From large diffuse to dense star-forming phases

Structure formation in the interstellar medium of galaxies

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In Short

- The large-scale environment of galaxies regulates cloud and star formation.
- How gas flows from large to small scales remains an open question.
- We aim to constrain the gas flow within the galaxy with global simulations.
- We will study the time and spatial evolution of bulk properties, for which observational constraints exist.

Stars form in dense, molecular clouds. The formed stars then inject energy and momentum into the surrounding gas and enrich the interstellar medium with metals. However, despite the fact that the process of low-mass star formation is quite well understood, it is still an unsolved issue how molecular clouds, the stellar nurseries, form [1]. Currently, top-down and bottom-up formation models work pretty well on either the global scales with disk-averaged properties or on small scales, where the cloud dynamics dominate the impact from the galactic environment. Both approaches can sufficiently explain certain observational results, but a unified model for cloud and star formation is still missing.

Molecular cloud formation is regulated by the dynamic interplay between gravity, turbulence and magnetic fields. Which dynamical agent dominates what stage of the cloud formation process remains to be fully understood. Here, sophisticated high resolution numerical simulations are needed due to the timescales of the process being far larger than a human life. These simulations will help to constrain the role of large-scale gas flows compared to magneto-hydrodynamic turbulence in the interstellar medium, both for individual clouds as well as for entire galaxies.

In this project, we aim to quantify cloud-scale properties, such as the boundedness or the mass spectrum and study their evolution in time and as a function of galactocentric distance. The results will provide insight into the still debated question of how molecular clouds form and how this process depends on galactic environment, such as formation within or in-between a spiral-arm or cloud formation near the galactic center. Our high resolution studies also allow us to investigate the transition region between a regime dominated by galactic forces and one within the cloud's region of influence. The importance of

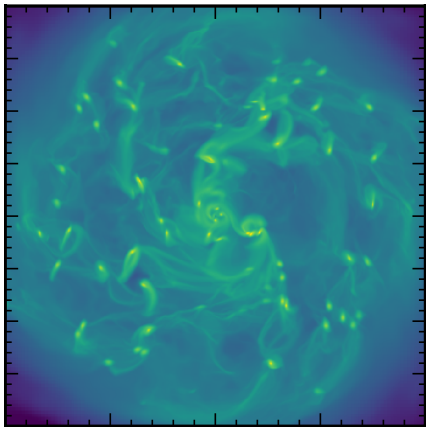

***Figure 1:** Face-on view of an initially strongly magnetized disc galaxy. The image size is $20 \times 20\,kpc^2$ and shows a strongly fragmented galaxy. Results were presented in [2].*

the galactic environment can be seen in Fig. 1. In this face-on view of a previously simulated galaxy, the clouds are observed to reside in quite different environments. Many of them undergo violent interactions with clouds in their environment and only a few seem to be isolated. Note also the highly structured interstellar medium between the clouds, which could give rise to significant gravitational torques exerted onto the clouds.

WWW

https://www.physik.uni-hamburg.de/en/forschung/institute/hs/group-banerjee/members/koertgen-bastian.html

More Information

[1] C.L. Dobbs, M.R. Krumholz, J. Ballesteros-Paredes, A.D. Bolatto, Y. Fukui, M. Heyer, M.-M. MacLow, E.C. Ostriker and E. Vazquez-Semadeni *Protostars & Planets VI* , (2014). doi:10.2458/azu_uapress_9780816531240-ch001

[2] B. Körtgen, R. Banerjee, R.E. Pudritz and W. Schmidt *MNRAS* **479**, (2018). doi:10.1093/mnrasl/sly094