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The universal distribution of halo interlopers in projected phase space. Bias in galaxy cluster concentration and velocity anisotropy?

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When clusters of galaxies are viewed in projection, one cannot avoid picking up foreground/background interlopers, that lie within the virial cone (VC), but outside the virial sphere. Structural and kinematic deprojection equations are not known for an expanding Universe, where the Hubble flow (HF) stretches the line-of-sight distribution of velocities. We analyze 93 mock relaxed clusters, built from a cosmological simulation. The stacked mock cluster is well fit by an m=5 Einasto DM density profile, with velocity anisotropy (VA) close to the Mamon-Lokas model with anisotropy radius equal to that of density slope -2. The surface density of interlopers is nearly flat out to the virial radius, while their velocity distribution shows a dominant gaussian cluster-outskirts component and a flat field component. This distribution of interlopers in PPS is nearly universal in mass. A local kappa=2.7 sigma velocity cut returns the line-of-sight velocity dispersion profile (LOSVDP) expected from the NFW density and VA profiles measured in 3D. The HF causes a shallower outer LOSVDP that cannot be well matched by the Einasto model for any value of kappa. After this velocity cut, which removes 1 interloper out of 6, interlopers still account for 23% of DM particles within the VC (close to the observed fraction of cluster galaxies lying off the Red Sequence). The best-fit projected NFW or Einasto model underestimates the 3D concentration by 5% (15%) after (before) the velocity cut, unless a constant background is included in the fit. Assuming the correct mass profile, the VA profile is well recovered from the measured LOSVDP, with a slight bias towards more radial orbits in the outer regions. An appendix provides an analytical approximation to the surface density, projected mass and tangential shear profiles of the Einasto model.

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