[S11-3] Physical Properties of Spiral Density Waves Triggered by a Tidal Encounter

Oh, S. H., Kim, W.-T. and Lee, H. M.
Seoul National University

We investigate tidal encounters of a disk galaxy with a point mass perturber using the GADGET numerical code. The target galaxy consists of three parts: a halo, a central bulge, and an exponential disk composed of stars and gas. We handle the halo and central bulge by using fixed gravitational potentials, but realize the razor-thin disk by live particles. The point mass perturber with a mass of 10 or 20% of the disk galaxy is set to move on a parabolic orbit with pericenter distance of 35 or 45kpc from the disk galaxy. We find that a tightly-wound, logarithmic, twin-armed global spiral pattern develops between the inner Lindblad and the corotation resonance radii. The arm pitch angle is $i=3-4°$ with a larger value corresponding to the stronger arm. The pattern speed of the arm is found to be ~6-10 km/s/kpc, which is very similar to the angular velocity of the perturber near the pericenter. The perturbed density corresponding to the $m=2$ mode relative to the background mean density is a linearly increasing function of radius and is less than 50% for $R<15$ kpc. However, the arm strength F, which measures the perturbed gravitational force relative to the background axisymmetric force, remains more or less constant over a range of radii. We find that the F value is proportional to the strength of tidal force at the pericenter, yielding $F \sim 2-4\%$ for a perturber with mass of 0.1 to 0.2 times the galaxy mass and with the pericentric distance of 35 to 45 kpc.

[S11-4] Instability of Galactic Spiral Shocks

Chang-Goo Kim[1], Woong-Tae Kim[1], Eve C. Ostriker[2]
[1]*Seoul National University,* [2]*University of Maryland*

We study non-steady motions associated with spiral shocks in vertically-stratified galactic disks using two-dimensional magnetohydrodynamic simulations. Our models are local and assume an isothermal equation of state. We first set up a stratified disk in hydrostatic equilibrium and then turn slowly on a spiral stellar potential. Unlike in one-dimensional cases, two-dimensional flows across the spiral arm become unstable by about the time when the spiral forcing attains its full strength. This results in highly turbulent motions of the gas whose density-weighted velocity dispersions at saturation is comparable to the sound speed of the medium. Two distinct mechanisms conspire to develop fully turbulent gas flows; small-scale instability at the shock front and large-scale flapping motions of the shock. The shock flapping motions are caused by the interplay between the vertical disk oscillations and shock crossings of the gas, whose frequencies are incommensurable to each other. The small-scale shock instability in our models appears to be very similar to those in the Bondi-Hoyle-Lyttleton (BHL) accretion problem despite the significant differences in the nature of an accretor, boundary conditions, etc. between the spiral shock and BHL problems. We suggest that among various mechanisms proposed for instability in the BHL problem the vortical-acoustic cycle between the shock and the sonic radius (Foglizzo 2002) is likely to be responsible for the small-scale instability seen in our models.