X21a Galaxy Evolution as Seen from Machine Learning

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Galaxies evolve in various aspects. Traditionally, properties that characterize galaxy evolution were chosen based on researchers' scientific intuition, and examined by them. However, such a classical approach would miss significant number of important features to represent the evolution of galaxies, since the dimension of galaxy survey data is enormous. Since we have an overwhelmingly large amount of new datasets, now it is a good moment to reconsider what the "galaxy evolution" is.

We demonstrate a method to extract the evolutionary features of galaxies through unsupervised machine learning algorithm. The dataset is a 52,000 galaxies with high-S/N, extracted from the public data provided by the VIPERS project. We constructed a multidimensional space of twelve luminosities (FUV, NUV, $u, g, r, i, z, B, V, J, H$ and Ks, and redshift. The luminosities were normalized to distribute around unity to match the range of redshifts ($0.4 < z < 1.3$), in order to avoid extremely elongated cluster in the data space. We applied a Gaussian mixture model to the data and estimated parameters by the Fisher Expectation-Maximization algorithm. This method automatically reproduced important characteristics of galaxies such as the classical active/passive galaxy dichotomy, star-forming galaxy main sequence, etc. We stress that, since we started from luminosity + redshift space, this analysis is free from the entangled selection effects that typically hampers the straightforward interpretation on the color-color planes. This will be a powerful tool to explore the next-generation astronomical datasets.