Numerical simulations of the galactic-scale interstellar medium

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The interstellar medium (ISM) is a highly complex coupled system. Many different physical processes influence its behaviour, acting over a broad range of length and time scales. It is difficult or impossible to capture the full breadth of this physics with simple analytical models, and for this reason detailed numerical simulations have long played a central role in the theoretical study of the ISM.

In this lecture, I will briefly introduce the main physical ingredients that have to be included in any comprehensive numerical model of the ISM, and will discuss the approaches that we can use to simulate these on computers. I will talk about how computational resource limits affect the scope of what we can simulate and will discuss some of the computational trade-offs that they force us to make. I will present several different state-of-the-art models as instructive examples and will close by giving my thoughts on where the field is headed in the future.

Bibliography

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- Kjellgren et al., 2025, arXiv:2502.02635