Z110a Interpretable deep neural networks reveal environmental influences on galaxy properties

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Galaxies are not isolated objects but reside within dark matter halos. Their properties are influenced not only by their host halos but also by the surrounding environment. Understanding these environmental effects is crucial for studying galaxy evolution. In this study, we leverage automatic differentiation techniques to construct an interpretable deep neural network (MLP) framework that characterizes environmental effects on galaxies and investigates how neighboring galaxies affect their properties in cosmological hydrodynamical simulations. Our models predict galaxy properties (stellar mass and star formation rate) given dark matter subhalo properties of both the host subhalo and of surrounding galaxies, which serve as an explainable, flexible galaxy-halo connection model. To quantitatively assess environmental influences and analyze correlations between environment and galaxy properties, we apply SHapley Additive exPlanations (SHAP). This interpretable machine learning approach enables us to understand the underlying physical mechanisms driving these relationships.

In this presentation, we will address the following questions: "How does the environmental influence on galaxy properties vary across different galaxy populations?" and "Which environmental parameters most strongly affect each galaxy population?" We will also particularly focus on AGN feedback and discuss its role in shaping the environmental dependence of galaxy properties.