Z113a Understanding Galaxy Evolution through Machine Learning

Suchetha Cooray, Tsutomu T. Takeuchi, Kai T. Kono, Shuntaro A. Yoshida (Nagoya U.)

Galaxy evolution is a complicated process that encompasses many physical properties in/around a galaxy (e.g., stellar mass, gas mass, star formation rates, star formation histories, environment). It is still challenging to describe the entangled processes from just the fundamental theory. The studies using observed data have given us the many galaxy scaling laws (e.g., star formation main sequence, Tully-Fisher relation, Faber-Jackson relation, Kennicutt-Schmidt). However, current galaxy surveys provide hundreds of physical quantities for hundreds of millions of galaxies, and characterizing the intricate nature through simple scaling laws is undesirable. There is a need for sophisticated multivariate analysis to simultaneously incorporate all these features to build a unified galaxy evolution theory. In this study, we have identified a universal two dimensional manifold (galaxy manifold) from an 11-dimensional space of luminosities from far ultraviolet to infrared using the latest dimensionality reduction techniques. We find that the manifold explains the traditional evolutionary features (star formation rates and stellar mass), allowing us to parametrize the manifold to derive fundamental equations of galaxy evolution. The found galaxy manifold will be a convenient interface between the galaxy properties and the observed luminosities, facilitating galaxy evolution studies across cosmic time.