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Modelling the dust properties and visibility of high-redshift galaxies

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Recent observations of high redshift galaxies are unveiling unexpected properties of early galaxy-formation. Observations in both rest-frame ultraviolet with the James Webb Space Telescope and rest-frame far-infrared with the Atacama Large Millimeter Array suggest an early population of bright massive galaxy, with a significant dust-obscuration already at redshift 7. To better understand the implications of those observations, we model the growth of galaxies and their dust content with the semi-analytical code DELPHI, which includes growth by mergers and accretion, star-formation, supernova feedback and dust evolution. We use the observed UV luminosity function from redshift 5 to 10 to constrain our model parameters: a star-formation efficiency of 15% and a coupling between supernova energy and ISM of 6%.
With this model we provide predictions of stellar mass function, dust masses, dust attenuation, dust temperatures, far-infrared luminosities and others, at all redshifts between 5 and 20. One of our main results is that to be consistent with the luminosity function of recent JWST detections at redshifts above 13, all the gas in galaxies has to convert into stars, with no feedback. This raises the question whether this population of galaxies is biased towards an unusually intensely star-bursting population, or has incorrect photometric redshifts. Otherwise, standard cosmology would need to be modified or we would need exotic stellar physics.

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