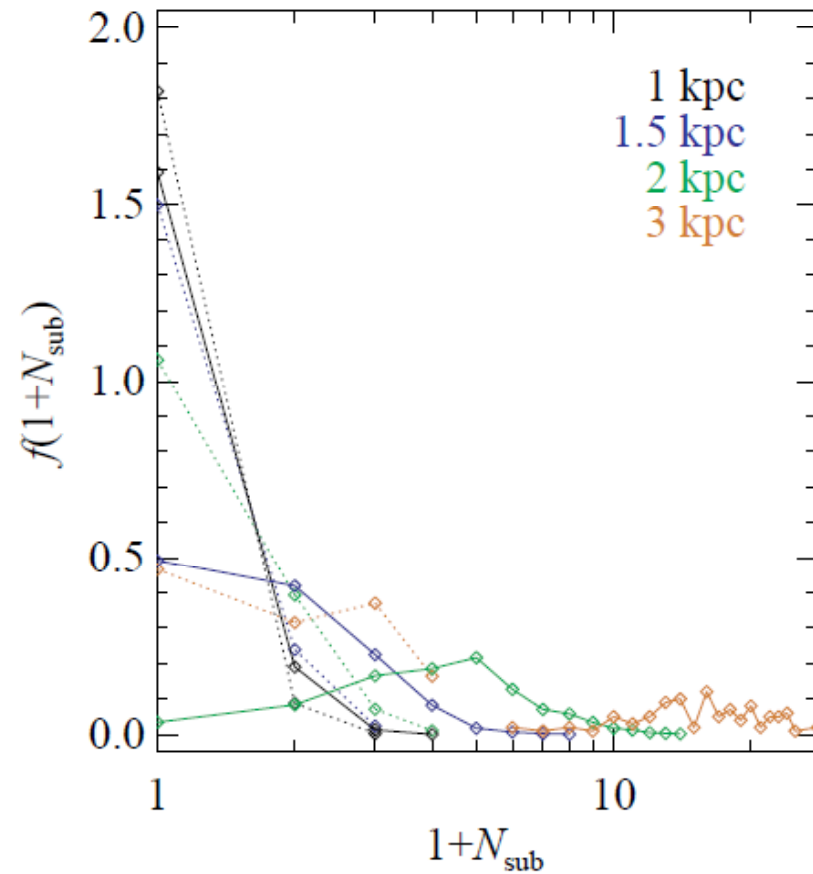
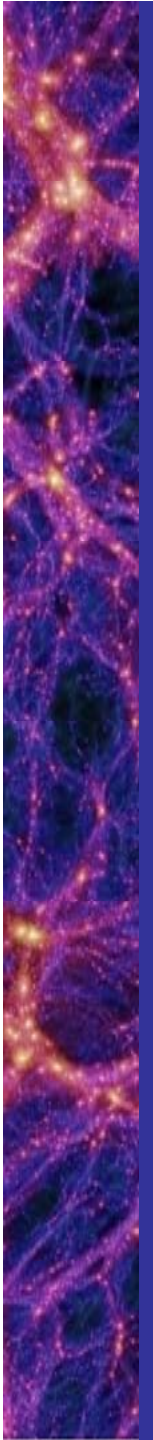
PHASE-SPACE STRUCTURES 13



PHASE-SPACE STRUCTURES 14



PHASE-SPACE STRUCTURES 15





ENERGY PROFILES OF DARK MATTER HALOES

Michał MACIEJEWSKI

Mark VOGELSBERGER

Simon D.M.WHITE

Volker SPRINGEL

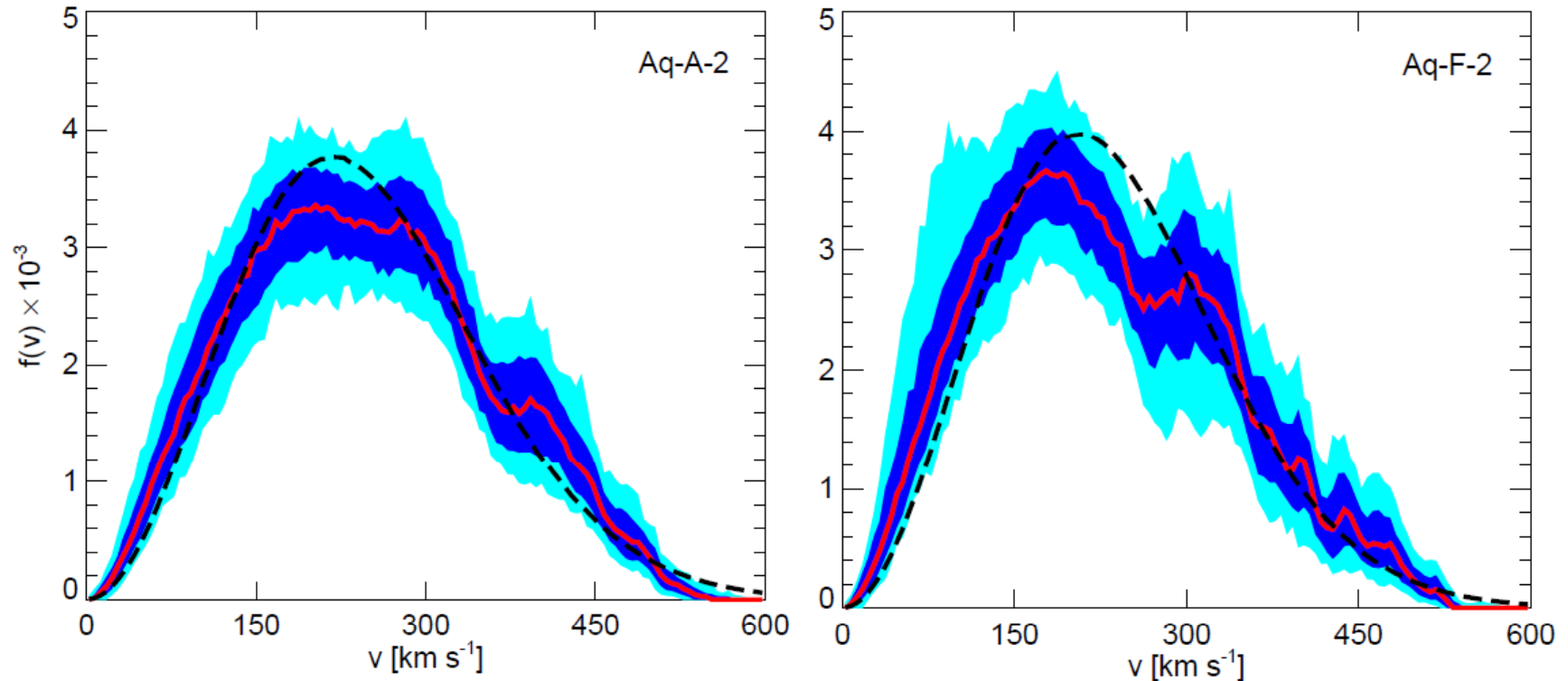
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Velocity profiles

17



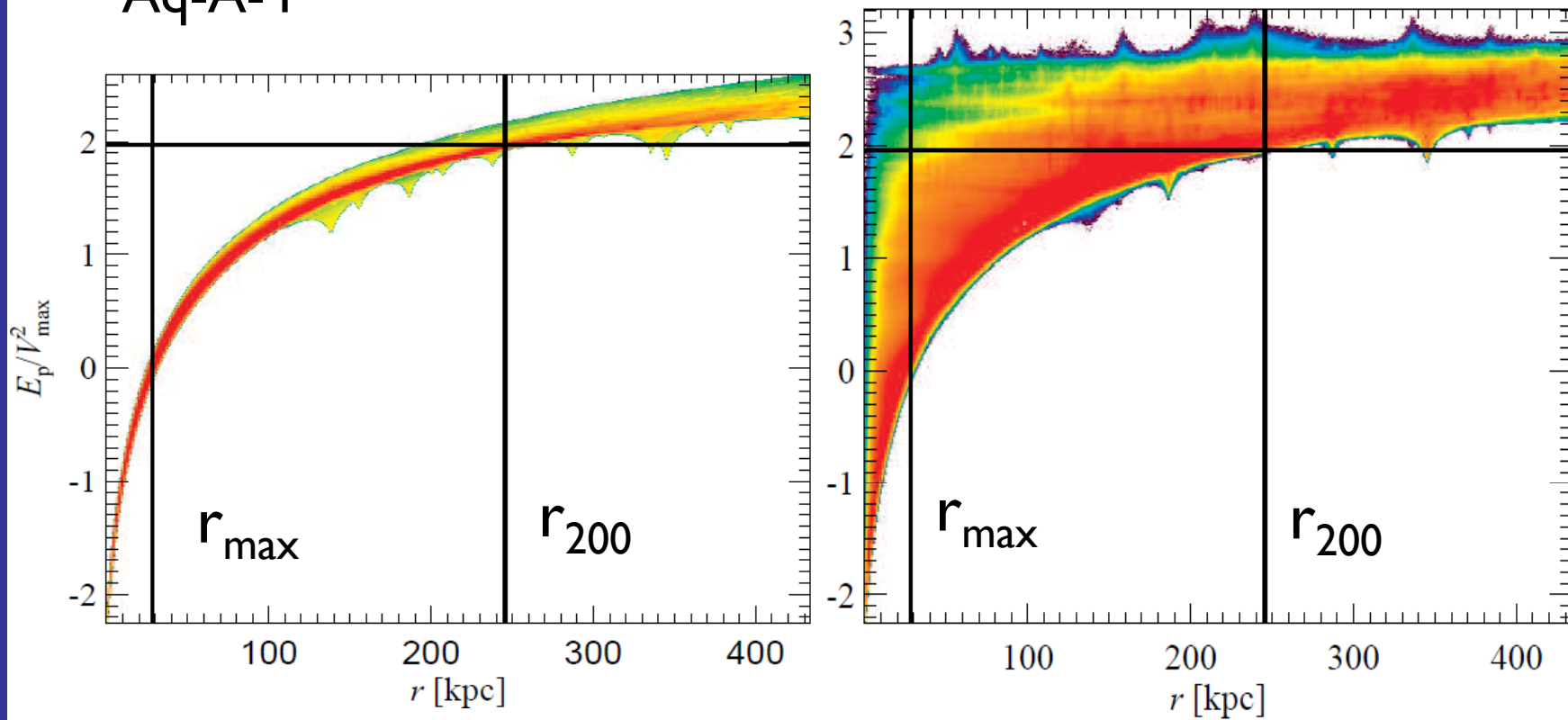
- **Vogelsberger et al. 2008**

Velocity modulus distributions for all 2 kpc boxes centred between 7 and 9 kpc from the centre of Aq-A-1.

