## 2. ROTATION

Next we determine the components of smaller magnitude $(B_r, B_\theta, v, w)$ by using $(B_\phi, u, \rho)$ in the previous section. Substituting equations (4) through (7) into the MHD equations and neglecting the higher order terms of $(B_r, B_\theta, v, w)$, we have

$$rw - r\cdot\frac{B_\phi B_r}{4\pi\rho u} = \text{constant} \ (\equiv \ell\phi) \ , \qquad (12)$$

$$B_r(r,\theta) = B_r(r_0)\cdot\left(\frac{r_0}{r}\right)^2\cdot\frac{1}{\sin\theta} \ , \qquad (13)$$

$$v = 0 \ , \quad (14) \quad : \qquad B_\theta = 0 \ , \quad (15)$$

where $r_0$ is an arbitrary constant with the same dimension as r. The gas is rotated by the magnetic torque [equation (11)].

## 3. CORE JET

The cold magnetic jet has intrinsically a slender gaseous core along the symmetry axis as suggested by equations (4) and (5). This core gas is assumed to have no magnetic field in it, and to be hot enough to balance laterally the outside magnetic pressure due to B, i.e.

$$P_c\,(r) = \frac{1}{8\pi}\ B_\phi^2\ (r,\theta_c).$$

The spatial gradient of $P_c$ accelerates the core gas like the "melon seed" effect. Numerical computations show that this core jet has a larger velocity than the cold magnetic one has and it is accelerated as log r. See the detailed discussions and conclusions in the reference.

## REFERENCE

Maruyama, T., and Fujimoto, M.: 1986, submitted to Pub. Astron. Soc. Japan.

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# COLLIMATION OF STELLAR WINDS BY THE MAGNETIC FIELD

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The pinching effect of the magnetic field is studied as a possible mechanism for collimating stellar winds into bipolar flows in star-forming regions. Axisymmetric, steady, polytropic stellar wind models are constructed by solving numerically the magnetohydronynamic equation. The magnetic field is assumed to be radial near the star. Far from the star the magnetic field makes a spiral near the equatorial plane and the toroidal components build up. The pressure and the tension of the toroidal magnetic field deflects the wind away from the equator toward the rotation axis. This deflection continues until the flow becomes nearly cylindrical near the rotation axis. This state is a pinch configuration in which dense gas is confined into a collimated flow by the toroidal magnetic field. This mechanism works under very general circumstances in the magnetic stellar winds from rotating stars.

## MAGNETIC FIELD AMPLIFICATION AND POLAR JET FORMATION IN PROTOSTARS

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There is a simple relationship among moment of inertia I, rotational kinetic energy K, and momentum L given by (David Layzer, private communication), $2IK \geqq L$. During the Hayashi phase a rotating protostar will amplify the trapped magnetic field by a dynamo-like process. Since the rotation is expected to be fast, many unstable modes will be excited and will grow exponentially in time until some nonlinear processes saturate the amplitude. However, it may happen that the reduction in rotational kinetic energy becomes so large that without increasing the moment of inertia the inequality given above may not be satisfied. The only way to increase the moment of inertia is to move the mass outward. This can be done by transferring the angular momentum outward through the magnetic field. So we will have a fast rotating mass shell at the outer edge of the star. Further transfer of angular momentum will push the shell against the accretion disk; the moving masses of the disk will divert the mass flow along the background magnetic field which extends perpendicular to the accretion disk. This results in the hollow cone jets from both poles because the outward motion is primarily on the equatorial plane.