The Splashback Radius

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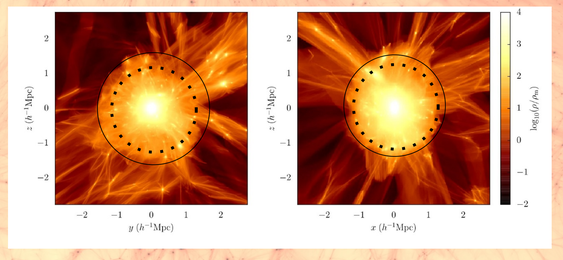
1. Key takeaways

- Do dark matter halos have boundaries? **Yes!**
- Are these boundaries physically interesting? **Yes!**
- Can these halo boundaries be observed? **Yes!**

2. Visual impression

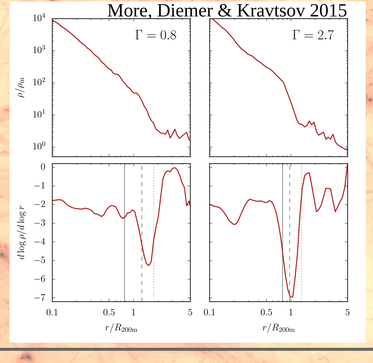
More, Diemer & Kravtsov 2015



- These galaxy cluster-sized halos have equal masses.
- Which of these lines would you assign as the physical boundary of dark matter halos? Poll by ticking below:
  - Solid:
  - Dotted:

3. Sharp drop in density: a physical feature

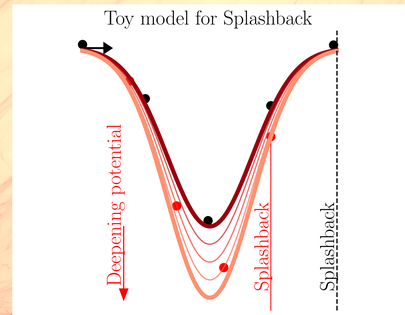
More, Diemer & Kravtsov 2015



- The density profiles (upper panels) of the halos above show sharp density drops at their outskirts.
- The solid circles in the poll above capture the steepest slope of the density profile (lower panel).

4. Splashback radius: the physical edge

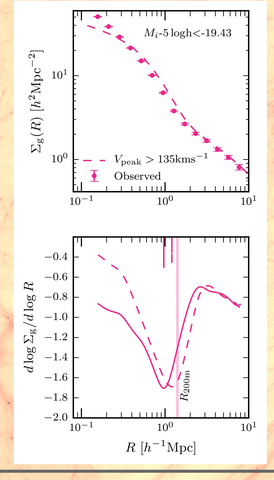
- Splashback radius is related to the orbits of dark matter particles within halos.
- The observed density drops are a result of the pile up of dark matter particles due to small radial velocities near the apocenter.
- If the potential deepens during the particle orbit due to mass accretion on to the halo, particles do not reach as far out.
- Larger the accretion rate, smaller the splashback radius
- **Quiz time: Which halo in Fig 1 has a larger accretion rate?**



5. Splashback radius in observations

More et al. 2016

- We obtained the surface density profiles of galaxies around massive clusters identified from the Sloan Digital Sky Survey
- The surface density profiles also show sharp steepening (solid line) corresponding to the splashback radius of these clusters
- Subhalo density profiles around simulated clusters of similar mass (dashed line) show that the observed splashback radius is smaller by about 20 percent.
- Could it be due to some systematics in optical cluster finding or due to dark matter self-interactions?



Summary

- Splashback radius is a physical boundary for dark matter halos, which depends upon the mass and the mass accretion rate history of the halo.
- We have detected the splashback radius of massive galaxy clusters from SDSS, a preliminary comparison shows that it is smaller than expected from cosmological simulations, a systematic study is currently underway.

References

Pseudoevolution of halo mass, Diemer, More & Kravtsov 2013, ApJ, 766, 25;

The outer density profiles of dark matter halos, Diemer & Kravtsov, 2014, ApJ, 789, 1;

Splashback radius as the physical halo boundary and the growth of halo mass, More, Diemer & Kravtsov, 2015, ApJ, 810, 1;

Detection of the Splashback radius and halo assembly bias of massive clusters, More et al. 2016, ApJ, 825, 39;