Energy profile

18

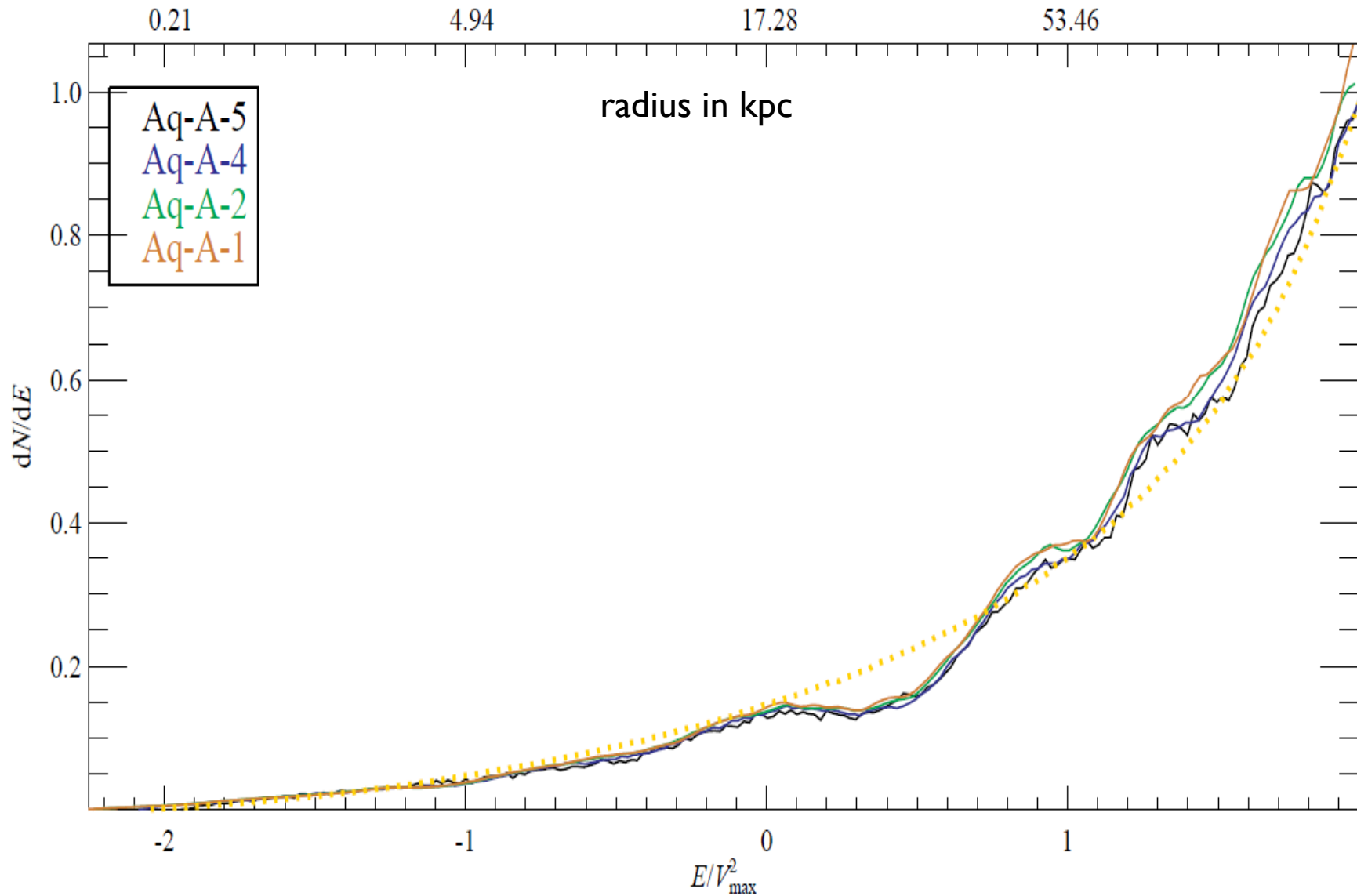
Aq-A-4



- Energy profiles dN/dE

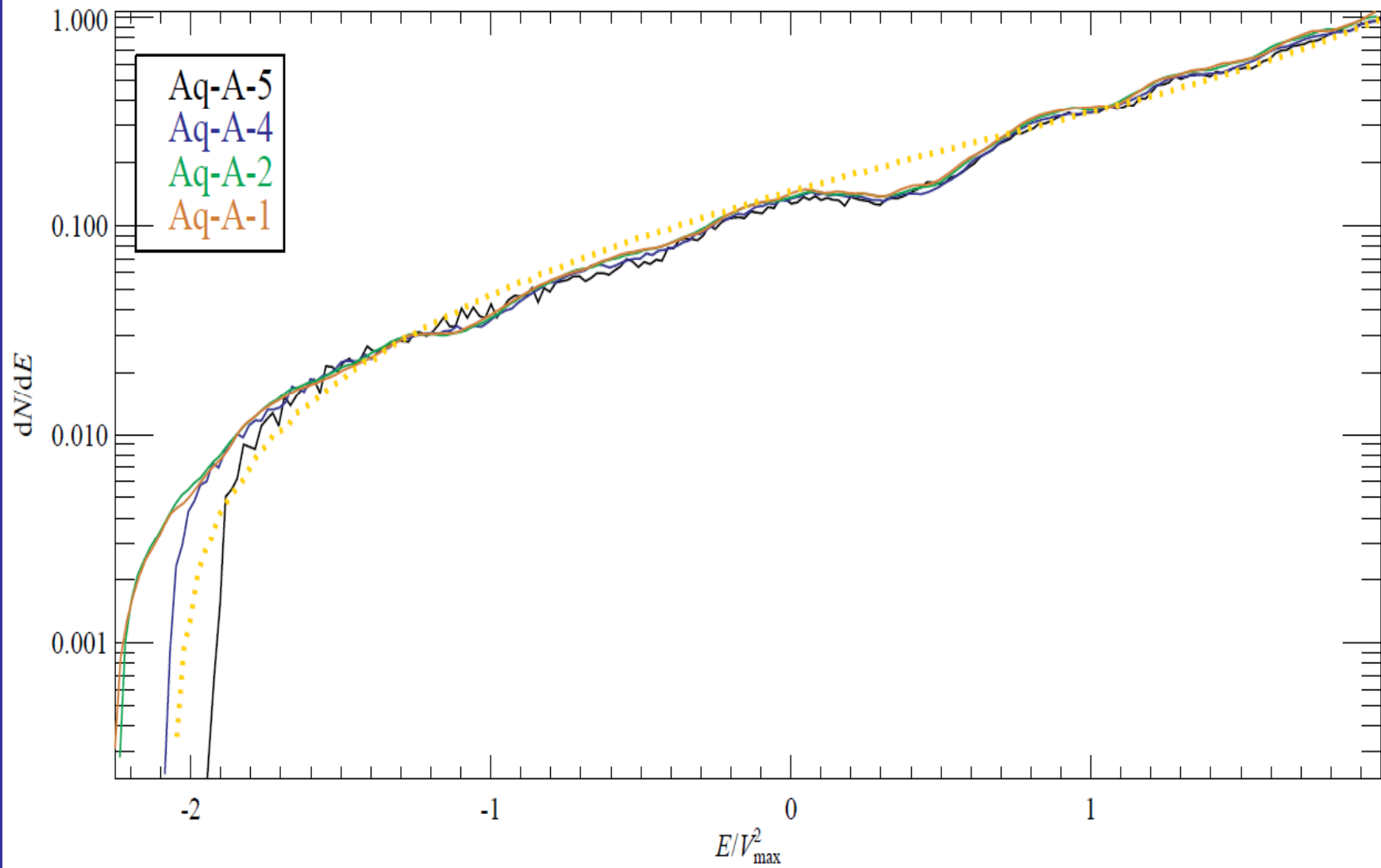
Energy profile

19



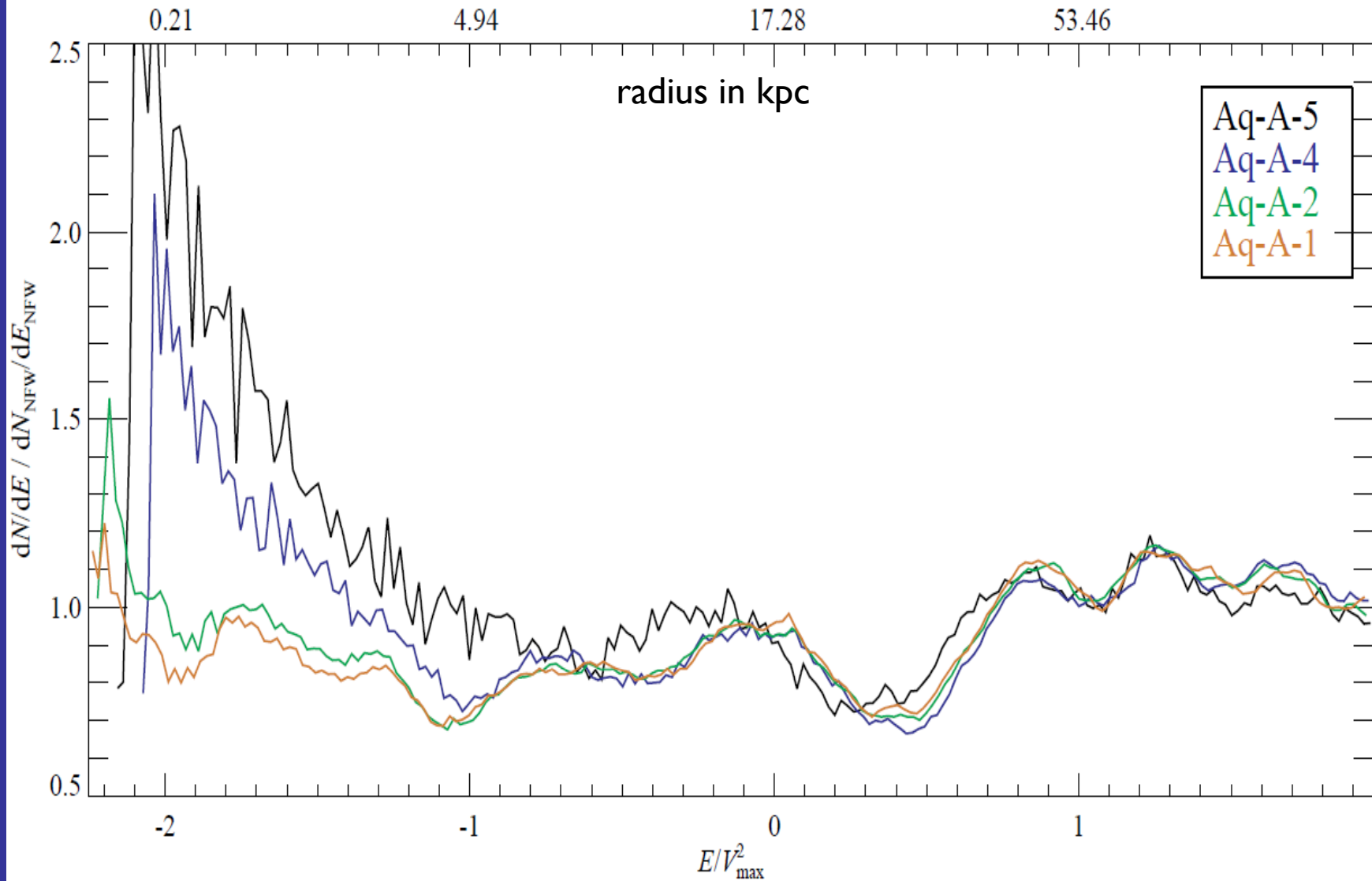
Energy profile

20



Energy profile

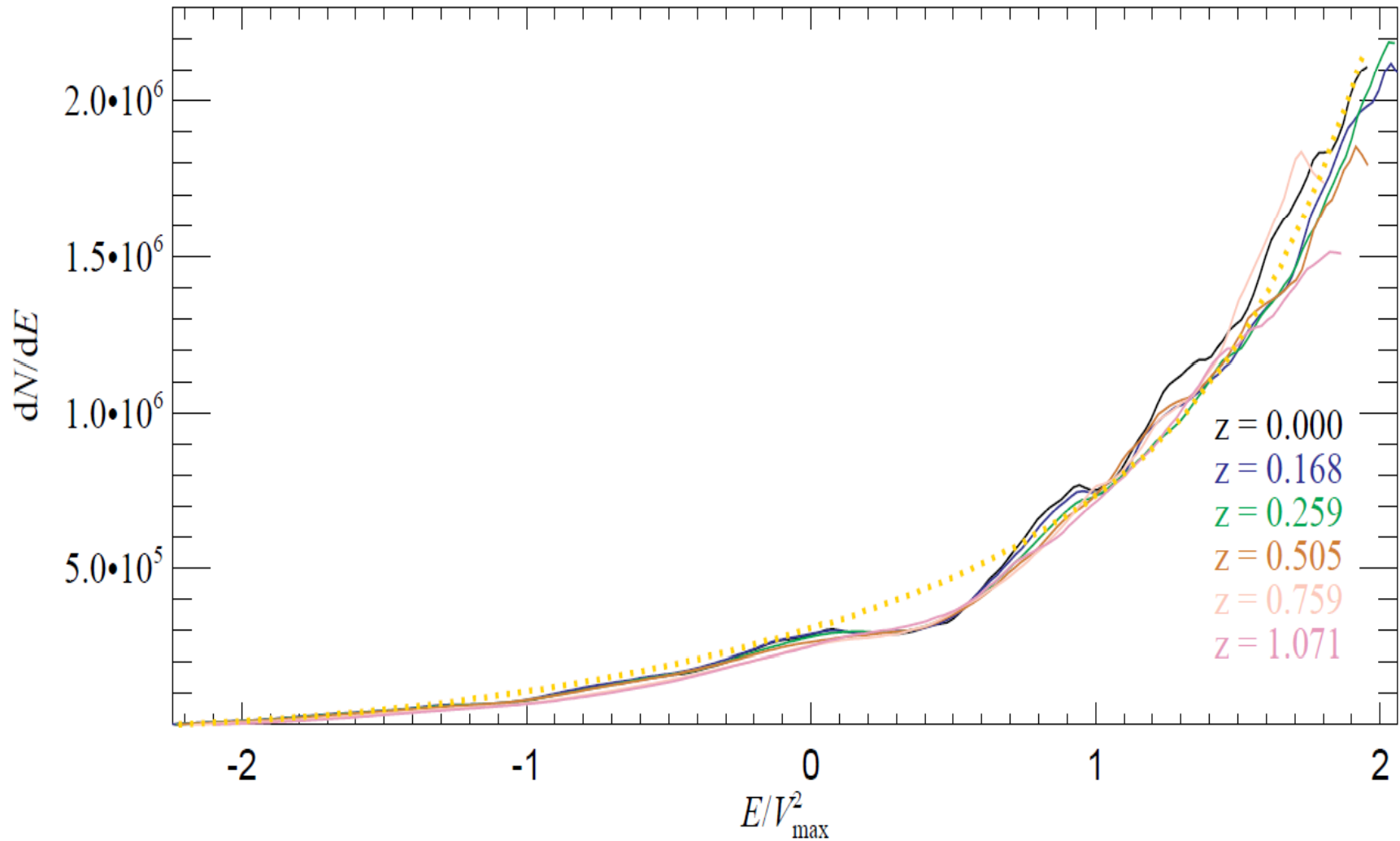
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Energy profile

