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Towards Understanding the Milky Way's Matter Field and Dynamical Accretion History based on GS^3 Hunter and WST

We present a novel deep-learning-based method, named Galactic-Seismology Substructures and Streams Hunter (GS3 Hunter), designed to search for substructures and streams in stellar kinematics data. GS3 Hunter combines Siamese neural networks to transform phase space information with the K-means algorithm for clustering. As a validation test, we apply GS3 Hunter to a subset of the Feedback in Realistic Environments (FIRE) cosmological simulations. The stellar streams and substructures identified align well with results previously reported by the FIRE team. In a similar vein, we apply the method to a subset of local halo stars from the Gaia and GALAH datasets, successfully recovering several known dynamical groups, including Thamnos 1+2, the hot thick disk, ED-1, L-RL3, Helmi 1+2, Gaia-Sausage-Enceladus, Sequoia, Virgo Radial Merger, Cronus, and Nereus. To investigate the origin of the Gaia-Sausage-Enceladus (GSE), we conduct a chemical dynamical analysis using APOGEE and DESI data. By incorporating chemical information (e.g., [Mg/Fe], [Al/Fe]), we classify the stars into accreted and in-situ populations, the majority of our sample consists of in-situ stars in the Galactic disk region, with a smaller fraction of accreted stars. Finally, we apply GS3 Hunter, without fine-tuning, to a subset of K giant stars from the LAMOST Data located in the inner halo region. We recover three previously known structures (Sagittarius, Hercules-Aquila Cloud, and the Virgo Overdensity), along with the discovery of several new substructures. Our group anticipate that GS3 Hunter will become a valuable tool for the community in the search for stellar streams and structures within the Milky Way (MW) and the Local Group. It will significantly advance our understanding of the inner and outer halos of the MW, as well as the galaxy's assembly and tidal stripping history. This contributed talk will also highlight recent progress in the accretion history of the MW.

Author: Dr WANG, Haifeng (University of Padova)

Presenter: Dr WANG, Haifeng (University of Padova)

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