Galaxy evolution in groups and clusters: star formation rates, red sequence fractions, and the persistent bimodality

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Using galaxy group/cluster catalogs created from the Sloan Digital Sky Survey Data Release 7, we examine in detail the specific star formation rate (SSFR) distribution of satellite galaxies and its dependence on stellar mass, host halo mass, and halo-centric radius. All galaxies, regardless of central-satellite designation, exhibit a similar bimodal SSFR distribution, with a strong break at SSFR ~ 10^-11 yr^-1 and the same high SSFR peak; in no regime is there ever an excess of galaxies in the `green valley'. Satellite galaxies are simply more likely to lie on the quenched (`red sequence') side of the SSFR distribution. Furthermore, the satellite quenched fraction excess above the field galaxy value is nearly independent of galaxy stellar mass. An enhanced quenched fraction for satellites persists in groups with halo masses down to 3 x 10^11 Msol and increases strongly with halo mass and toward halo center. We find no detectable quenching enhancement for galaxies beyond ~2R_vir around massive clusters once these galaxies have been decomposed into centrals and satellites. These trends imply that (1) galaxies experience no significant environmental effects until they cross within ~R_vir of a more massive host halo, (2) after this, star formation in active satellites continues to evolve in the same manner as active central galaxies for several Gyrs, and (3) once begun, satellite star formation quenching occurs rapidly. These results place strong constraints on satellite-specific quenching mechanisms, as we will discuss further in companion papers.

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