22

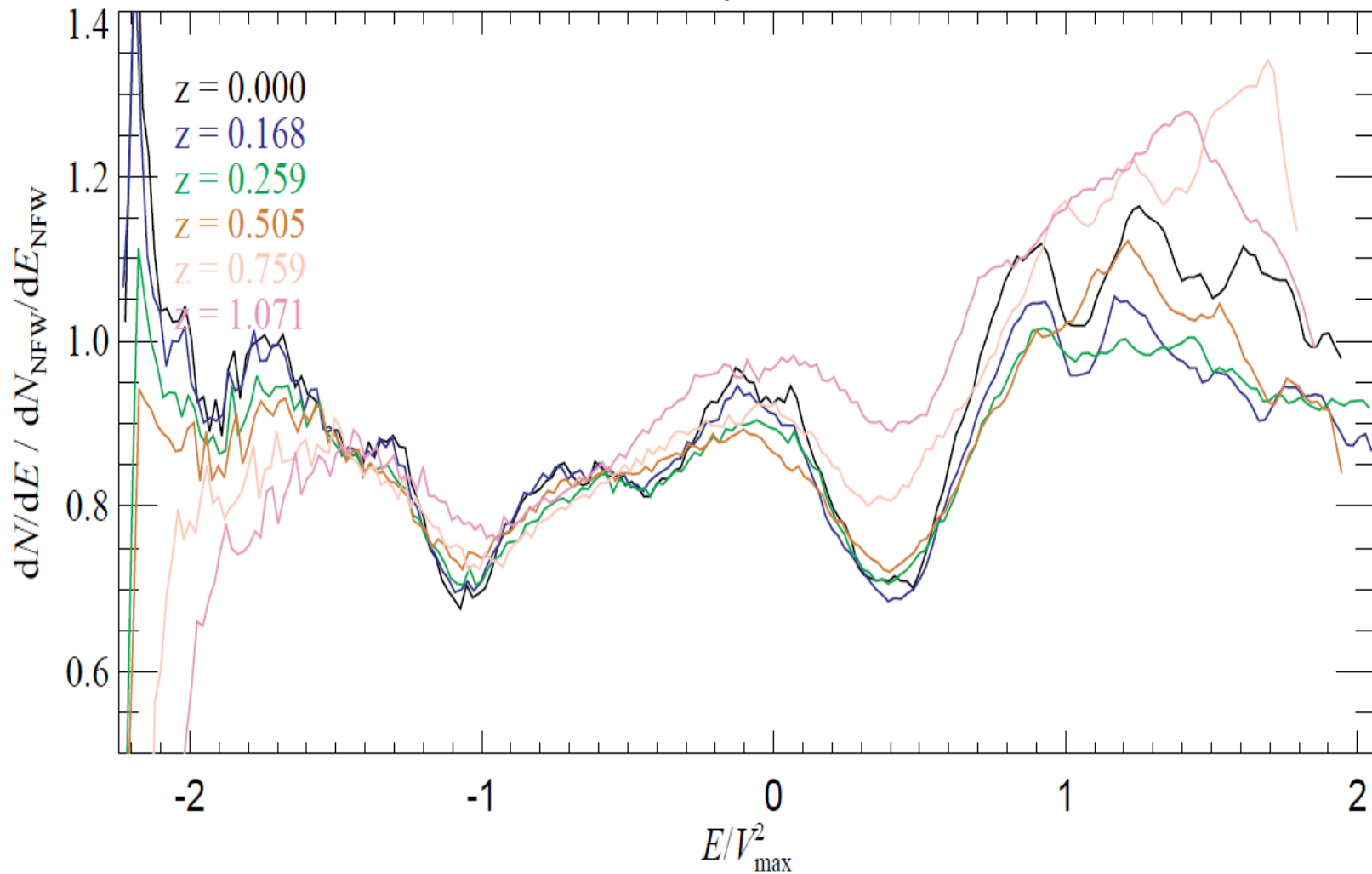
Aq-A-2



Energy profile

23

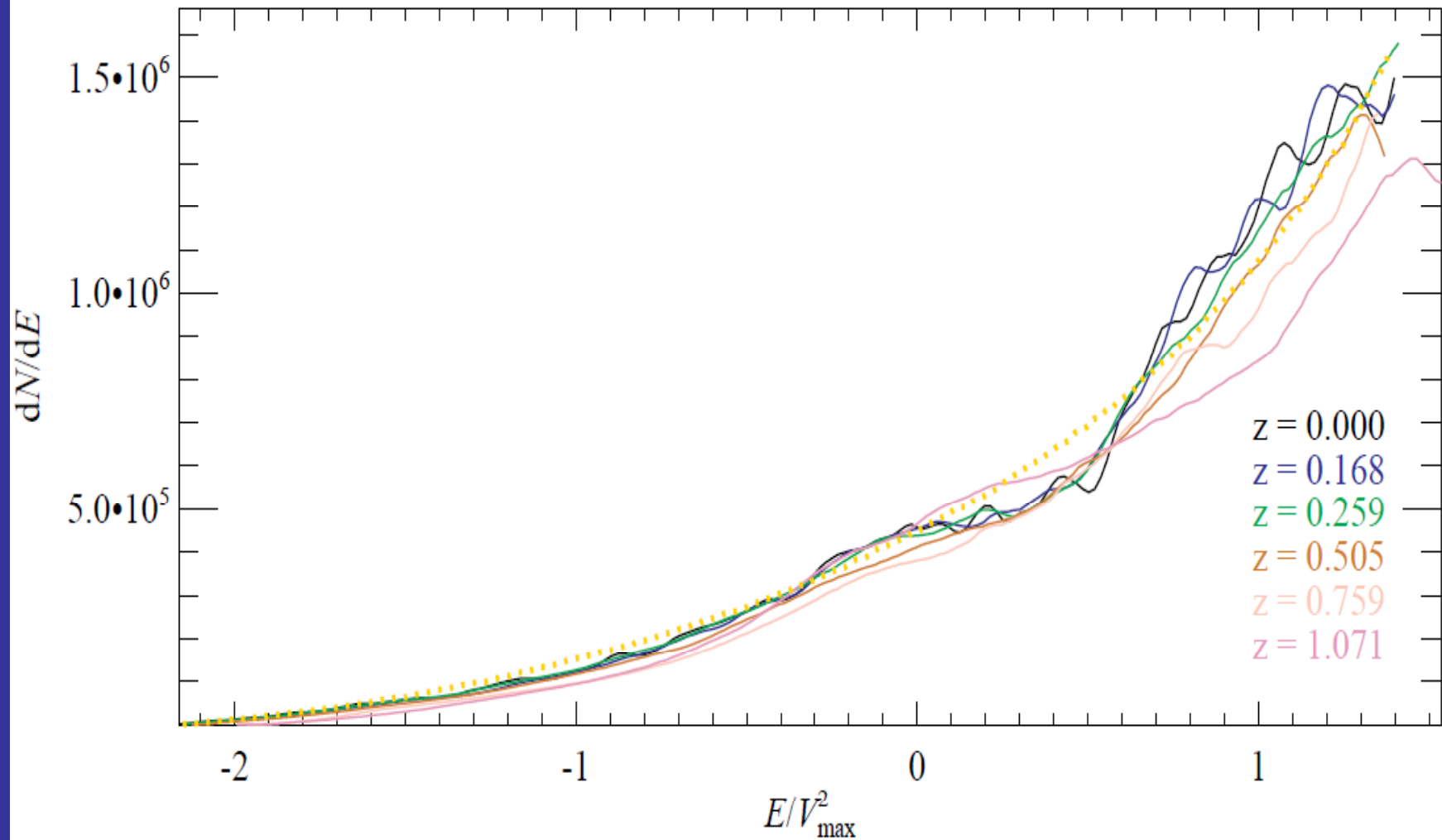
Aq-A-2



Energy profile

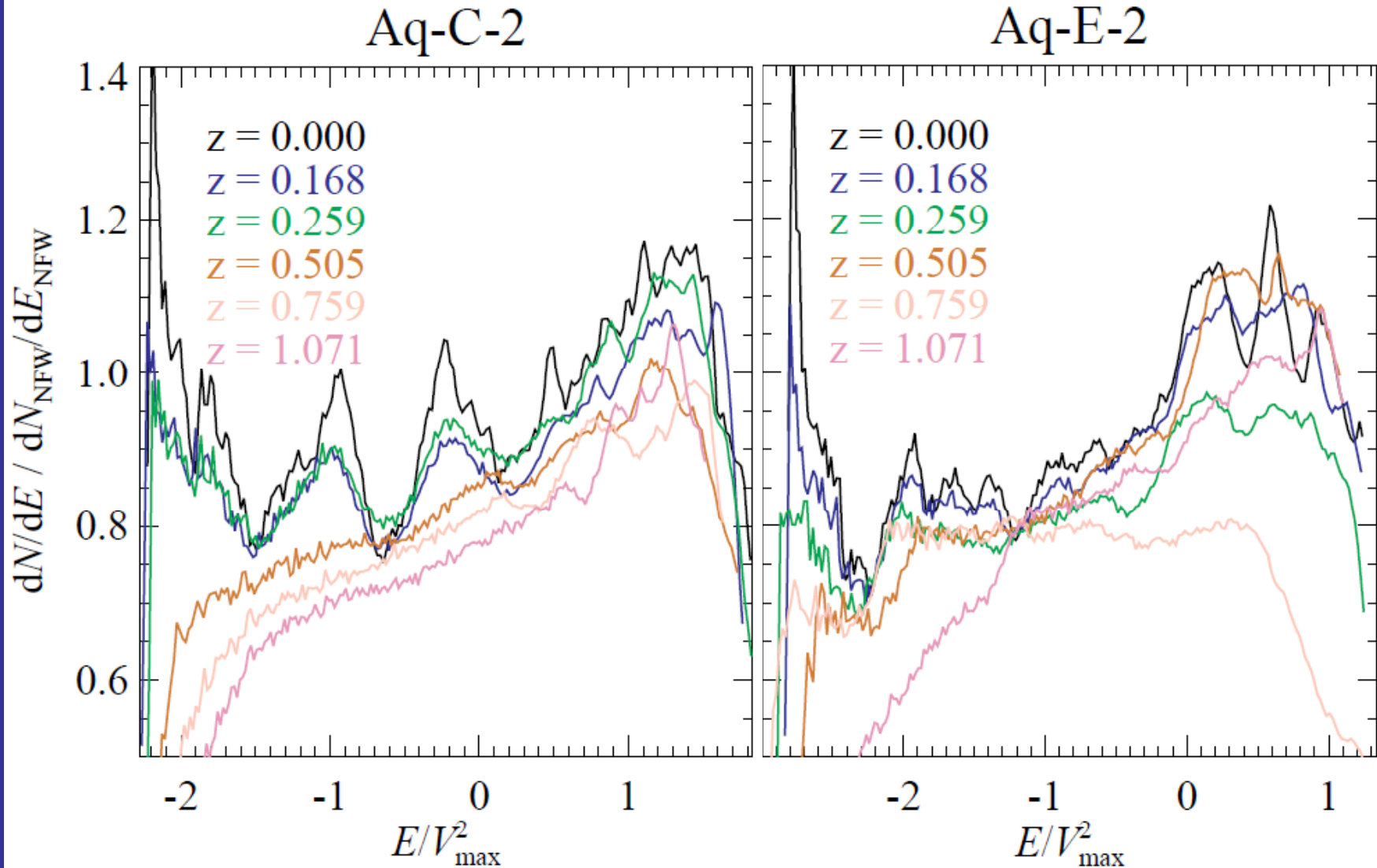
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Aq-B-2



