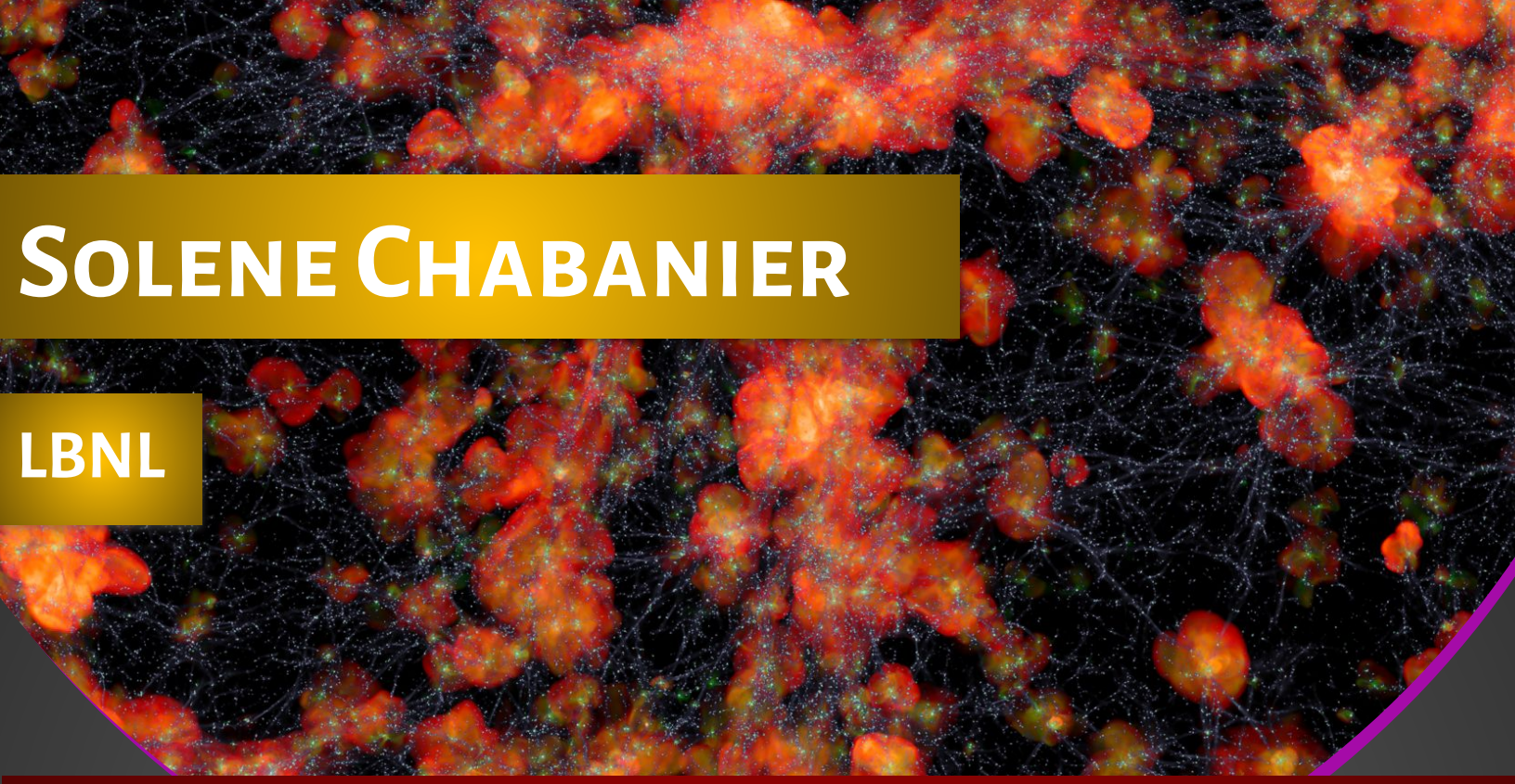

Solene Chabanier

LBNL

Towards precision cosmology with the lya forest: theoretical modeling with hydrodynamical simulations

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Neutral hydrogen in the Intergalactic Medium produces a collection of Lyman-alpha absorbtions, called the Lyman-alpha forest, seen in the spectra of background objects, which is a great tracer of matter at high redshifts. So far, observational measurements have been conducted on large and small scales independently, through the 3D auto-correlation function and the 1D power spectrum, with sensitivity to the expansion rate and the amount of relativistic particles respectively. Thanks to the strong increase of close quasar pairs with DESI, offering us to conduct cosmological inference from 3D correlation measurement for the first time, through the Lya 3D power spectrum, which would significantly increase precision of cosmological parameters and break degeneracies between cosmological and thermal parameters. However, cosmological interpretation of Lya data is made difficult by its theoretical modeling since we have to rely on hydrodynamical simulations for our theoretical predictions. Indeed, because the gravitational growth of structures at small scales is highly non linear and also the Lya gas is sensitive to the baryonic physics in the IGM. The control of modeling uncertainties is therefore very challenging. I will present the comparison of two different numerical codes to study the overall accuracy in modeling the IGM and reproducing Lya observables. Then, I will present the evaluation of the impact of AGN feedback on the Lya forest to prevent degeneracies with neutrino effects using the suite of Horizon-AGN simulations. Finally, I will present the new suite of extremely large volume hydrodynamical Nyx simulations, which significantly increases both the volume and physical resolution of current state-of-the-art similar simulations in order to study the accuracy and precision of analytical models.