Put a ring on it: signposting the formation path of today's S0 galaxies

Galaxy evolution

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S0 galaxies are the only Hubble type that is relatively abundant in both low- and high-density environments, suggesting that systems with this morphology may have followed more than one evolutionary path. This idea is supported by a wealth of new evidence indicating that the S0 designation actually accommodates a heterogeneous population with a wide range of properties. Recent high resolution numerical simulations also show that S0s formed through merger events may develop a transient star forming ring on their departure from the main sequence as they evolve to become quiescent objects. In an attempt to shed more light on the physical processes that drive their evolution, we have analyzed spatially resolved spectral data from a sample of ~500 S0s identified in the MaNGA survey. Inspection of the spectral maps has revealed the existence of a good number of lenticular systems with significant radial gradients in the star formation activity. A substantial fraction of the S0 for which star formation decreases inside-out harbors rings visible in the nebular (H?) component and sometimes also in the stellar (D4000) one, especially in galaxies with a passive global spectrum. Objects with this type of quenching are preferentially located in low-mass galaxy aggregations. We speculate that the inside-out configuration may result from an evolutionary pathway involving a gas-rich merger, with a captured satellite in globally passive systems and with a similarly large companion for systems still holding a relatively important star formation activity. In contrast, S0s in which star formation is depressed from the outside in are found in large groups. This latter quenching is consistent with the suppression of star formation due to the removal of the least gravitationally bound cold gas in their outer disks as they infall towards high-density cluster regions.