Locking of the rotation of disk accreting magnetized stars

M. Long, M. Romanova

Dept of Astronomy, Cornell University (Long@astro.cornell.edu / Phone: +1-607-255-6789)

In the rotational equilibrium state of disk accreting magnetized stars, the star's rotation can be “locked" at an angular velocity Ω_{eq} due to the disk-magnetosphere interaction. The early models proposed that the magnetic field has a dipole configuration everywhere and that the difference between spin-up torque, which arises from the magnetic connection of the star to the disk within the corotation radius $r_{co} = (GM/\Omega_*^2)^{1/3}$, and the spin-down torque, which arises outside, determines the spin evolution of the star. For a particular value of the star's rotation rate, Ω_{eq}, the spin-up torque balances the spin-down torque and the star is in the rotational equilibrium state.

We investigate disk accreting magnetized stars using axisymmetric magnetohydrodynamic (MHD) simulations with Godunov-type code. Our simulations show the magnetic field threading the disk may be more complicated than the dipole field and tends to be inflated and possibly opened due to the difference between the angular velocities of the foot-points, and reconnected later. This kind of reconnection leads to quasi-periodic oscillations of the inner region of disk. Numerically, we find that the corotation radius r_{co} is related to the magnetospheric radius r_A as $r_{co}/r_A \approx 1.2 - 1.5$ for such torqueless accretion, by performing a large set of numerical simulations for different values of star/disk parameters.