University of Miami, Physics Department Colloquium

Star Formation, Supermassive Black Holes & the End of the Universe (as we know it)

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Abstract

I will present an overview of several outstanding problems in the field of galaxy evolution, from both a theoretical and observational perspective. Most importantly, I will ask a seemingly simple question: "why do galaxies stop forming stars?" To address this, I introduce a novel machine learning method for analyzing the dependence of star formation on galaxy and environmental parameters. Our machine learning technique is highly effective at extracting causality (not merely correlation) from models, and hence is of great value in the analysis of observational data (where causality is generally hidden).

We apply our machine learning rechnique to three of the largest observational galaxy surveys (SDSS, MaNGA and CANDELS), and to four sophisticated cosmological models (LGalaxies, Eagle, Illustris and Illustris-TNG). In observations, we demonstrate that central galaxy quenching is governed primarily by global (galaxy-wide) physics, and is most strongly connected with the conditions at the very center of massive galaxies (especially the peak central density). Interestingly, these results are precisely predicted by the latest models of Active Galactic Nucleus (AGN) feedback. This strongly suggests that supermassive black holes play a fundamental role in determining the fate of galaxies - once a black hole reaches a critical mass, it shuts down accretion of gas into the system, ending star formation forever. Whilst the Universe may last indefinitely (due to accelerated expansion), it will be entirely dark within ~100 billion years.