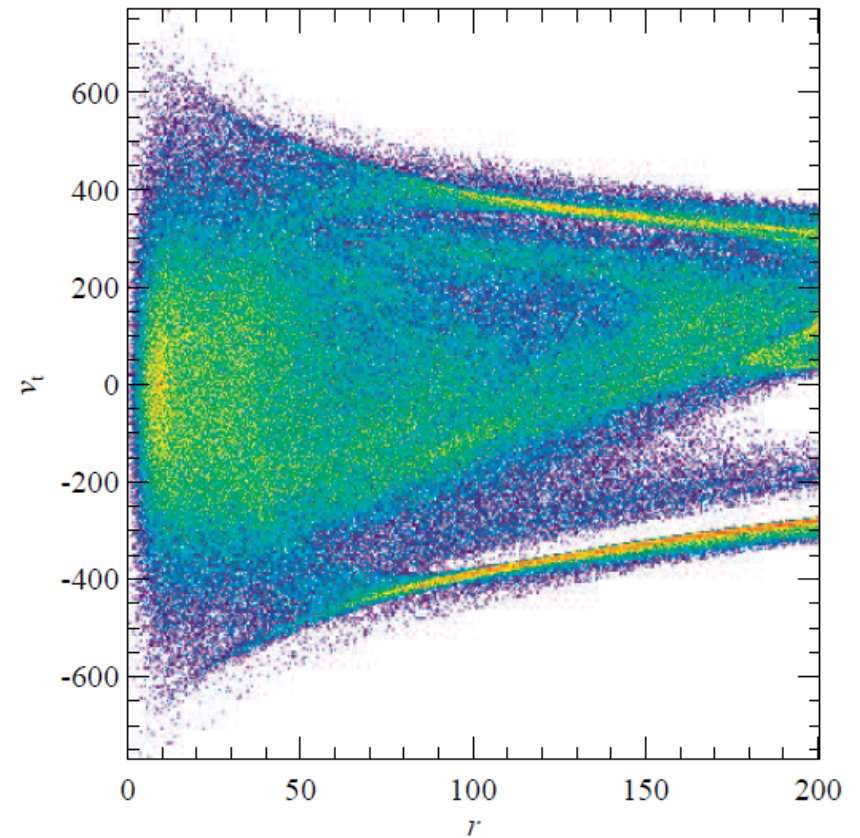
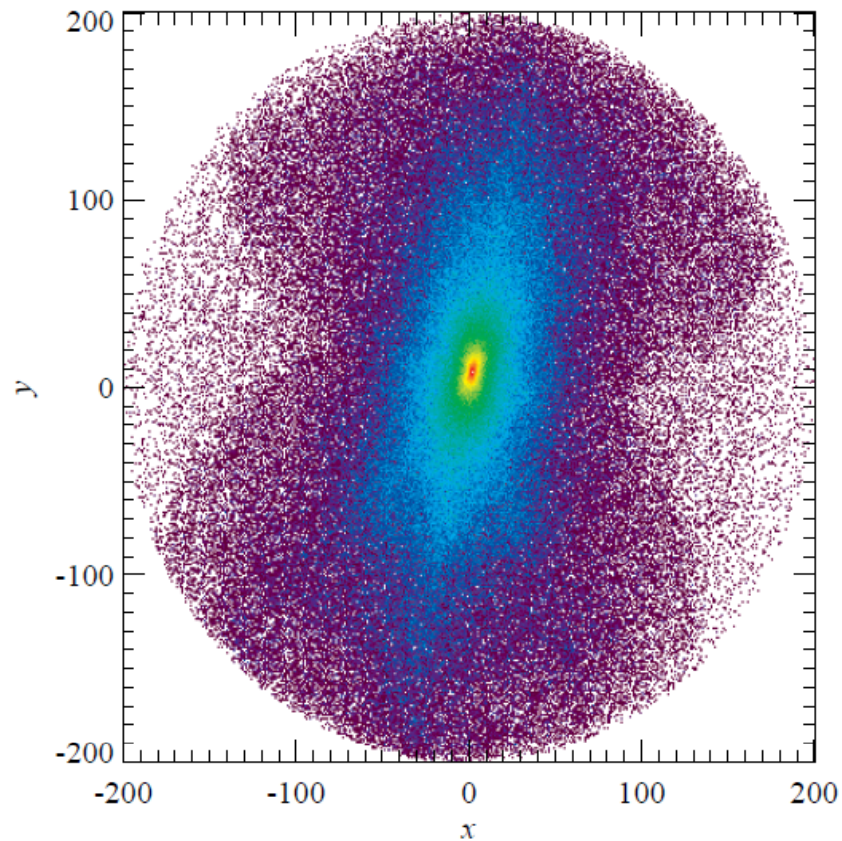
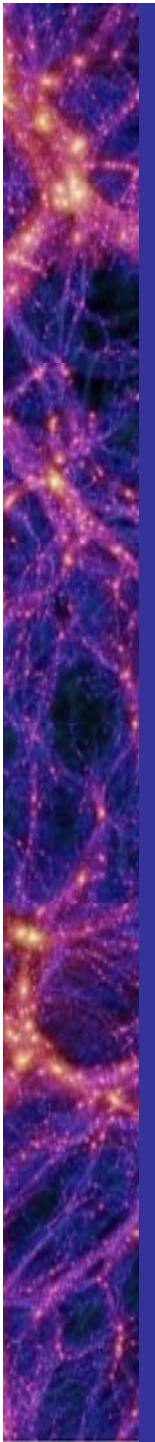
Energy profile

25



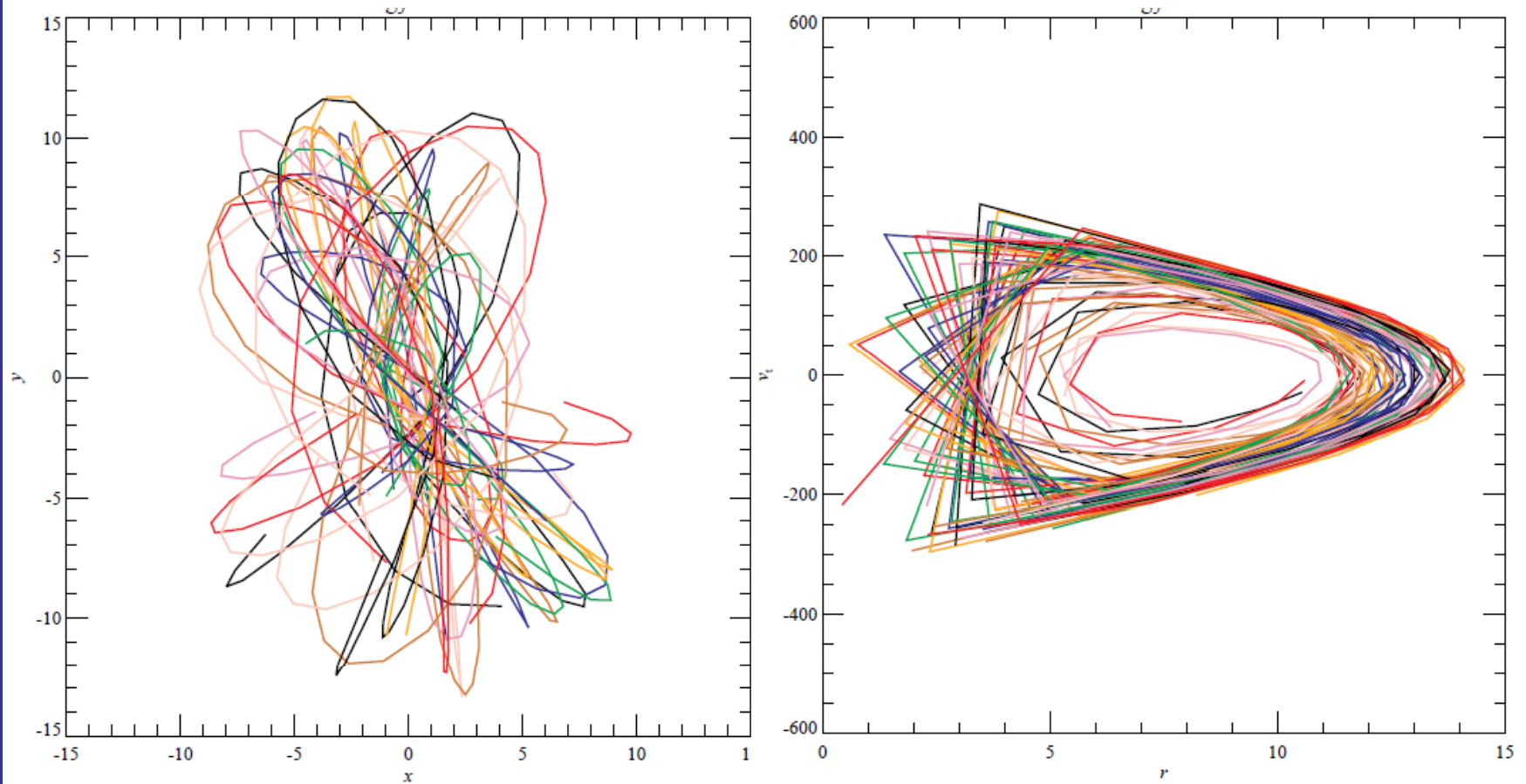
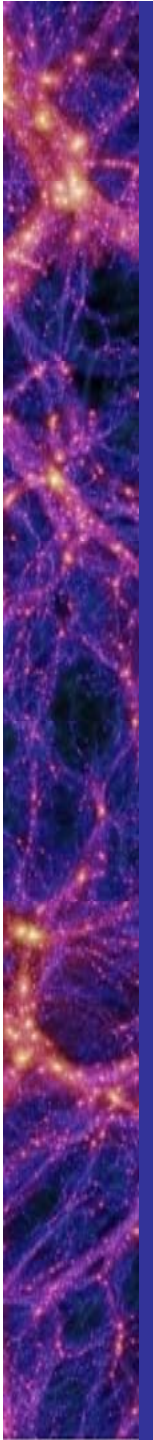
Energy profile

