The Post-processing and Disruption of Substructure in Galaxy Clusters

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Context

Numerous studies have suggested that a significant fraction of galaxies in clusters have previously spent time as satellites in a host system, such as a group, and that some may be pre-processed by these systems before reaching the cluster environment. But once they enter the cluster, group galaxies may face the combined environmental effects from group and cluster - so called 'post-processing'. Using a set of high resolution cosmological N-body simulations of galaxy clusters, we investigate the effects of post-processing, and study the breakdown of substructure inside clusters. We track the evolution of satellites and their hosts after entering the cluster.

Membership criterion

We use a similar criterion as in Han et al. (2018) to define satellites and host halos in the simulations.

We applied this binding criterion (red line in Fig. 2) at the moment that hosts fall into the cluster (crossing 1Rvir), which means they are defined at a variety of redshifts.

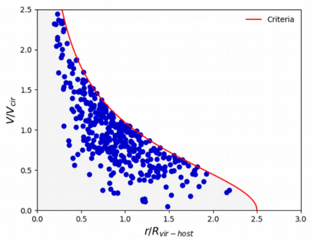

Fig. 2: Phase-space diagram for satellites in the host-centric frame at the cluster infall time.

Motivation

Understanding how groups break-up in clusters could potentially help us identify the pre-processed galaxies, once they have left their groups and mixed in with the cluster population.

Disruption process

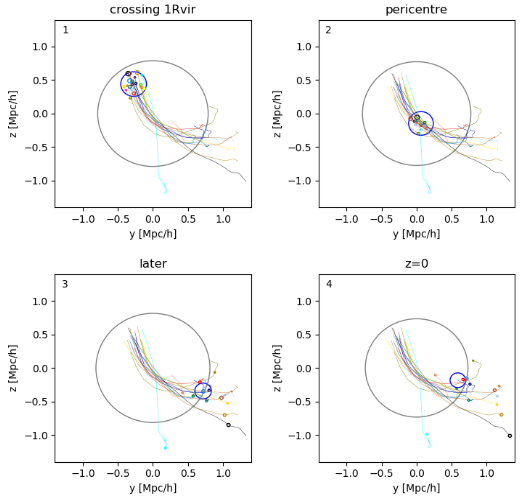

Fig. 1: Dissociation of a host halo when it passes the cluster pericentre for the first time, shown as a time sequence.

Outcome of satellites at z=0

We track the evolution of the hosts and their satellites once they enter the cluster until z=0 and by using the binding criterion. By doing this we identify these possible outcomes:

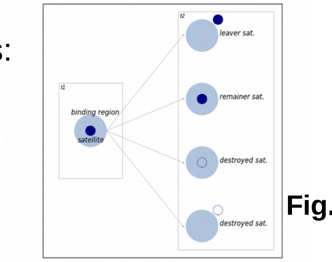

Fig. 3: Schematic Figure.

Results

- The few satellites that remain bound to their hosts after a pericentre passage are found typically close to their host centres.

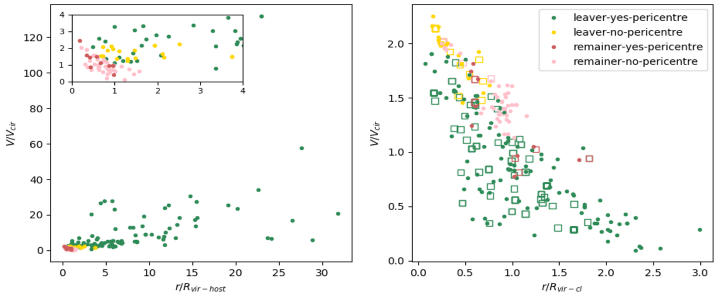

Fig. 6: Left panel: Phase-space diagram for satellites in the host-centric frame at z=0. Sub-figure shows a zoomed in region of the same plot. Right panel: Phase-space diagram for satellites (filled dots) and hosts (squares) in the cluster-centric frame at z=0.

- ~90% of satellites whose host has passed pericentre will leave their host by z=0, and this typically no later than half a Gyr after pericentre passage.

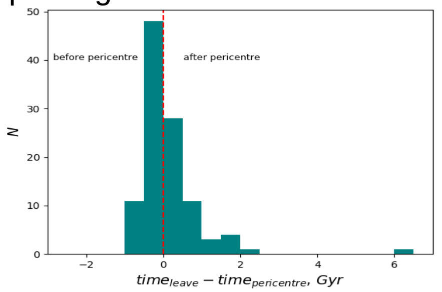

Fig. 5: Distribution of the amount of time that a satellite become unbound respect to the first pericentric passage of its host.

- Satellites leave with high velocities, and quickly separate to large distances from their hosts, making their identification within the cluster population challenging.

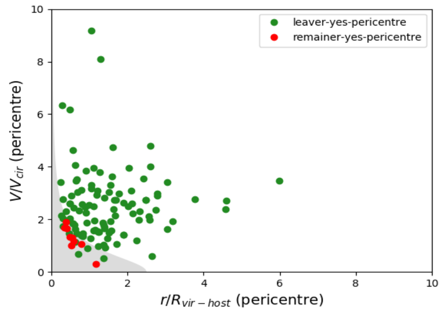

Fig. 4: Phase-space diagram for satellites in the host-centric frame at the (first) pericentre time. Green points correspond to the leaver satellites, while red points are remainer satellites.