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Constraining feedback prescriptions with Lyman-alpha absorption around galaxies

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Understanding the physics of the gas present in galactic halos and spread among galaxies is of primary importance to get insight into galaxy formation and to address the open questions about the epoch of reionization. In particular, outflows of gas produced by stellar feedback (e.g. supernovae, stellar winds) or an AGN alter the physical state of gas in the circum- and intergalactic media (CGM and IGM) surrounding galaxies, although the details of these processes are still poorly understood. The nature of such processes can be unveiled exploiting Lyman-alpha absorption, which is a formidable tool to probe IGM and CGM. We use the state-of-the-art Illustris and Nyx hydrodynamic cosmological simulations to reproduce the observations of the Lyman-alpha absorption due to neutral hydrogen extending from 20 kpc up to several Mpc around foreground star-forming galaxies, quasars, and damped Lyman-alpha absorbers (DLAs), illuminated by a background quasar. We find that both simulations do not produce enough absorption within the virial radius to match the observations. Outside the virial radius up to ~1 Mpc, Nyx and Illustris yield very different predictions of the Lyman-alpha absorption. We assert that such differences could be ascribed to the diverse feedback prescriptions in the two simulations. Nevertheless, both simulations are consistent with currently available data within the error bars. Thus, improving the precision of measurements of Lyman-alpha absorption in the CGM with future observations, thanks to JWST and surveys like DES, has a great potential to constrain feedback prescriptions in numerical simulations. We show that the discrepancy can be due to the presence of cooler gas in the CGM, extra turbulence in the CGM, or unresolved physics in the CGM.

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