Numerical scheme based on the Riemann solver problem applied to protoplanetary disks

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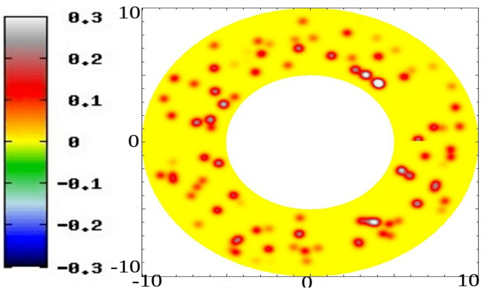
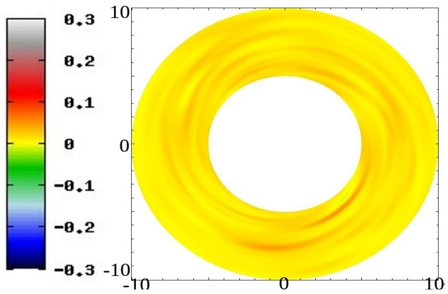
Abstract

Many fascinating astrophysical phenomena can be simulated insufficiently by standard numerical schemes for the compressible hydrodynamics equations. In this work, we develop in a first-order well-balanced scheme [1] for the compressible Euler equations with keeping the gravitational source term. This model is designed for the planetary formation that consists of momentum, continuity and energy equations written in cylindrical coordinates:

$$\frac{\partial w}{\partial t} + \frac{1}{r}\frac{\partial r F(w)}{\partial r} + \frac{1}{r}\frac{\partial G(w)}{\partial \theta} = Q(w). \tag{1}$$

In which, the vectors field F and G present respectively the fluxes in the radial and azimuthal directions. In this presentation, we will show that the finite volume method (FVM) is successfully implemented, which preserves a certain class of steady states. Additionally, we demonstrate the performance of the numerical code through some numerical tests. In particularly, the time evolution of gas orbited around the star, and some properties of the Rossby wave instability.





References

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