Weak evolution of the mass-metallicity relation at cosmic dawn in the FirstLight simulations

Daniel Ceverino\textsuperscript{*1}, Ivanna Langan\textsuperscript{2}, and Kristian Finlator\textsuperscript{3}

\textsuperscript{1}Universidad Autonoma de Madrid – Spain
\textsuperscript{2}University of Copenhagen = Københavns Universitet – Denmark
\textsuperscript{3}New Mexico State University – United States

Abstract

Little is known about the mass–metallicity relation (MZR) in galaxies at cosmic dawn. Studying the first appearance of the MZR is one of the keys to understand the formation and evolution of metals. In order to lay the groundwork for upcoming observational campaigns, we analyse 290 galaxies in haloes spanning Mh=10^{-9}-10^{-11} \, \text{M}_\odot selected from the FirstLight cosmological zoom simulations to predict the MZR at z = 5–8. Over this interval, the metallicity of FirstLight galaxies with stellar mass M_{\ast}=10^{-8} \, \text{M}_\odot declines by < 0.2 dex. This contrasts with the observed tendency for metallicities to increase at lower redshifts, and reflects weakly evolving or even increasing gas fractions. We assess the use of the $R_3=\text{OIII}(5007\AA)/\text{H}_\beta$ strong-line diagnostic as a metallicity indicator, finding that it is informative for $12 + \log (O/H) < 8$ but saturates to $R_3=3$ at higher metallicities owing to a cancellation between enrichment and spectral softening. None the less, campaigns with JWST should be able to detect a clear trend between $R_3$ and stellar mass for M_{\ast}> 10^{-7.5} \, \text{M}_\odot. We caution that, at fixed metallicity, galaxies with higher specific star formation show higher $R_3$ owing to their more intense radiation fields, indicating a potential for selection biases.

\textsuperscript{*}Speaker