Forming spheroids in single minor mergers

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Abstract

Understanding how rotationally-supported discs transform into slowly-rotating, dispersion-dominated spheroids is central to our comprehension of galaxy evolution. Morphological transformation is largely driven by mergers. While major mergers are particularly efficient at transforming discs into spheroids, recent work has highlighted the significant role of other processes, like minor mergers, in driving morphological change. Given their rich merger histories, spheroids typically exhibit large 'ex-situ' stellar mass fractions, i.e. mass accreted from external objects rather than having been formed in-situ. This is particularly true for the most massive galaxies (M> 10^{11}M_sun), whose stellar masses typically cannot be attained without significant merging. Here, we explore an unusual population of massive (M> 10^{11}M_sun) spheroids, in the Horizon-AGN cosmological simulation, which exhibit very low 'ex-situ' mass fractions. These spheroids form via a single minor-merger event, where the merger mass ratios are typically in the range 0.11 - 0.33, with a specific orbital configuration, where the satellite orbit is almost co-planar with the disc of the massive galaxy. The merger triggers a catastrophic change in morphology (over only one or two dynamical timescales) and induces a prolonged period of in-situ star formation that produces a massive spheroidal galaxy. Our study demonstrates that it is possible for the assembly histories of some of the most massive spheroids to not involve any major mergers, or indeed any significant merging, contrary to what is often assumed.

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