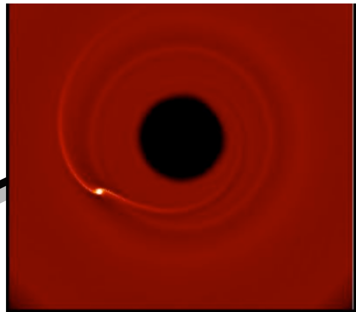

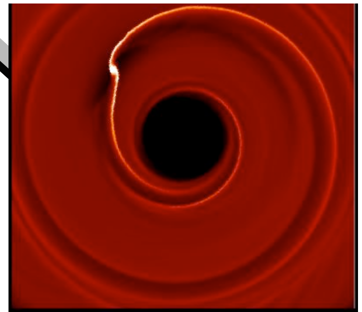

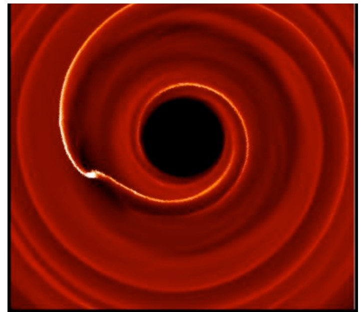

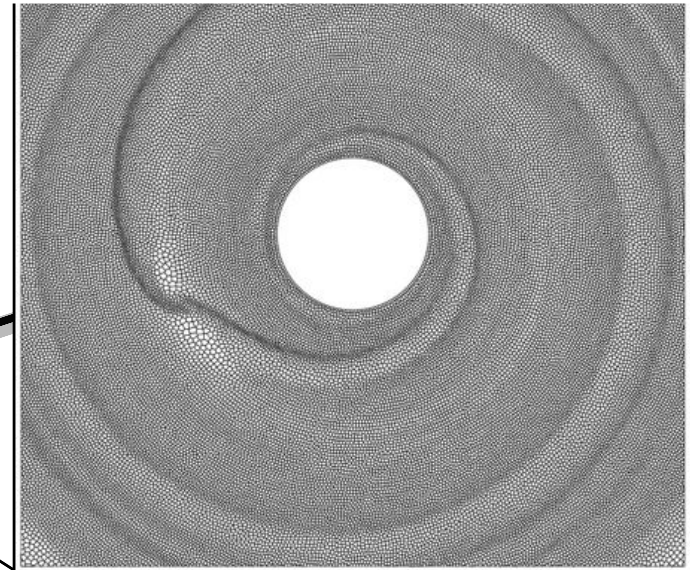

SIMULATING CIRCUMSTELLAR DISKS ON A MOVING VORONOI MESH

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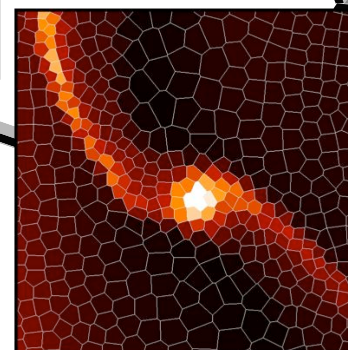
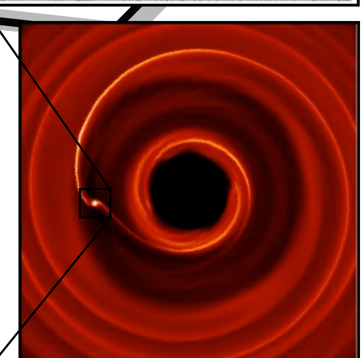




ABSTRACT

We present preliminary results of a novel approach to the numerical study of gas disks around young stars using the Voronoi-tessellation cosmological code **AREPO** (Springel,2010).

This finite-volume code is shock-capturing and second-order-accurate in time and space. Its moving mesh makes it a Lagrangian/Eulerian code that satisfies Galilean invariance and has a very low diffusivity due to its unbiased unstructured grid. Its pseudo-Lagrangian nature makes it ideal for problems that show large dynamical range in density, such as gravitationally unstable systems with clustering and collapse. The self-gravity solver is implemented consistently for collisionless particles as well as for the gas "particles" (Voronoi cells) in an *N*-body fashion using a tree algorithm.

The hydrodynamics+*N*-body approach of **AREPO** is unparalleled in its ability to treat self-gravitating systems that lack of a symmetric configuration, while retaining the resolution and accuracy of conventional grid codes. Thus, it combines the benefits of both particle- and mesh-based codes. Precisely, these two approaches are used in numerical studies of circumstellar disks depending on the physical process of interest. For example, those studies that choose particle based codes -- such as SPH -- focus on gravitationally unstable disks or the tidal interaction of disks. On the other hand, grid codes are preferred in studies of planet-disk interaction, where proper treatment of shocks, wakes and gaps requires an accurate shock-capturing method. We present examples of how the flexible approach of **AREPO** can be used to simulate these and other types of problems.

AREPO'S MUSCL-HANCOCK SCHEME (Muñoz et al,2011)

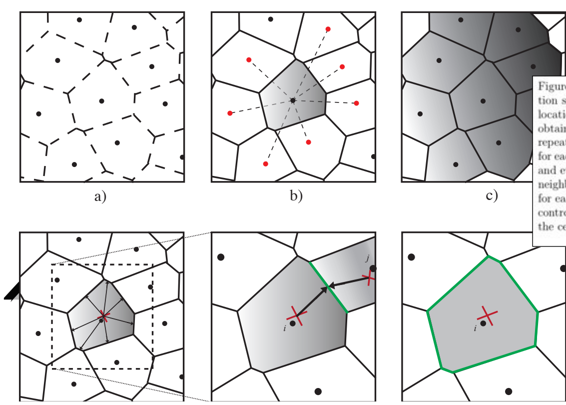
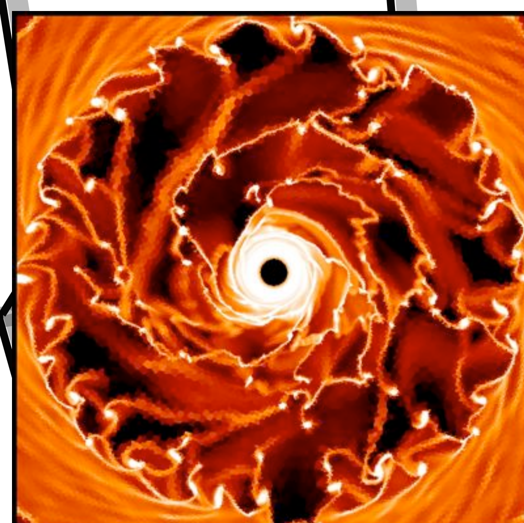


Figure 1: Schematic representation of the mesh geometry and the MUSCL-Hancock integration scheme implemented in AREPO : a) The Voronoi mesh is uniquely determined by the location of the mesh-generating points. b) A gradient estimate for all primitive variables is obtained from the immediate neighbors of a given cell. c) The gradient-estimation process is repeated for each cell in the domain and thus a piece-wise linear reconstruction is obtained for each primitive variable. d) The primitive variables are extrapolated toward each interface and evolved for half a time-step. e) For each face, a pair of extrapolated quantities for two neighboring cells i and j forms a local Riemann problem. f) The Riemann problem is solved for each face of a cell, yielding time-centered Godunov fluxes for the entire boundary of the control volume V_i of cell i. These fluxes are used for updating the conserved quantities of the cell through Eq. (24).



EXAMPLE:
SELF-GRAVITY,
DISK FRAGMENTATION WHEN Q~1

REFERENCES

- Springel, V. (2010) MNRAS, 401, 791-851