Numerical simulations

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Panelists: C. Kobayashi, A. Marcowith, R. Smith, S. Walch
Moderators: J. Pety, E. Ntormousi

Scope of numerical simulations

How do you design your numerical experiment?

1. Designing your numerical experiment with the proper degree of complexity: How do we make our setup as simple as possible (but not simpler)?
2. Choosing the proper code for your experiment: Do you need an SPH, grid, or hybrid code? Are we properly advertising strengths and weaknesses of different methods for different problems?
3. How to bridge scales? The dynamical range of a code is, by construction, limited. How do we bridge small-scale, detailed simulations with more physics to larger-scale simulations? What are possible side effects to watch for in this process? Specific examples: star formation, feedback, B-fields, turbulence that can impact multiple scales.

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4. Models (e.g.CLOUDY) as a tool for subgrid modeling: how do we decide beforehand what models to incorporate into the simulation as subgrid physics versus simulating the process directly?

5. How do we plan numerical simulations of the ISM as a foreground for current and future cosmological experiments (SKA, EUCLID, LITEBIRD, …)? Is a change of approach required?

Synergy between simulations and observations

How do we learn to speak the same language?

1. How do you decide your comparison strategy? (Designing a numerical experiment thinking of a particular observable/system to reproduce vs predicting observables in a statistical way.)
2. Which statistical metrics are appropriate for which goal? Going beyond the power spectrum: characterizing the structure of the medium.
3. Speaking the same language: Simulators and observers working together on specific problems can be the answer: how do we coordinate the different ways to confirm/refute a theory/scenario?
4. How do we explore the parameter space adequately and efficiently with simulations so that they can be useful for observations?

Synergy between simulations and observations

How do we learn to speak the same language?

5. Is the use of subgrid physics affecting our capacity to reproduce observations? What should be kept in mind in this context?

6. Models as a post-processing tool to go closer to observations: choosing the right approximations, the right code for post-processing, talking to observers directly about the observable quantities to reproduce

7. Should we hire students to bridge the gap between “pure simulator” and “pure observer”?

8. Simulations as a tool to propose future observations: how can we set up workshops targeted at exchanging expertise?

The future of numerical simulations

New directions, codes, techniques

1. New generations of simulations: Which are the new directions in ISM simulations in the Milky Way, nearby galaxies and high-redshift galaxies? Are the same physics relevant, do we use the same codes?
2. New generations of numerical codes:
3. The most widely used MHD codes are more than a decade old. What do we need for the next generation of codes in terms of physics included, efficiency, modularity?
4. Which are the physics to routinely include in the next generation of codes? Chemistry, cosmic ray transport, other?