Model - References

Model

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•Hidalgo, M. A.: Correction to "A study of the expansion and distortion of the cross section of magnetic clouds in the interplanetary medium" (vol 108, pg 1320, 2003), J. Geophys. Res., 110(A3), 110, A03207, doi:10.1029/2004JA010752, 2005.

To learn more…

• Hidalgo, M. A., T. Nieves-Chinchilla, C. Cid. Elliptical cross-section model for the magnetic topology of magnetic clouds. Geophysical Research Letters, **29** (13), 10.1029/2001GL013875, 2002.

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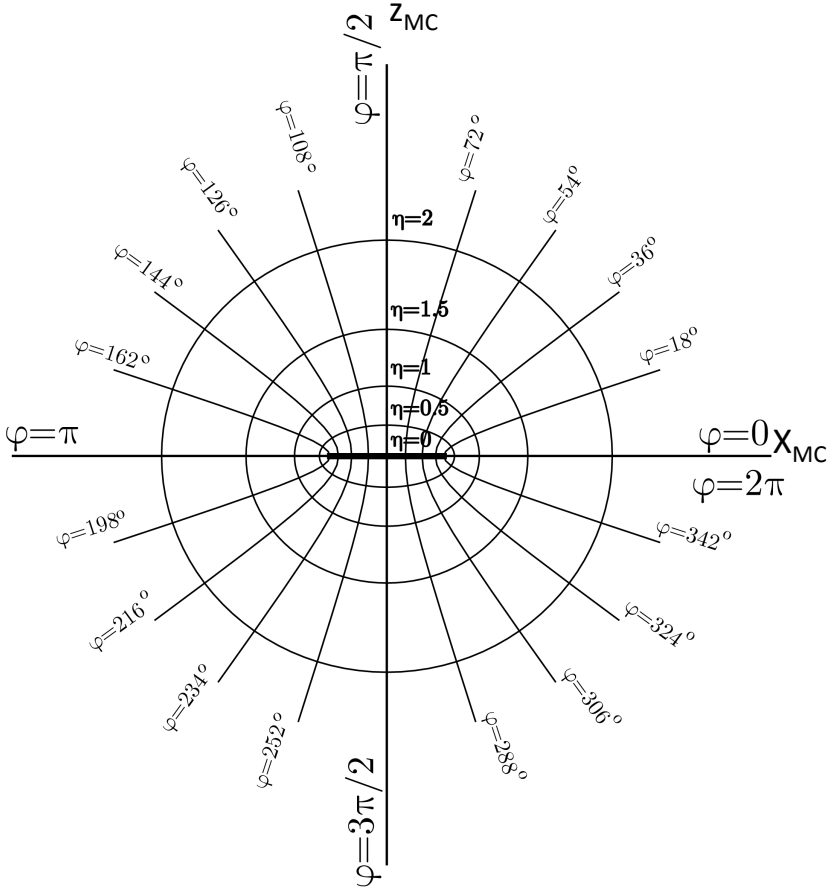
• Nieves-Chinchilla, T., Viñas, A. F.-, and M. A. Hidalgo. Magnetic Field Profiles Within Magnetic Clouds: A Model Approach. Earth, Moon and Planet, (2009) **104**: 109-113. doi: 10.1007/s11038-008-9252-0.

• Nieves-Chinchilla, T., Gomez-Herrero, R., Viñas, A. F.-, Malandraki, O., Dresing, N., Hidalgo, M.A., Opitz, A. Sauvaud, J.-A., Lavraud, B., Davila, J.M. Analysis and study of the in situ observation of the June 1st 2008 CME by STEREO. JASTP in press.

Model – Coordinate system



Elliptic Cylindrical Coordinates:

$$x_{MC} = a \cosh\eta \cos\varphi$$
$$y_{MC} = y$$
$$z_{MC} = a \sinh\eta \sin\varphi$$

where ***a*** is the focal distance

Model – Equations & Constrains

Magnetic Field Topology

$$B_\eta = 0$$

$$B_y = B_y^0 - a\mu_0 j_\eta \sinh(\eta) E\left[\varphi \,|\, -1/\sinh^2(\eta)\right]$$

$$B_\varphi = -\mu_0 j_0 a \frac{\sinh(\eta)}{\sqrt{\cosh^2\eta - \cos^2\varphi}}$$

- Radial component
- Axial component
- Poloidal component

Non force-free conditions, then the current density components are

$$j_\eta = cte$$

$$j_y = \frac{j_0 \cosh(\eta)}{\sqrt{\cosh^2\eta - \cos^2\varphi}}$$

$$j_\varphi = \frac{-j_\eta}{\sqrt{\cosh^2\eta - \cos^2\varphi}} \cosh(\eta) F\left[\varphi \,|\, -1/\sinh^2(\eta)\right]$$

➔

$$j_\eta = \alpha(t_0 - t)$$

$$j_y^0 = \lambda(t_0 - t)$$

The cross section expansion

Note:
F *and* ***E*** *are the elliptic integrals of first and second kind.*

The constraint is given through the plasma pressure…

$$\nabla p = -\nabla\left(\frac{B^2}{2\mu_0}\right) + magnetic\ tension(=0) \Rightarrow \quad \boxed{p + \frac{B^2}{2\mu_0} = C_1}$$