The Key Factors Boosting Star Formation Rates of Galaxies

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The star formation rate (SFR)-stellar mass (M∗) relation of galaxies has long been a subject of research interest in astronomy. Why do galaxies with similar stellar masses have different star formation rates? To address the question, in this study, I utilize the large spectroscopic data from the Sloan Digital Sky Survey (SDSS) and the deep imaging dataset obtained by the Hyper Suprime-Cam (HSC) Survey to investigate the impact of galaxy mergers and interstellar medium properties of isolated galaxies on the star formation rate. I first use the HSC images to find a subset of galaxies undergoing the merging process and apply a machine learning algorithm for identifying merging and isolated galaxies. I then perform statistical analyses to quantify the star formation rates of galaxies as a function of various properties. The results show that on average, galaxy mergers have 2 times higher star formation rates than isolated galaxies. Merging galaxies also demonstrate a higher likelihood of residing above the main sequence of star-forming galaxies. Furthermore, the increase in star formation rates is significant when there are only tidal structure interactions or peripheral contacts within the galaxy system. For isolated galaxies, star formation rates increase with gas velocity dispersions in relatively low-mass galaxies, in which the correlation can lead to up to 4 times higher star formation rates, but this trend becomes weaker in high-mass galaxies. Finally, I found that galaxies may prefer to form stars in specific gas density environments. The results demonstrate that the merging of galaxies, kinematics and density of gas are three of the key factors that affect star formation rate (SFR)-stellar mass (M∗) relation of galaxies.