26



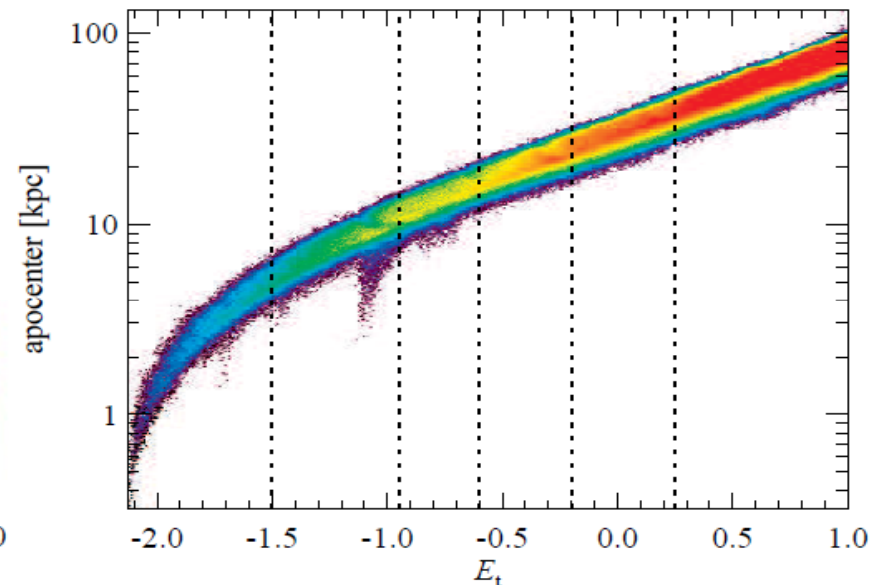
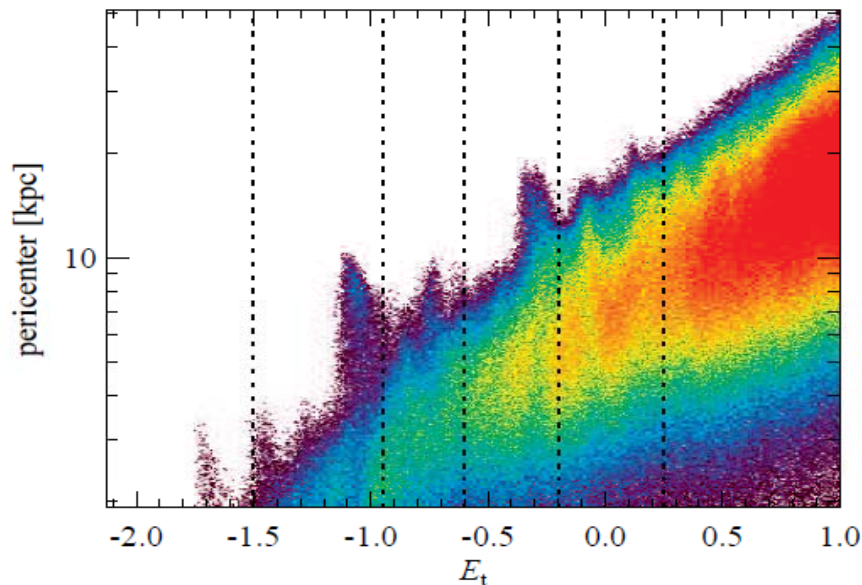
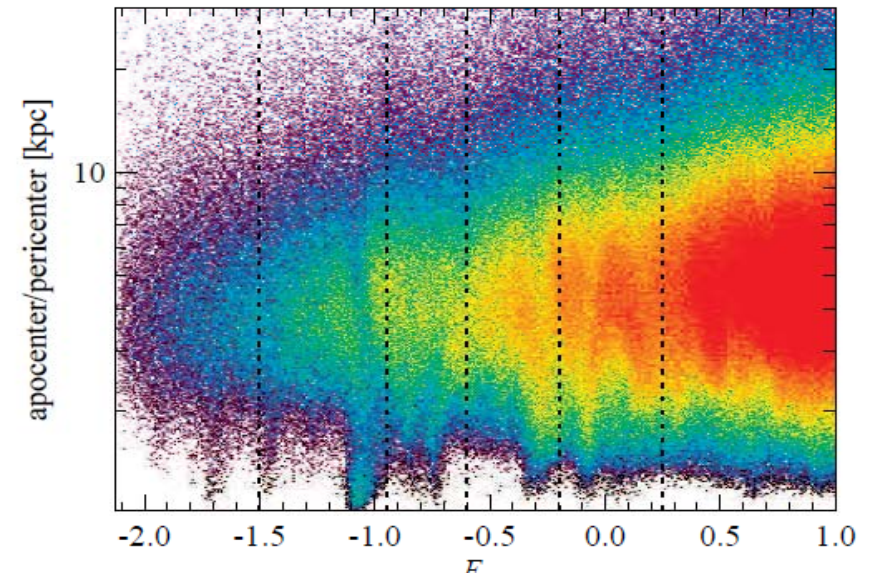
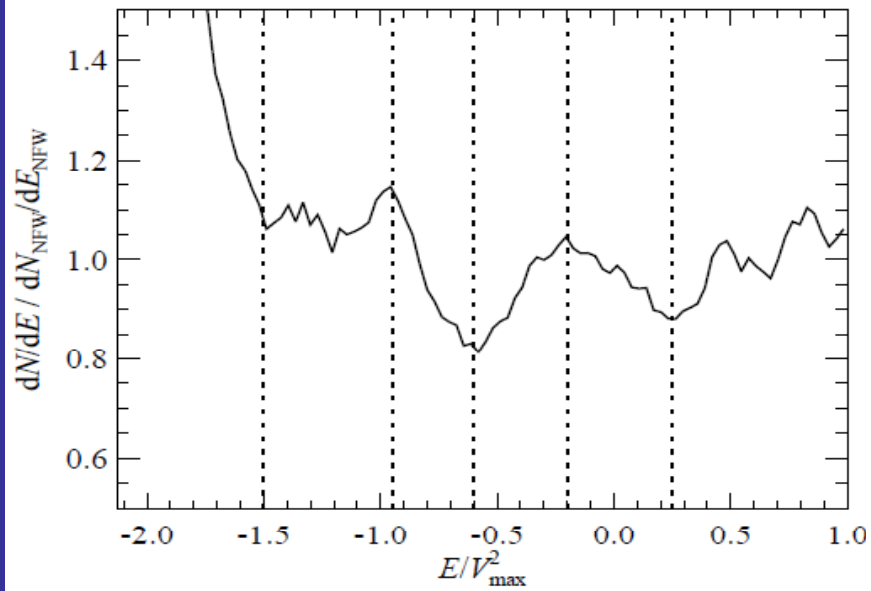
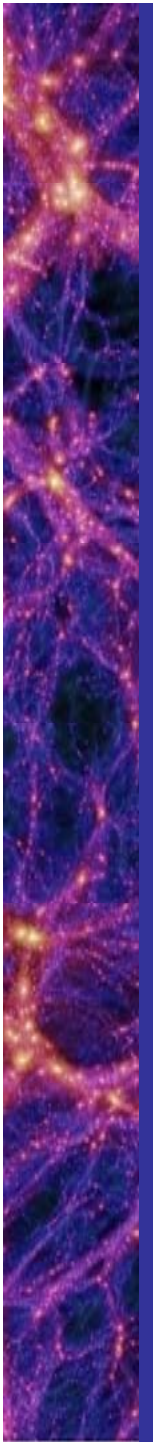
Energy profile

