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Synthetic nebular emission lines of simulated galaxies in the early Universe(Michaela Hirschmann)

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We present a detailed analysis of synthetic optical and UV emission lines of simulated galaxies out to the epoch of re-ionisation. The theoretical strong emission lines are derived from self-consistently coupling "new-generation" spectral models accounting for nebular emission from both young stars and AGN to new sets of high-resolved cosmological hydrodynamic zoom-in simulations of young galaxies as well as to the IllustrisTNG simulation. Investigating the evolution of optical line-ratios in the BPT diagrams, we find that the simulations can successfully reproduce the observed trend that for a given [NII]/Ha ratio, the [OIII]/Hb ratio is increasing towards high redshifts as a consequence of increased SFRs in young galaxies. Standard selection criteria in the classical BPT diagrams can appropriately differentiate simulated star-forming galaxies, galaxies dominated by AGN and composite galaxies at low redshifts, but they fail to distinguish the main ionising source(s) in metal-poor galaxies, which dominate in the early Universe. To robustly classify the ionising radiation of such metal-poor galaxies, we propose 11 novel diagnostic diagrams based on equivalent widths and luminosity ratios of UV lines. We additionally highlight the multifaceted imprint of AGN feedback in projected 2D nebular emission line maps of massive high-redshift galaxies, such as (i) central Ha deficiencies, (ii) reduced extent of Ha emission, and (iii) flattened [NII]/Ha gradients of high-redshift galaxies. Our novel interface between simulations and observations is potentially important for the interpretation of high-quality spectra of very distant galaxies to be gathered by next-generation telescopes, such as the James Webb Space Telescope.

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