OBSERVATIONAL CONSTRAINTS ON ANGULAR MOMENTUM TRANSFER DURING GRAVITATIONAL COLLAPSE*

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ABSTRACT. A simple calculation of the expected spectral signatures of model protostellar accretion flows suggests how the rotation curve of the accretion disk may be deduced from radio frequency molecular line observations. We compare synthetic observations with actual data to derive rotation curves, braking torques, and minimum magnetic field energies required to effect the braking.

1. Introduction

Similar to the way in which galactic rotation curves may be deduced from HI position-velocity of *l,v* plots, the rotation curves of accretion flows may be deduced from molecular line observations. We illustrate this with synthetic NH_3 spectra computed for 3 model accretion flows.

In th case solid body rotation, $\omega \propto r^0$, the projected velocity is constant along any line of site resulting in a linear dependence of the emission velocity with position across the disk. In the case of angular momentum conservation, $\omega \propto r^{-2}$. The faster rotation in the center of the disk spreads the emission over a larger range in velocity. Figure 1 illustrates the appearance of the intermediate case indicative of partial loss of angular momentum or braking. (The repeating pattern in velocity is caused by the electric quadrupole splitting of the NH_3 line.) A summary of the parameters of several accretion flows from data published elsewhere is shown in Table 1.

Given a rotation curve and infall velocity, the minimum magnetic field energy density required to effect the braking may be estimated from the spin-down torque as,

$$DL/Dt = (DL/Dr)(Dr/Dt) = (4\pi r^2\rho(r))(r^2\Omega(r))v_r$$

The results for two flows are presented in Table 2.

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E. Falgarone et al. (eds.), Fragmentation of Molecular Clouds and Star Formation, 438–439.

Table 1

Source	Radius	$\omega(r)^{-1}$ (yrs)	$v_r(r)$ (km s^{-1})	$\rho(H_2)$ (cm^{-3})
G10.6C[1]	0.35pc	4×10^5	2.7	2×10^4
$500M_\odot$*		$\propto r^{-2.5}$	$\propto r^{-0.8}$	$\propto r^{-0.35}$
G10.6B[2]	0.2pc	$\sim 7 \times 10^5$	?	4×10^3
$200M_\odot$		$r^0 < \omega < r^{-2}$		
G10.6A[2]	0.2pc	$\sim 7 \times 10^5$	?	1.5×10^4
$100M_\odot$		$r^0 < \omega < r^{-2}$		
G34.3[3]	100au	525 ± 20	3.6 ± 0.25	$4 \times 10^{9 \pm .3}$
$4M_\odot$		$\propto r^{-0.5 \pm 0.05}$	$\propto r^{-0.3 \pm 0.04}$	$\propto r^{-0.4 \pm 0.1}$

* Masses indicate the total core mass, the radius refers not to the "boundary" of the core, but the radius within the core for which the properties ω, ρ, v are tabulated.

[1] Keto, E. 1990, *Ap. J.*, **355**, 190.

[2] Cool, A., and Ho, P. 1990, *in preparation.* [3] Keto, E., Jeffrey, W., and Proctor, D. 1990 *in preparation.*

Table 2

Source	Radius	DL/Dt (ergs)	Required B (mG)	$\rho(H_2)$ cm^{-3}
G10.6C	0.35pc	2×10^{46}	0.3	2×10^4
	0.025pc	9×10^{45}	10	1.5×10^7
G34.3	500au	4×10^{44}	75	2×10^9
	100au	2×10^{44}	200	4×10^9