MHD SIMULATIONS OF STAR-DISK INTERACTION IN YOUNG STARS WITH THE VAC CODE.

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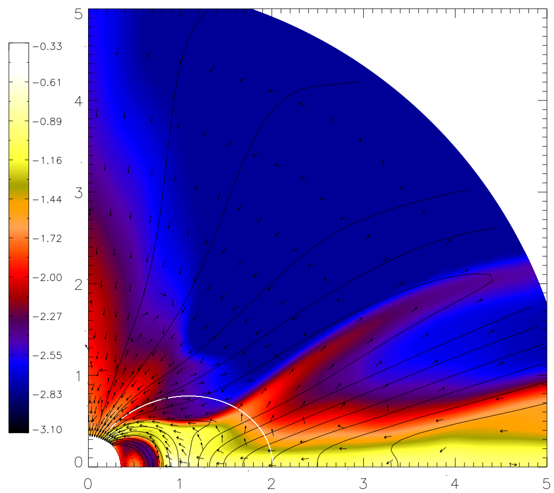

Figure 1: Resistive MHD simulation for a 5 days period CTTS with $B_* = 141G$ and $\alpha_m = 1$ after 10 days. We show the density distribution in the computational domain. The black lines draw the magnetic field lines and the black arrows represent the velocity field. The white line represents an initial magnetic field line anchored at R_{co}. An accretion column is formed and one observe the expansion of the poloidal magnetic field and transient disk ejecta. The accretion rate at the stellar surface is equal to $2, 4.10^{-8} M_\odot.yr^{-1}$. The star is being spun up in this configuration.

We present new results from 2.5D MHD simulations done with the VAC code taking into account the rotation of a low mass Classical T-Tauri protostar and a thin keplerian accretion disk including resistivity. Firstly, we explicit the physical conditions necessary to form accretion columns at the disk inner edge. We expect that when the magnetic field becomes strong enough, the accretion flow is diverted from the disk midplane and then occurs along the magnetic field lines forming accretion columns. This radius may be defined as the truncation radius R_t of the disk. Its position respect to the corotation R_{co} is still an open issue because the models consider $R_{co} \sim R_t$ to avoid the problem of differential rotation leading to restricted connectivity between the disk ans the star in long term evolution whereas observations show $R_t < R_{co}$ because otherwise too strong stellar dipolar magnetic field ($B_* > 10kG$) are necessary for fiducial accretion rate around $\dot{M} = 10^{-8} M_\odot.yr^{-1}$. To study this point, we solve the full set of resistive MHD equations with the VAC code modified to compute correctly the magnetic torque. We consider a 0.8 $M_\odot$ young star with a radius of 2 $R_\odot$, a rotation period of 5.1 days and a pure dipolar magnetic field with a stellar value at the equator equal to $B_* = 141G$.

We carry out a set of simulations by varying the initial position of the truncation radius R_t and study its evolution in time and the possibility to have polar accretion. We demonstrate that all runs converge towards the same truncation radius corresponding to equipartition between magnetic pressure and disk thermal pressure. Accretion columns are thus formed even for weak dipolar magnetic field ($B_* \sim 100G$) like in figure 1, what is closer to observational constraints.

Then, we show the difficulties to connect the star to the disk beyond the corotation according to the disk resistivity strenght for instance or the distance between the truncation radius and the corotation one. When we achieve this connection, we stress the necessity to extract the excess of angular momentum brought by the young star into the disk beyond the corotation in order to sustain accretion flow in its outer part to feed accretion columns for long term interaction. This is done by adding a magnetic field in the disk for which we will show preliminary results or by using a turbulent viscous disk (see Zanni contribution).