27

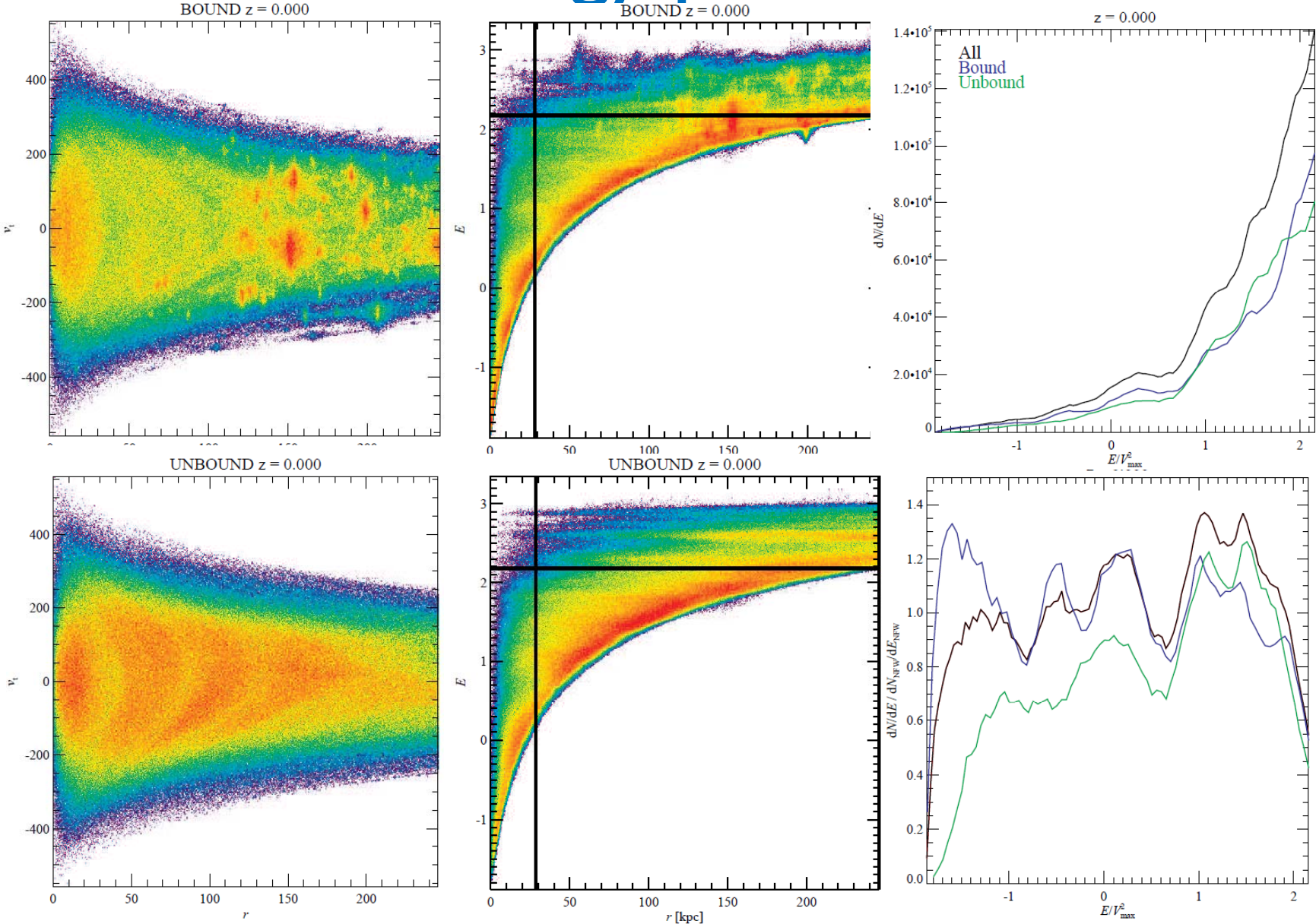


Energy profile

28



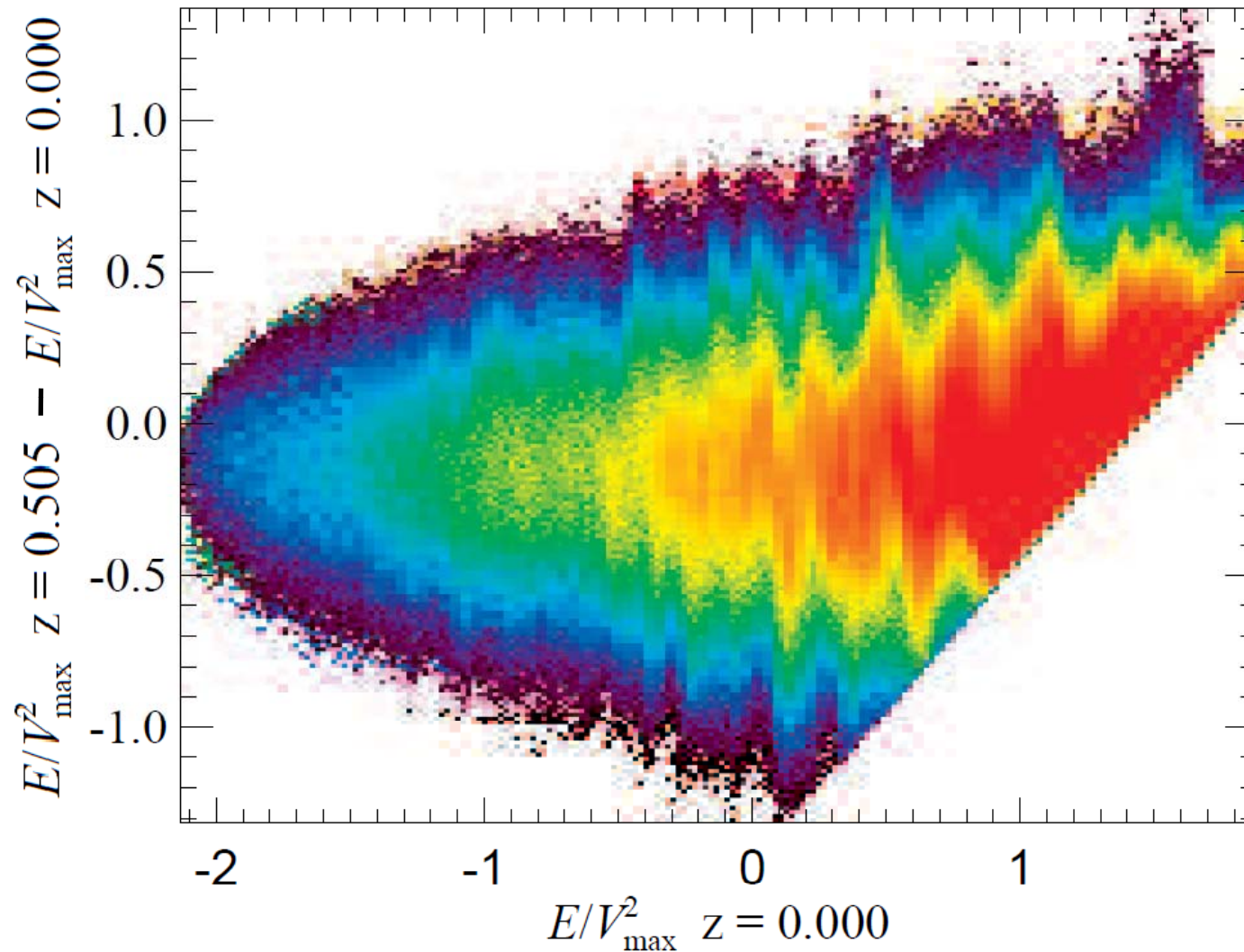
Energy profile



Energy profile

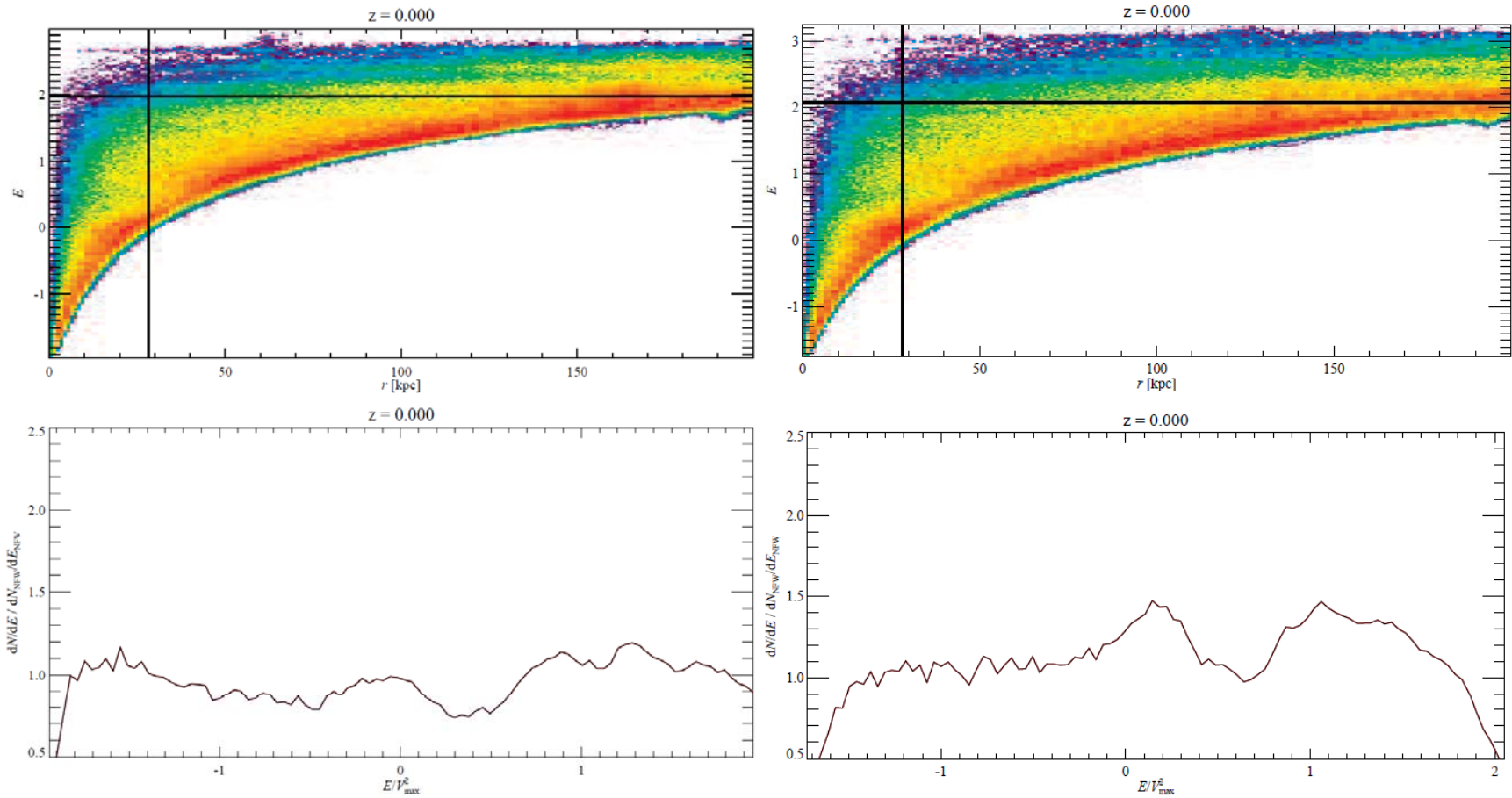
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Aq-C-4



