DUST EVOLUTION AND POPULATION III-II TRANSITION IN YOUNG GALAXIES

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Dust grains are essential for a transition from the massive, first stars (Population III stars, $\sim$ a few $\times 10\ M_\odot$) to the low-mass, normal stars (Population I/II, $\sim 0.1-1.0\ M_\odot$), since the dust grains cool the star-forming gas and cause the low-mass fragmentaion resulting in low-mass star formation. We couple the evolution of mass and size distribution of dust grains with an analytic model of galaxy formation and evolution and investigate the Population III - Population I/II transition. In our model, we construct merger trees to follow the hierarchical structure formation of dark matter halos and take into account the suppression of star formation by the Lyman-Werner background and the photoionization heating.

We find that the Population III stars can form in the massive galaxies with virial temperatures $T_{\rm vir} \geq 2.2 \times 10^4$ K even in the redshift $z \leq 6$ and these Population III galaxies consist of progenitors hosting only the Population III star formations. We conclude that since the Population III galaxies are not enriched by dust from asymptotic giant branch stars, the Population III-II transition due to dust cooling can be well described by the critical metallicity.