1. Hierarchical Scales of Clump Clusters in High-Redshift Disk Galaxies / 2. MERA: A RAMSES Post Processing Tool Written in The Julia Language

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Abstract

1. Many disc galaxies have been observed at high-redshift, which typically contain a few giant clumps on kpc scales and 10^8-10^9 Msol. Recent simulations and observations with better spatial resolution are pointing to a possible substructure representing the observations. We study in more detail the substructure formation within the framework of gravitational instability of a massive disc galaxy. We employ simulations under well defined conditions and different initial and final resolution (3-90 pc).
In the high resolution runs higher densities can be reached, and the initial structures can collapse further and fragment to many clumps on smaller scales than the initial Toomre length (kpc scales). They group to clump clusters (CCs) from bottom-up within relatively short times and are present over the whole simulation time. We identify several mass and size scales (hierarchy) on which the clusters appear as single objects at the corresponding observational resolution between 10^8 - 10^9 Msol. Most of the clusters emerge as dense groups and the more massive ones on larger scales are more likely to be open structures represented by a single object with not necessarily a strong gravitational connection.
The artificial pressure floor (APF) which is typically used to prevent for spurious fragmentation strongly influences the initial clumps in our low resolution runs, with typical parameters used in cosmological zoom-in simulations. They experience a shift in density, size and mass which is given by the APF. These clumps form directly on larger scales 0.3-1 kpc with 10^8-10^9 Msol, comparable to the initial Toomre length. The reason is that they cannot collapse further due to the APF which is already induced at much lower densities than in the high resolution case. The APF leads to an effective resolution of 21-375 pc between our runs, which is given by the minimal possible Jeans length. Future work has to investigate the clump cluster properties and their relationship to the galaxy mass and the influence under variations of stellar feedback.

2. I am developing a code purely written in the Julia language to improve my workflow with processing the RAMSES data. It can be used interactively, due to just-in-time compilation. It is fast (c-like) and memory lightweight, since it uses the AMR data for the processing. Many optimized functions are implemented, which can be combined to achieve the intended analysis with only a few lines. It comes with tutorials, and many examples presented in Jupyter notebooks. Several Julia packages can be used for plotting or your familiar Matplotlib library, since Python code can directly be called from Julia. MERA, will be released this year, and it might be of interest for many RAMSES users. It can be easily extended with more features.

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