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Hierarchical fragmentation in high redshift galaxies revealed by hydrodynamical simulations

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High redshift galaxies have a very different morphology than nearby ones. Indeed, the high gas fraction in such galaxies drives strong gravitational instabilities which lead to fragmentation and formation of giant star forming structures of masses up to 10^8 and 10^9 \msun often dubbed «giant clumps». Recent observations with high resolution questioned the existence of the giant clumps by showing only lighter structures or no structures at all. We use Adaptative Mesh Refinement (AMR) hydrodynamical simulations of galaxies with parsec-scale resolution to study the formation of structures inside high redshift galaxies. We show that the star formation occurs in small gas clusters with mass between 10^6 and 10^7 \msun that are themself located inside giant complex with mass up to 10^8 and 10^9 \msun. Those massive structures are the giant clumps observed with HST. 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. By realizing mock observation of the simulated galaxies we show that at very high resolution with instrument like ALMA or with the help of gravitational lensing only the lighter 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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