On the Origin and Kinematics of the Molecular Gas in Early-Type Galaxies

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Over the past few years, early-type galaxies have shed their "red and dead moniker, thanks to the discovery that many host low-level residual star formation. As part of the ATLAS^{3D} project we are conducting a complete, volume limited survey of the molecular gas in 260 local early-type galaxies with the IRAM-30m telescope and the CARMA interferometer. With these data we are attempting to understand the origin of this molecular gas, and study its distribution, kinematics and star formation properties. We find that around 22% of early-type galaxies in the local volume host molecular gas reservoirs, with central discs, polar structures and rings being common. This detection rate is independent of galaxy luminosity and environment, but does depend on the galaxy kinematics. We find that although the molecular gas extent is smaller in early-type galaxies, the linear size scales fairly robustly with the optical and stellar characteristic scale-lengths, independent of the galaxy morphology. The origin of the molecular gas seems to depend strongly on environment, with misaligned gas (indicative of externally acquired material) being common in the field but completely absent in Virgo. I will discuss the origin of the gas in these CO-detected galaxies and touch on the implications for the formation and evolution of red sequence galaxies. I will also present kinematic analyses, including the first molecular gas Tully-Fisher relation for early-type galaxies, and show that molecules may be the kinematic tracer of choice for probing the M/L evolution of galaxies over cosmic-time.