Ludwig-Biermann Award Talk

The Physics Driving the Molecular Cloud Lifecycle during Galaxy Formation and Evolution

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The cloud-scale physics of star formation and feedback represent the main uncertainty in galaxy formation and evolution studies. In recent years, it has become clear that the 'star formation relation' between the gas mass (surface density) and the star formation rate (surface density) depends strongly on the spatial scale. We have shown that this multi-scale nature of the star formation relation is a direct probe of the cloud-scale physics of star formation and feedback. By quantifying the details of this scale dependence, we can directly measure fundamental quantities such as molecular cloud lifetimes, star formation efficiencies, feedback timescales, feedback outflow velocities, feedback coupling efficiencies, and coherence length scales. While these quantities were previously only accessible in the Local Group, it is now possible to measure them across a representative part of the galaxy population, from the nearby Universe out to high redshift ($z > 2$). I will present the first results of the systematic application of this method, showing that the molecular cloud lifecycle exhibits a strong dependence on the galactic environment. Understanding this environmental dependence provides a promising avenue for constraining the physics of star formation and feedback during galaxy formation and evolution.