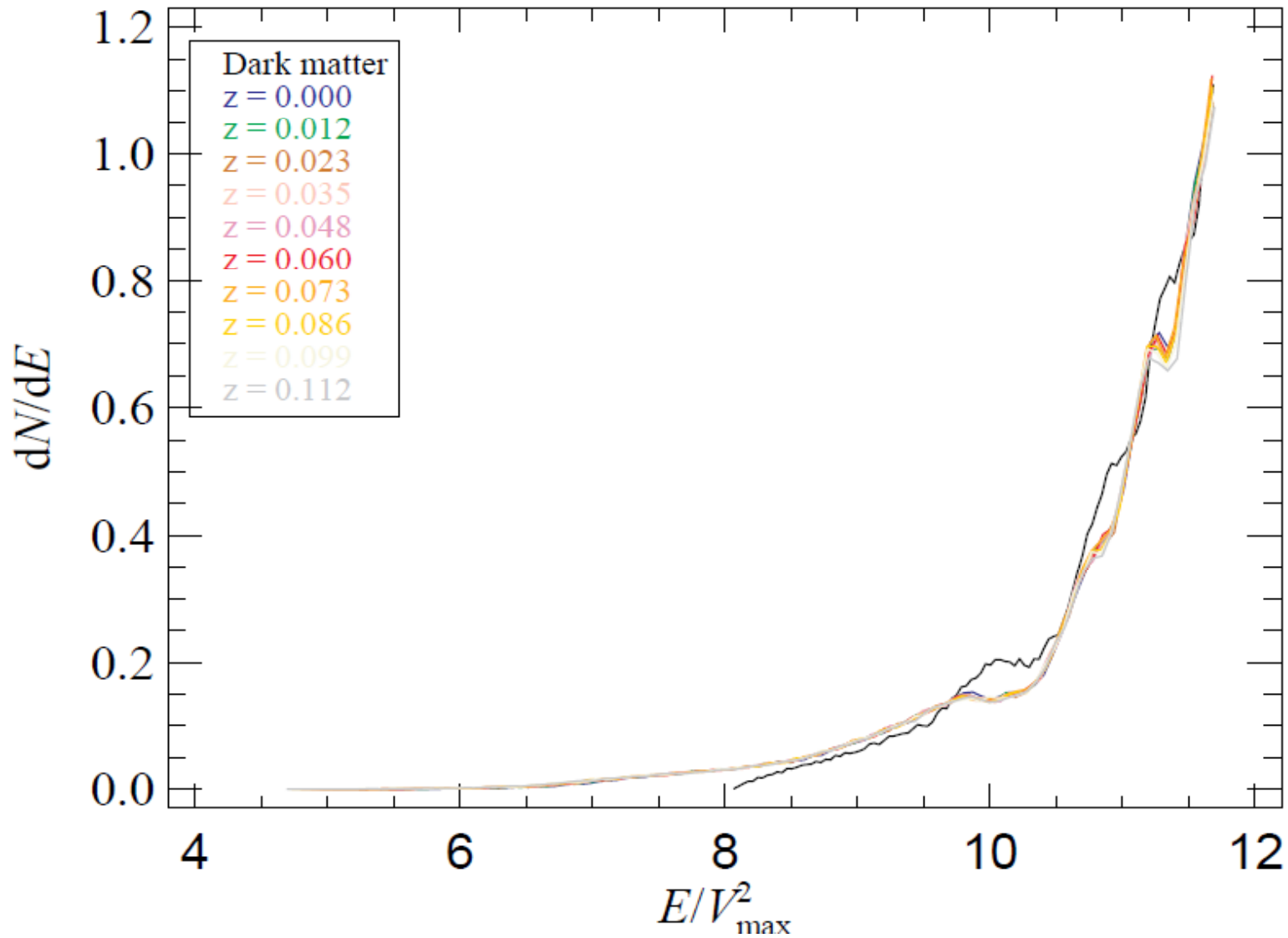
Energy profile

31



Energy profile

32

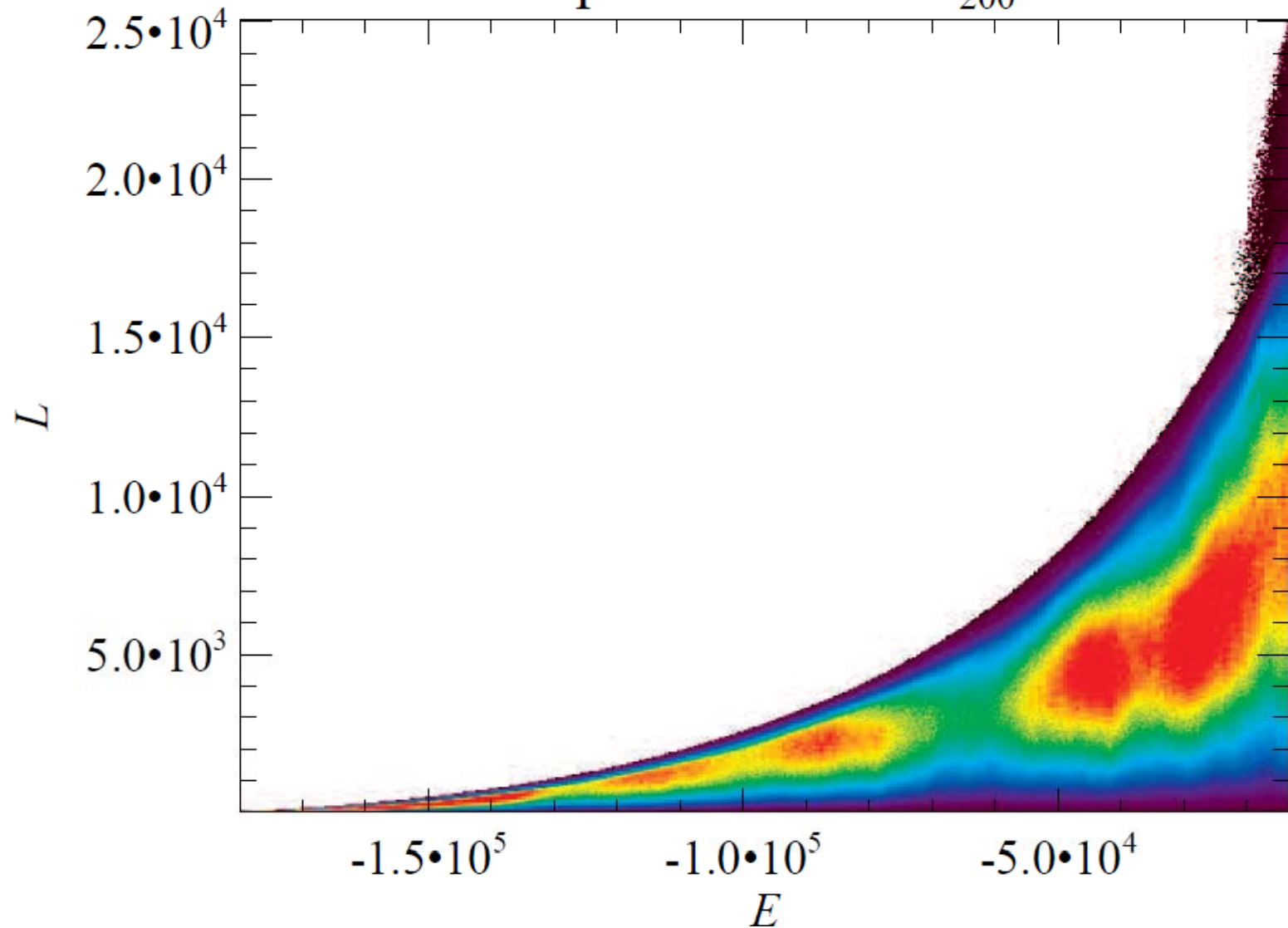


Angular momentum space

Energy profile

34

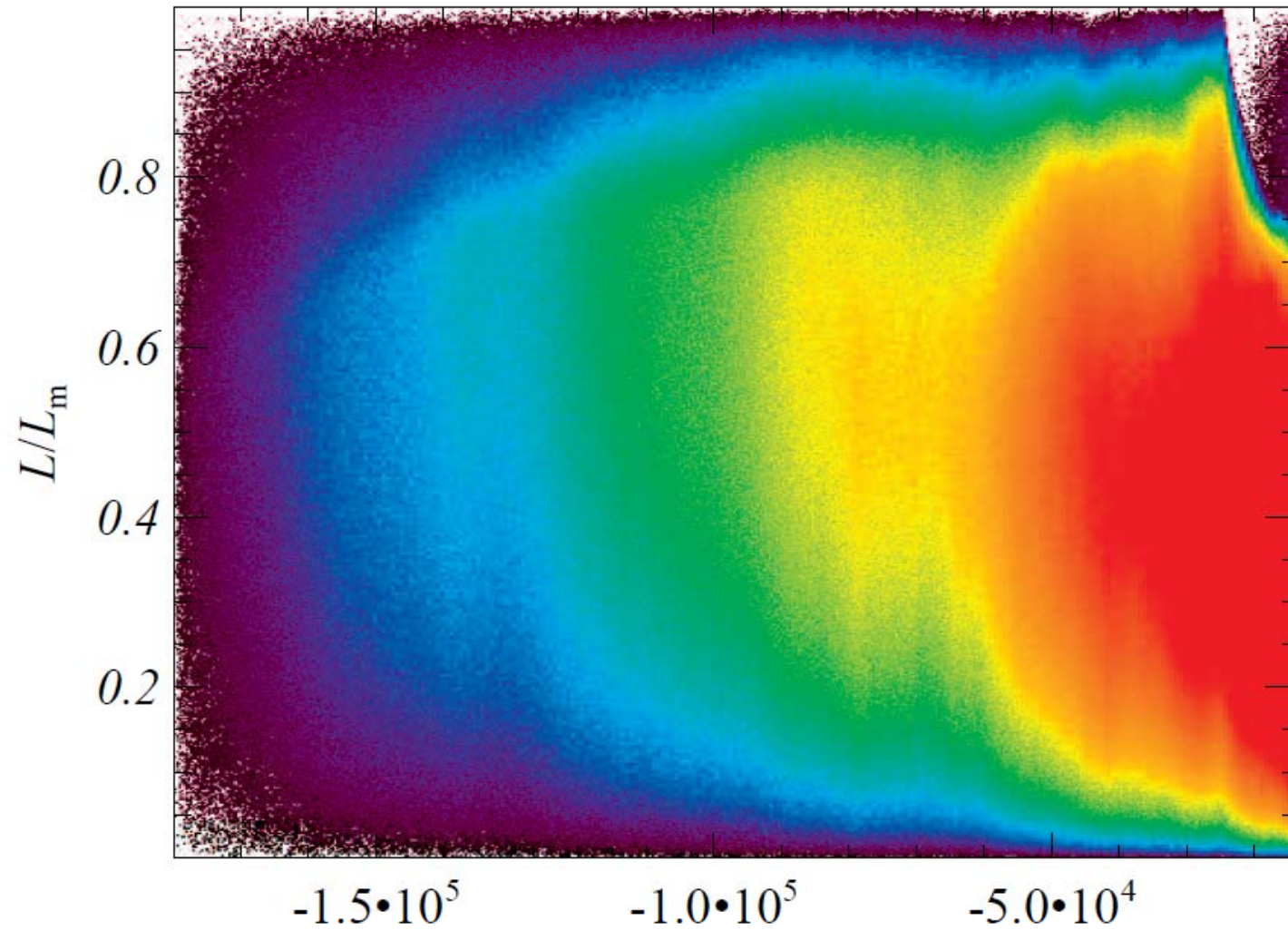
Aq-A-2 $r = 0-0.5r_{200}$



Energy profile

35

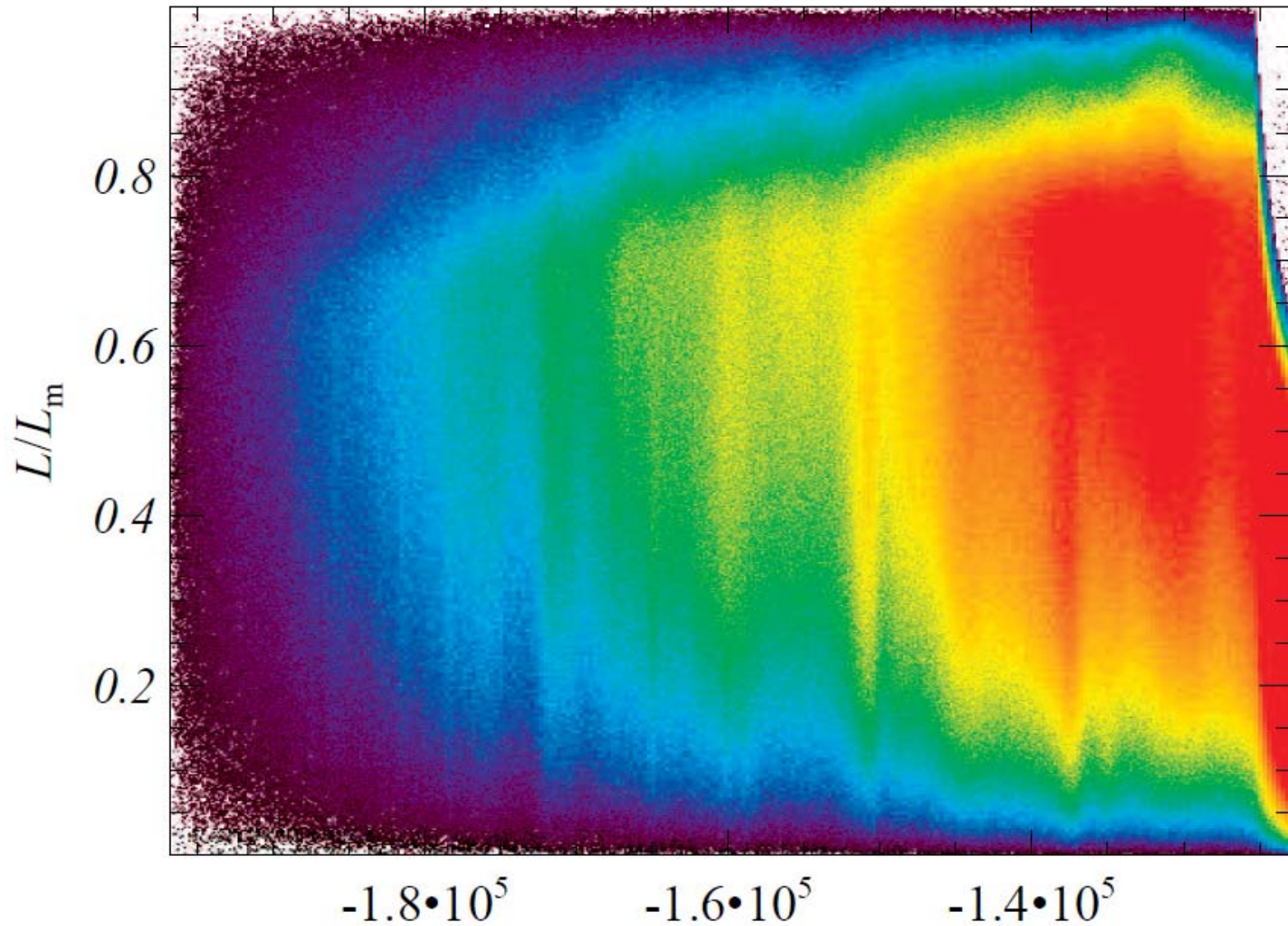
Aq-A-2 $r = 0-0.5r_{200}$



Energy profile

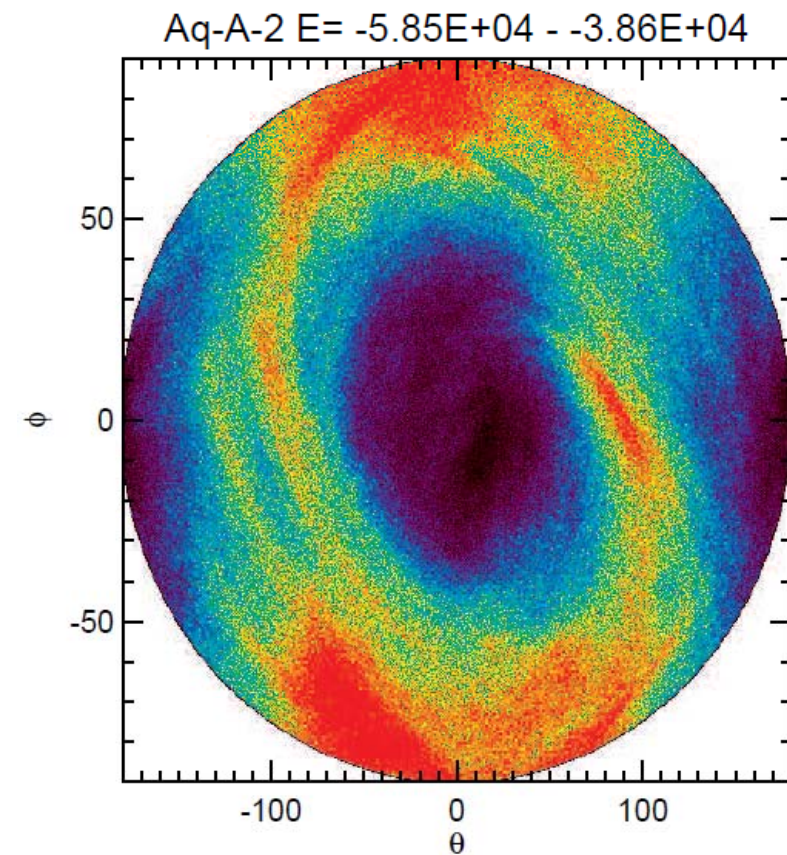
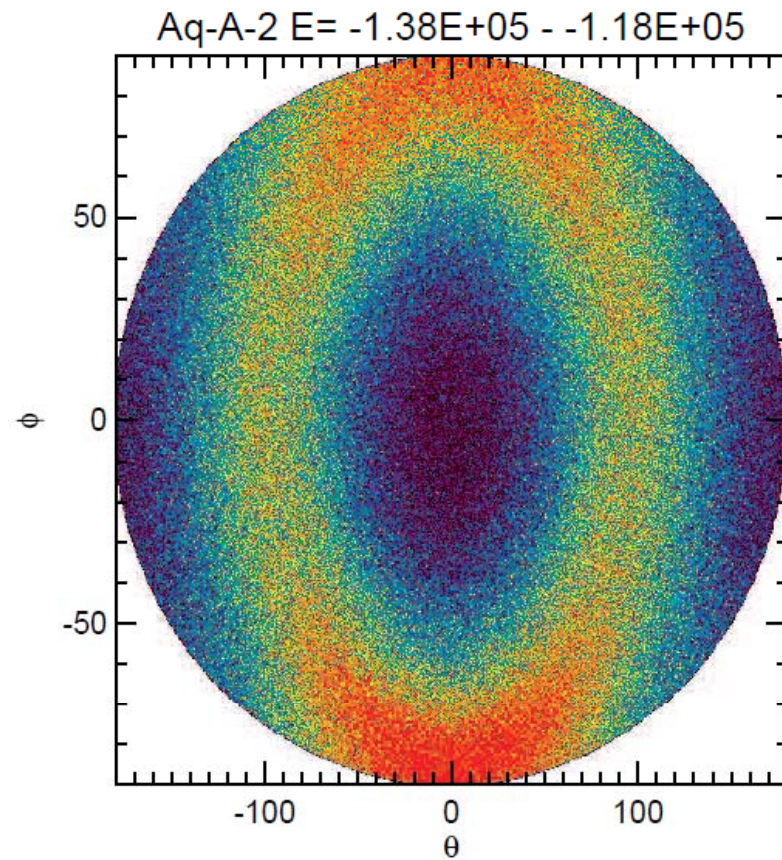
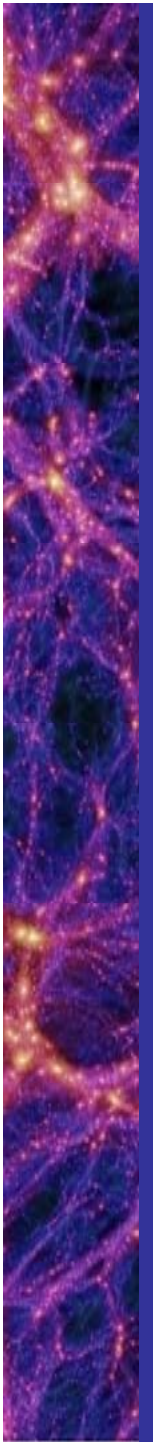
36

