A new subhalo finder: Hierarchical Bound-Tracing (HBT)

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Halos and subhalos



The Tracing Approach

- The complete halo catalog gives the complete source subhalo catalog
 - Every satellite subhalo originates from an infalling halo (hierarchical universe)
- Simply traverse the halo merger trees once from the earliest to latest time
- And strip unbound particles for every halo at every later time **Complete Subhalo Catalog**





Muldrew, Pearce & Power, 2011 Knebe et.al, 2011

Difficulties in Tracing

- Technical
 - Quality of recorded progenitors will affect quality of descendent
 - Relaxed source subhalo:

allow re-accretion

- Contaminating particles undermine the unbinding process
 - Improved unbinding algorithm
 - Adaptive update of source subhalo
- Physical
 - satellite-satellite merger
 - Hierarchical unbinding
 - Tests for local accretion and time resolution



subhalo tracing

Infall tracing

Adaptive update of candidate subhalos and hierarchical merging

- Candidate subhalo should be large enough to contain the subhalo, but small enough to define the reference frame for unbinding
- 1. In the beginning, the candidate subhalo is the fof halo;
- 2. After infall, the subhalo is stripped, and the candidate halo is updated to the preginitor of mass sqrt(corefrac0) of the source, when the mass of subhalo is dropped to less than a fraction corefrac0 of the candidate mass;
- 3. Merger tree is built

Advantages of HBT subhalos compared with SUBFIND

- Complete
- Heavier and Larger
- Less Truncated
- More Abundant in halo center
- Physical

Results

Scale-invariant mass function

Systematically heavier subhalo mass than SUBFIND



Results

Larger and less truncated



6 times more massive

Results

More Abundant in halo centers





Summary

- HBT
 - Extending halo merger tree to subhalo level by tracing halo remnants
- Features
 - Remains high subhalo **resolution** in halo centers
 - Physically constructed merger tree
 - No need for spatial search, thus faster
 - Public
- Successful tracing --> correct physical understanding