Chapter 4

List of Group Projects

Attendants will choose one of the following projects and carry out simulations under the supervision of the instructor. We expect 5 – 6 members for each project. The afternoon session on Friday is allocated for the presentation of achievements of each group.

1. Cloud Collision with the Galactic Gas Disk

   T. Kudoh (NAOJ)

   You will perform 2D-axisymmetric hydrodynamic or magnetohydrodynamic simulations to study the impact of the cloud with the Galactic disk. One of the motivations of this simulation is to explain the mushroom- shaped cloud of the Galactic worm candidate GW 123.4-1.5. Kudoh & Basu (2004) have recently performed the hydrodynamic simulation with adiabatic gas and reproduced the mushroom-shaped structure of the gas. You will perform the similar simulations with cooling effect of the gas or the magnetic field, both of which are probably not negligible in the real Galactic gas. You will research how different shapes you get when you include these effects. You could also perform the similar simulations with the 2D-Cartesian coordinate. You may think about the limitations of 2D-axisymmetric or 2D-Cartesian simulations.

   Reference
   "A mushroom-shaped structure from the impact of a cloud with the Galactic disk"
   Kudoh, T. & Basu, S., 2004 Astron. Astrophys., 423, 183

2. Hot Gas around Moving Clusters of Galaxies

   N. Fukuda (Okayama Univ. of Science) and N. Asai (Chiba Univ.)

   Chandra observations revealed the detailed structure in hot gas around moving clusters of galaxies (e.g. cold front and tail). We will model the gas around the clusters in hot intergalactic medium and simulate it including the heat conduction.

3. Magnetic Reconnection (Stability of Craig-Henton Solution)

   M. Oka and T. Miyagoshi (Kwasan Observatory, Kyoto Univ.)

   Magnetic reconnection is an important energy-release process in the universe and is considered to be responsible for solar flares and substorms in the Earth's magnetosphere. The analytic solution of magnetic reconnection has been found quite recently (Craig & Henton, 1995), but its non-linear evolution and stability are still unclear. Then, in this group, we will perform parametric survey of the Craig-Henton solution with a help of numerical simulation. Preliminary results have been already obtained by Hirose et al. 2004 and previous simulation school assignments of the years of 2002 and 2004. We will extend these results and discuss their physical meaning.

4. Nonlinear Evolution of the Magnetic Buoyancy Instability

   S. Nozawa (Ibaraki Univ.)

   By means of magnetohydrodynamic simulations, we study nonlinear evolutions of the magnetic buoyancy instability such as the Parker instability in a gravitationally stratified magnetized gas layer. You will set up initial conditions for the Galaxy or for the Sun, and simulate the growth of the instability. We discuss how the magnetic loops created by the instability will actually be observed.

5. Magnetorotational Instability in Accretion Disks

   M. Machida (NAOJ) and R. Matsumoto (Chiba Univ.)

   We study the effects of resistivity, initial configuration of magnetic fields, vertical gravity, and radiative cooling on the growth of the magnetorotational instability. Both local simulations and global simulations will be assigned. When the radiative cooling is included, the disk will shrink in the vertical direction when the density exceeds some critical value. We will explore the possibility that magnetic energy is released explosively in such disks.

6. Relativistic hydrodynamic/MHD simulations

   S. Koide (Toyama Univ.)

   We plan to perform relativistic hydrodynamic/MHD simulations with CANS and general relativistic MHD code. The distinct theme of the simulations are as follows:

   - Relativistic shock tube problems with CANS
   - Interaction of relativistic flow and magnetic field with CANS
   - Stability of a rotating disk around a black hole
   - Plasma falling into a black hole
   - Interaction of plasma and magnetic field around rapidly rotating black hole

7. Disk Flare Model

   K.E. Nakamura (Matsue National College of Technology)

   The disk flare model successfully explains strong X-ray activities of young stellar objects. According to this model, magnetic field loops connecting a central star and its surrounding disk are twisted by the disk rotation. The strongly wound magnetic loops expand and change their initial dipole configuration to an open one. Since a current sheet is formed inside the expanding loop, magnetic reconnection occurs in the presence of resistivity. A large amount of energy is released by the magnetic reconnection. We will study the influence of the disk flare on the disk structure by using the 2-dimensional MHD code including heat conduction. Our aim is to simulate the evaporation of cool disk plasma to the hot corona.