THE FIELD CONDITION: A NEW CONSTRAINT OF SPATIAL RESOLUTION IN SIMULATIONS OF THERMALLY UNSTABLE HYDRODYNAMICS

Hiroshi Koyama
Astronomical Data Analysis Center, NAO
AND
Shu-ichiro Inutsuka
Department of Physics, Kyoto University
第 *15* 回理論懇シンポジウム/*2002* 年度計算センター大規模シミュレーション成果報告（*mhk28a*）

ABSTRACT

We present the dynamics in thermally bistable medium by using one-dimensional numerical calculations with cooling, heating, (realistic) thermal conduction, and physical viscosity. We set up a two-phase medium from thermally unstable one-phase medium and follow the long-term evolution of the medium. We focus on the spatial resolution because we have to resolve Field length λ_F that is the critical wavelength for thermal instability (TI). The result of our calculation shows that the two cold clouds eventually collide in the calculations with thermal conduction, while clouds never collide in the case without thermal conduction. We find it necessary to keep the cell size less than $\lambda_F/3$ to achieve a converged motion in two-phase medium. We refer to the constraint that $\lambda_F/3$ be resolved as the Field condition. The inclusion of thermal conduction to satisfy the Field condition is crucial for numerical studies of TI and turbulent interstellar two-phase medium: the calculations of TI without thermal conduction are susceptible to contamination by artificial phenomena that do not converge with increasing resolution.

REFERENCES

Koyama, H., & Inutsuka, S. ApJL submitted, astro-ph/0302126

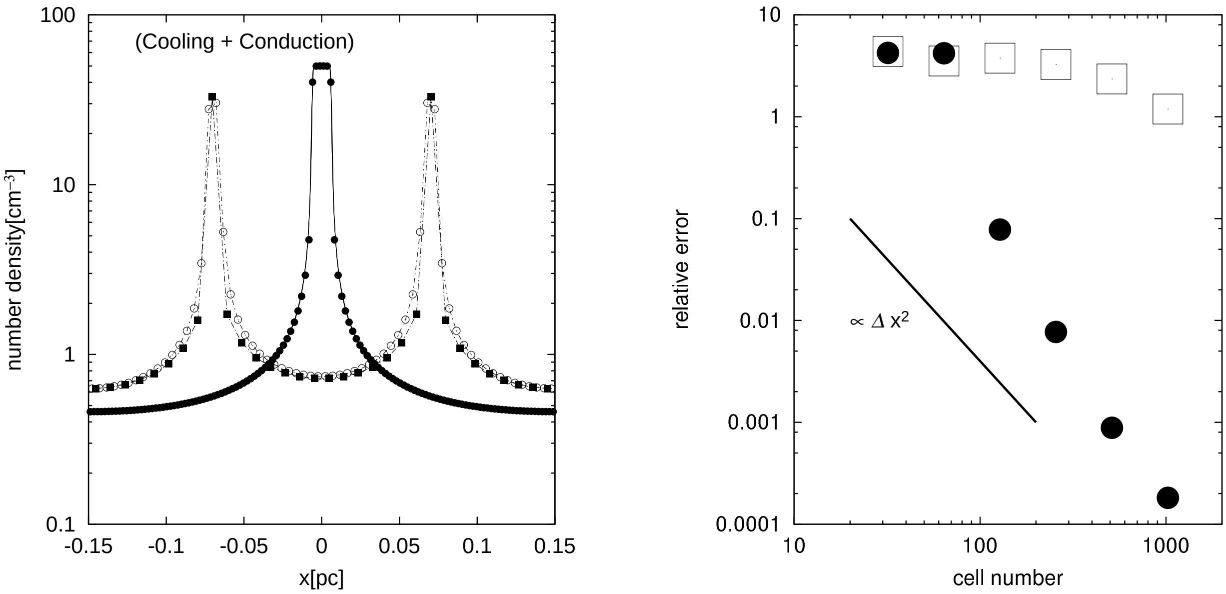

Fig. 1.— *Left*: The snapshots at t=12 Myr with resolutions ranging from 32 to 1024 cells; filled boxes connected by dot-dash lines (32 cells), open circles connected by dot-dash lines (64), filled circles (128), and solid lines (256, 512, 1024). The calculations with 256, 512, and 1024 cells show convergence in the cooling + conduction model. The calculations with 32 cells (filled boxes) and 64 cells (open circles) don't show coalescence because of insufficient cell numbers to resolve conductive cooling. *Right*: The convergence test of density distribution at $t = 10$ Myr. The error function is defined by equation (6) in the reference paper. The cooling model (open boxes), and the cooling + conduction model (filled circles) are presented. The Field length is a function of temperature and density and, hence, should be defined locally: it varies spatially in a range of 0.6–0.003 pc in this problem. Therefore, we conclude that at least three cells are required to resolve Field length and to obtain physically acceptable solution.