Discovering Extremely Rare Neutral Carbon Absorbers in Intergalactic Medium Using Machine Learning

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Rare concentrations of neutral atomic carbon (C I) in interstellar clouds of high redshift galaxies are excellent tracers of cold molecular clouds, providing a window to understand the conditions and properties of star-forming regions in the early Universe. Currently, it is not possible to conduct further statistical analysis on the true role of C I in star and galaxy formation, as there is an insufficient number of known C I absorbers. This is partially due to the traditional manual methods for detecting C I absorption lines in quasar spectra, which are inefficient and prone to human error. In this work, I modified a convolutional neural network (CNN) to replace manual detection methods, allowing for faster C I detection at a high accuracy. The CNN was taught to recognize the shape of a C I absorber in a quasar spectrum using synthetic training data in which artificial C I absorption lines were injected into quasar spectra. When applied to quasar spectra in the Sloan Digital Sky Survey (data release 12), the CNN identified 332 C I candidates with a 96.4% accuracy. After a process of manual verification to remove false positives, 128 total discoveries were made, including 55 definite C I absorbers, 35 strong C I absorber candidates, and 38 weak C I absorber candidates. This C I absorber catalog is the largest one assembled to date, and can be used in further research on interstellar processes in the early universe and galaxy formation. Additionally, the CNN can be modified to identify other elemental absorbers.

Awards Won:
Third Award of $1,000
China Association for Science and Technology (CAST): Award of $1,200