X02a **Non-linear violent disc instability with high Toomre's Q in high-redshift clumpy disc galaxies**

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We utilize zoom-in cosmological simulations to study the nature of violent disc instability with giant clumps in high-redshift galaxies. This study performs instability analyses using local Toomre's Q parameter based on a two-component model of gas and stars smoothed on a $\simeq 1$ kpc scale to focus on the formation of massive giant clumps of $\sim 10^8$–10^9 $M_\odot$ for clumpy star-forming galaxies in redshifts between $z \sim 1$ and 5. We find that inter-clump disc regions can have Q values significantly higher unity, while the regions of $Q < 1$ are confined to collapsed clumps where the surface densities are high. However, significant fractions of new clumps form in the disc regions that are apparently Toomre stable with $Q \gtrsim 2$. This result proposes that giant clumps can form due to mechanisms other than the standard Toomre instability, and such formation of giant clumps is beyond the applicable domain of the linear perturbation theory, i.e. non-linear violent disc instability. The non-linear clump formation could be induced by rapid decay of turbulent pressure of gas by dissipation, Toomre instability on small scale followed by intense accretion of gas and mergers with other clumps, or instability for non-axisymmetric perturbations. In addition, the non-linear instability could also be stimulated by external perturbations such as minor mergers, tidal interactions, and counter-rotating streams feeding the discs, which may may induce excessive compressive modes of turbulence which may represent the high Q values.