U06a Peculiar velocity reconstruction of galaxy clusters with CNN for the kSZ effect

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Cosmic matter flow is caused by a gravitational field mainly produced by dark matter, and it allows to probe the evolution of the density field in the Universe; however, the dark-matter distribution is not directly observed. Galaxy distribution follows the cosmic density field, but their distributions are not linearly related.

Therefore, we used the convolutional neural network (CNN) to train the relation between galaxy distribution around a galaxy cluster and its peculiar velocity, particularly in the line-of-sight (LOS) direction. The training was performed using the SDSS's mock galaxy and galaxy cluster catalogs constructed from the Magneticum cosmological hydrodynamic simulations. Our network was tested both in real and redshift space of simulated galaxies, respectively, and we found that the cluster's peculiar velocity is successfully reconstructed in both cases. Then, we applied this trained network for the actual SDSS galaxy distribution and reconstructed the LOS velocities of $\sim$ 30,000 galaxy clusters. The cluster's LOS velocity causes the spectral distortion of cosmic microwave background (CMB) radiation due to the scattering of intracluster gas, so-called the kinetic Sunyaev Zel'dovich (kSZ) effect, and thus this kSZ signal is sensitive to the gas distribution. While the current kSZ measurements are limited due to the weakness of the signal, we detected the kSZ signal at 4.9 sigma using the cluster's reconstructed velocities and found their gas distribution extending beyond the virial radius. This measurement can be used to constrain baryonic feedback effects, such as star formation, supernova, and AGN.