Aq-F-2 $r = 0-0.25r_{200}$



Angular momentum

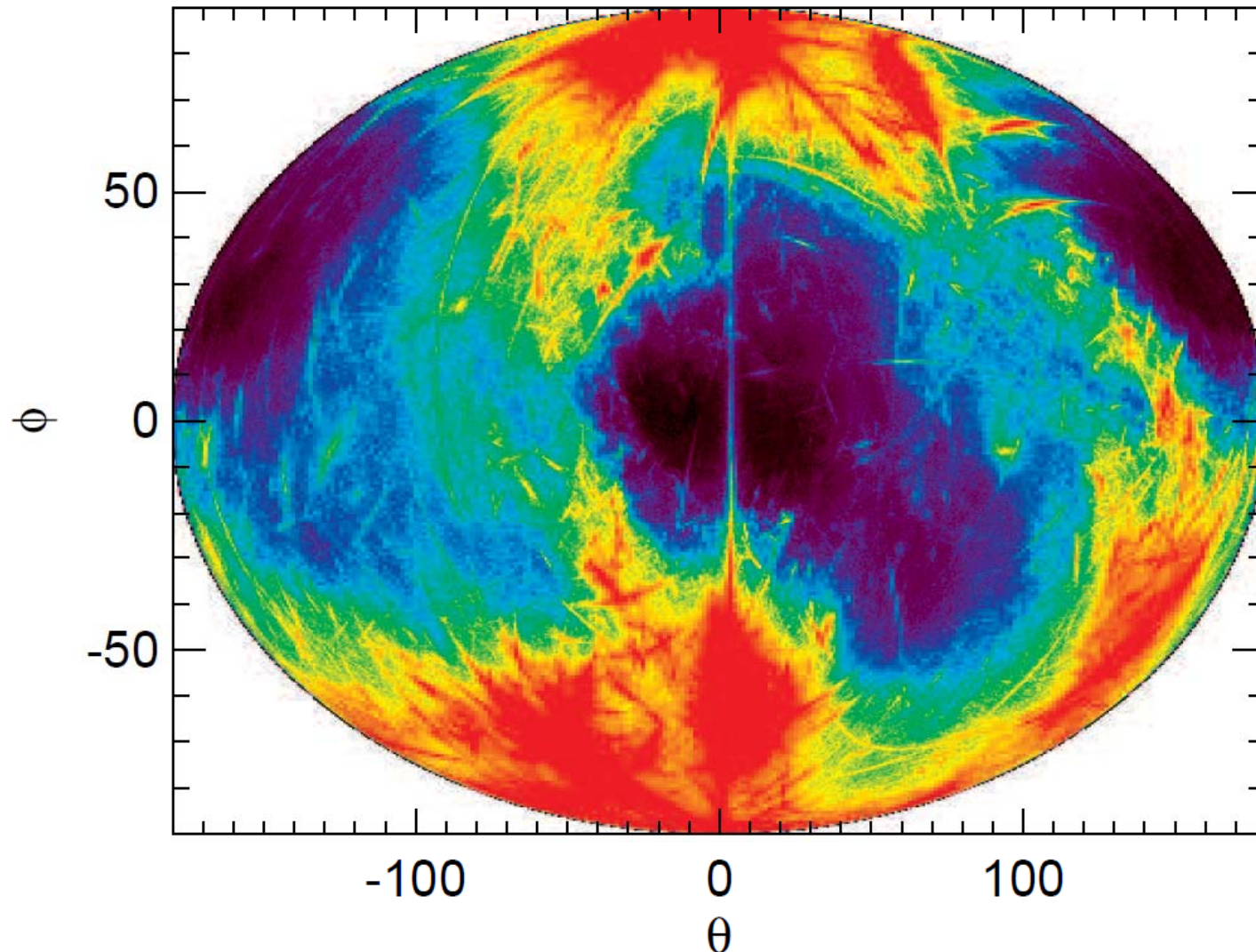
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Energy profile

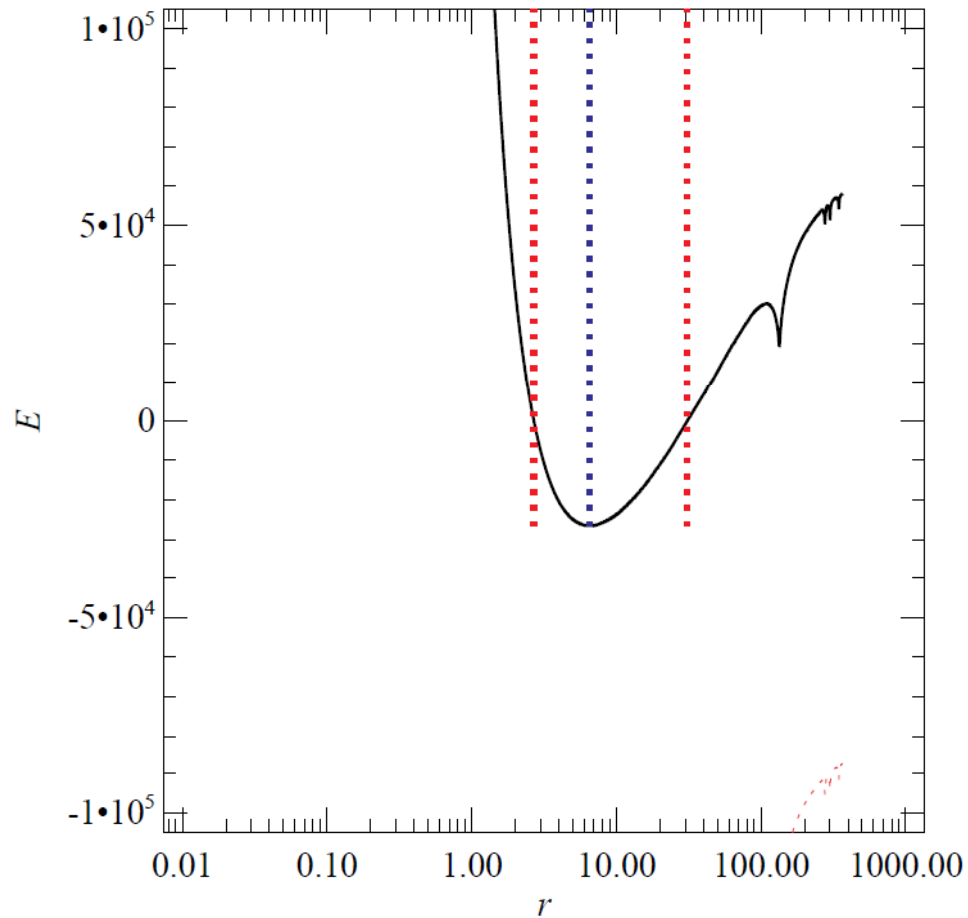
38

Aq-A-2



Orbital phase

39



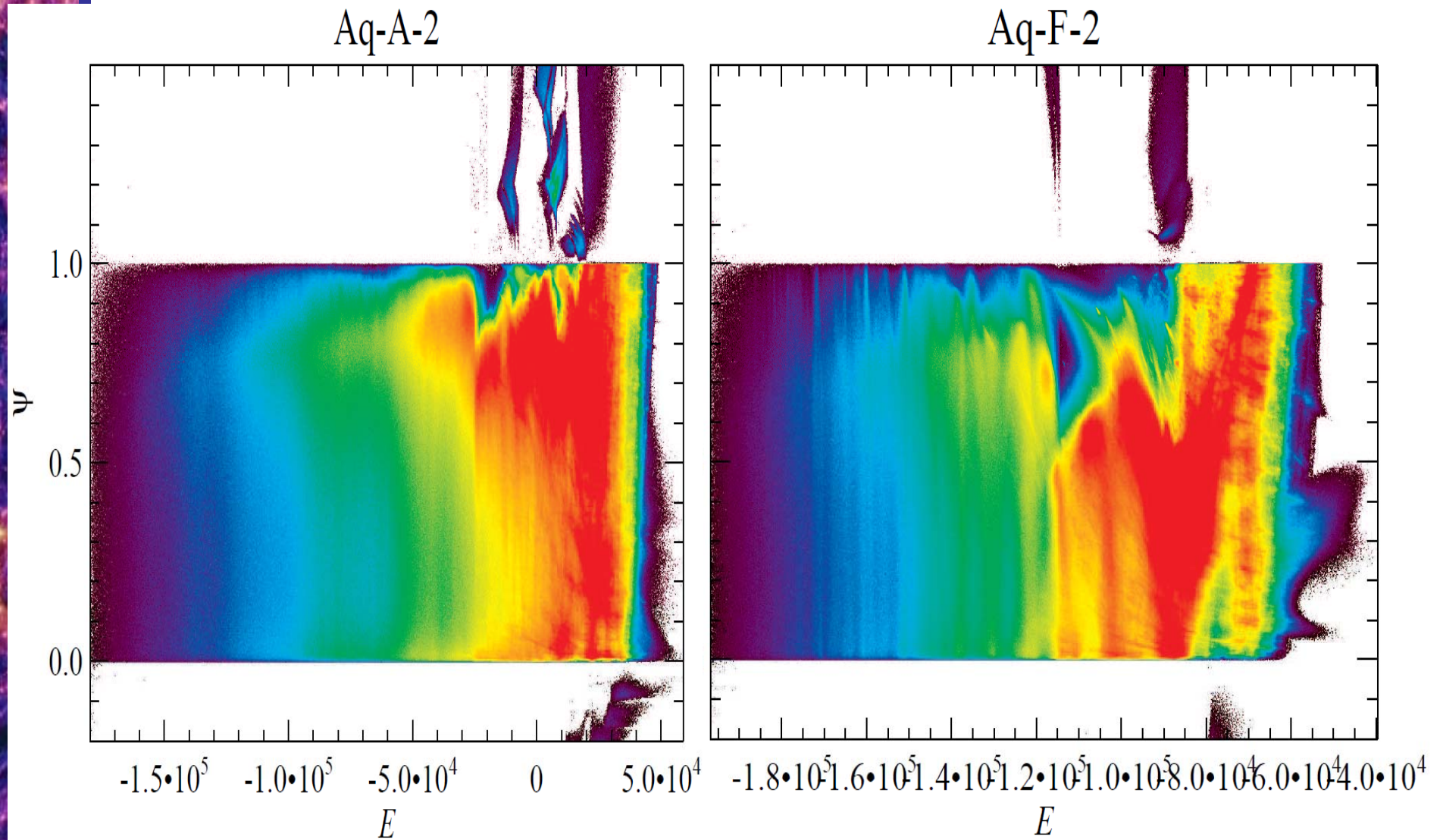
$$L^2/2r^2 + \varphi_{\min}(r) - E_t = 0$$

Orbital phase:

$$\Psi = (r - r_p) / (r_a - r_p)$$

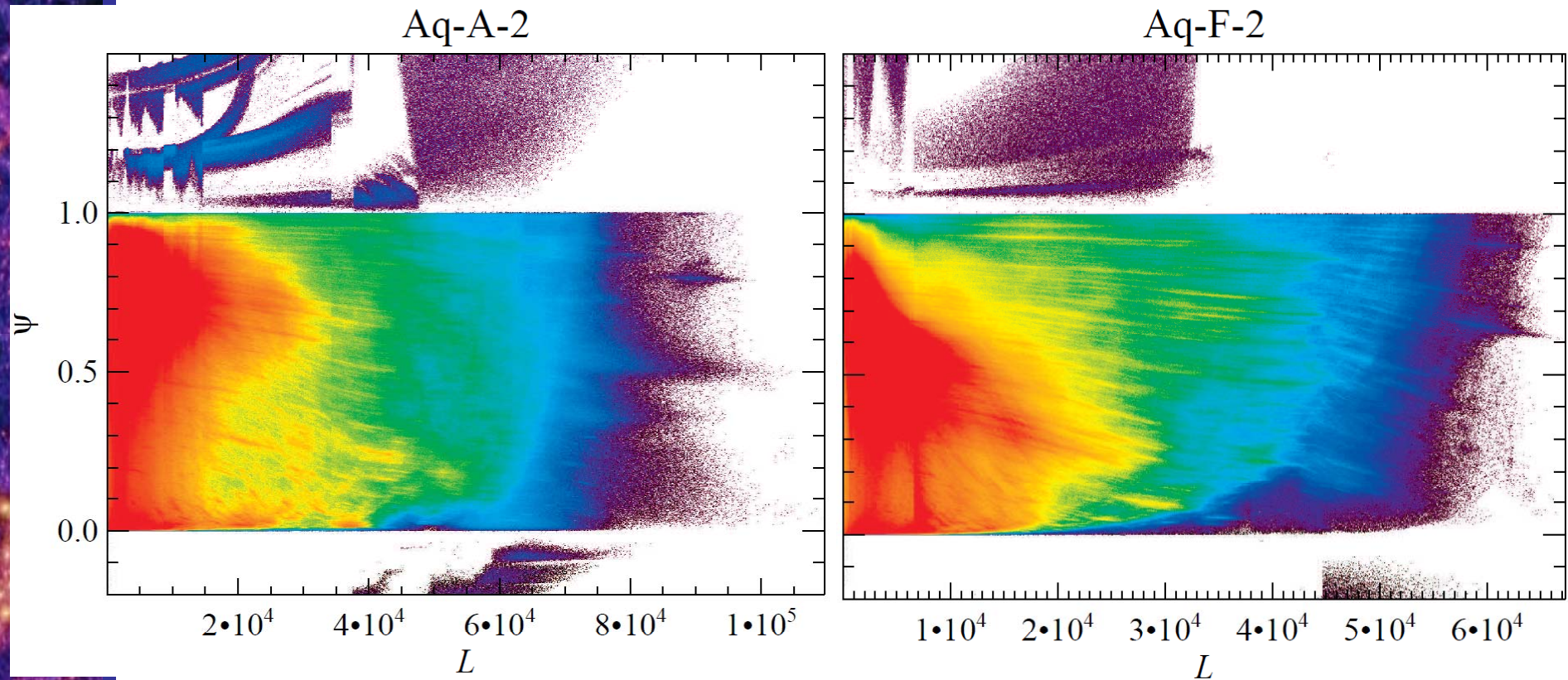
Orbital phase

40



Orbital phase

41



A vibrant, abstract background featuring a complex, interconnected network of glowing purple and blue lines, resembling a cosmic web or a dense neural network. The lines are illuminated with bright yellow and orange points, creating a starry, ethereal effect against a dark, deep blue background.

THANK YOU