Hierarchical fragmentation in high redshift galaxies revealed by hydrodynamical simulations and strong gravitational lensing

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Abstract

It is known that 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 10ˆ8 and 10ˆ9 solar masses often dubbed " giant clumps ".
We use Adaptative Mesh Refinement (AMR) hydrodynamical simulations of galaxies with parsec-scale resolution to study the formation and the internal structure of those giant clumps. We observe that being above their own Jeans' mass those structures fragment into few dense regions of typical mass between 10ˆ6 and 10ˆ7 solar masses.
Unfortunately telescopes cannot resolve such substructures yet. By realizing mock observations of galaxies we analyze how strong gravitational lensing can reveal this hierarchy. This analysis shows that gravitational lens such as the Cosmic Snake (see Cava et al. 2018) separates the substructures of the giant clumps. At the same time, this leads to the non-detection of the giant clumps, even when those are present and physically bound in the non-lensed galaxy, introducing a bias in the detection of the structures.
Similarly, observations at resolutions higher than HST imaging, for instance with ALMA, may miss the detection of giant clumps as they resolve the scale of their substructures.

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