Automated Detection of Major Mergers using Deep Learning and Cosmological Simulations

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We introduce a deep learning based method for detecting galaxy mergers and getting estimates of some of their physical properties in an automated way. By analyzing the merger tree of Horizon-AGN, a cosmological hydro-dynamical simulation, we tracked the evolution of massive major mergers (with stellar masses larger than 10^{10} solar masses and mass ratios larger than 1:4) in the redshift range $0.5 < z < 4$. From this sample of mergers, we generated a large set of multi-wavelength HST-like mock images in the observer-frame considering also multiple projections, where a set of physical parameters, that are relevant for the description of a merger, is associated to each one of the these images. The values for these parameters, such as mass ratios, distance of the progenitors, time before/after the merger, among many others, were queried directly from the simulation.

Using this synthetic dataset we trained a Convolutional Neural Network (CNN) for identifying galaxy mergers and retrieve also their corresponding physical information. The analysis of the accuracy achieved by this method allow us to understand its limitations, and, specially, this also allow us to constrain the observability time-scale for the mergers that are identified by it. By doing this, we avoid assuming any arbitrary value for this time-scale which implies having a more realistic estimate of the galaxy merger rate, since its value is being calibrated indirectly from the cosmological simulation. We present the results obtained when this method is used with CANDELS data and we also discuss how to make predictions, using these results, for the merger rate values that will be calculated by different merger detection methods when JWST data is available.