Hierarchical fragmentation in high redshift galaxies revealed by hydrodynamical simulations

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Abstract :

High-redshift galaxies have very different morphologies compared to nearby ones. Indeed, the high gas fractions lead to the formation of giant star forming structures of masses up to 10^8 and 10^9 $M_\odot$ often dubbed «giant clumps». Recent observations at high resolution questioned the physical existence of giant clumps by showing only low-mass structures or no structures at all. We use Adaptative Mesh Refinement hydrodynamical simulations of galaxies with parsec-scale resolution to study the formation of structures inside high-redshift galaxies. We show that star formation occurs in small gas clusters with masses between 10^6 and 10^7 $M_\odot$ that are themselves located inside giant complexes with masses up to 10^8 and 10^9 $M_\odot$. Those massive structures correspond to the giant clumps observed with the Hubble Space Telescope. They are found to be gravitationally bound and present a relation between their Jeans' masses and their substructures masses coherent with a scenario of hierarchical fragmentation. We also compare the top-down fragmentation of an initially warm disk and the bottom-up fragmentation of an initially cold disk. Through mock observations of the simulated galaxies, we show that at very high resolution with instruments like the Atacama Large Millimeter Array or through gravitational lensing, only low-mass structures are detected. This leads to non detection of the giant clumps and therefore introduces a bias in the detection of the structures.

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