X55a Understanding Galaxy Evolution through Machine Learning

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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 entirely. 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. Thus, sophisticated multivariate analysis is necessary to explore the high dimensional feature space and build a unified picture of galaxy evolution. In this study, we extract a lower-dimensional manifold (galaxy manifold) from the higher-dimensional space of galaxy emissions by using the latest dimensionality reduction techniques. The discovered manifold can explain conventional evolutionary features such as star formation rates and stellar mass continuously, showing clear trends of galaxy evolution along the manifold. Lastly, the galaxy manifold can be parameterized to derive a fundamental set of equations for galaxies, enabling us to explore the evolution of these objects across cosmic time.