

Dwarf Galaxies: Insights from the Most Compact to the Most Diffuse Systems

Galaxy clusters are the largest gravitationally bound structures in the Universe. Although numerical simulations provide detailed predictions of their assembly and evolution over cosmic time, observational confirmation of these models remains limited. The galaxy populations of nearby clusters are dominated by dwarf stellar systems, whose origin, however, is still not fully understood.

Over the past five years, we have assembled an extensive spectroscopic dataset using MMT/Binospec, including more than 250 dwarf early-type galaxies and dozens of dwarf post-starburst systems across three massive nearby clusters: Coma ($D = 99$ Mpc), Abell 2147 ($D = 165$ Mpc), and Abell 168 ($D = 193$ Mpc). These observations are complemented by re-reduced archival spectroscopic data for the Virgo Cluster ($D = 16.5$ Mpc), obtained from the Keck, Gemini, and VLT public archives. In addition, we have incorporated reprocessed deep optical imaging from Subaru/HSC and CFHT/MegaCam, optimized for low-surface-brightness detection through improved sky background subtraction, which allowed us to trace outer parts of dwarf galaxies, which can have features of such processes as recent tidal interactions and ram-pressure stripping.

Together, these spectroscopic and photometric datasets, further enriched by ongoing large-scale surveys such as DESI, enable us to place strong statistical constraints on the evolutionary pathways of different dwarf galaxy subclasses. These include compact ellipticals (cEs), for which new DESI-based samples emphasize the key role of precessing within infalling groups; classical dwarf ellipticals (dEs), where our long-slit spectroscopy reveals a significant fraction of kinematically decoupled cores and counter-rotating components, indicative of past mergers; and, finally, ultra-diffuse galaxies (UDGs), whose younger progenitors, post-starburst dwarfs, highlight ram-pressure stripping as a dominant evolutionary mechanism.