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CORRECTION

Correction to: On Fields and Mass Constraints for the Uniform Propagation of Magnetic-Flux Ropes Undergoing Isotropic Expansion

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When expressing the steady current density $\mathbf{J}_{\mathrm{c}}$ (convection-current) it is easy to check that, up to $O(R_{\mathrm{FRcore}}/R_{\mathrm{cFR}})^2$, its evaluation ($\mathbf{J}_{\mathrm{c}} = \nabla \times \mathbf{H}$, see *e.g.* Jackson, 1963) gives an axial component that is

$$J_{\mathrm{c}x}(\mathit{modified}) = A(t)/\mu_0 \bigl\{ H B_x \bigl[1 - 2\rho/R_{\mathrm{cFR}} \bigl(\cos(\varphi) - |\sin(\varphi)| \bigr) \bigr] + \Delta j_{cx} \bigr\}$$

with

$$\Delta j_{cx} = \rho/R_{\mathrm{cFR}} \bigl(\cos(\varphi) - |\sin(\varphi)| \bigr) J_1 \bigl(A(t, \rho, \varphi) \bigr) / A(t, \rho, \varphi)$$

correcting/completing the $\mathbf{J}_{\mathrm{c}}$ expression presented before Equation 8 in the paper. The meaning for each symbol used follows:

H $(= +1$ or $-1)$ is the handedness of the flux rope (FR).
$\mathbf{H}$ $(= \mathbf{B}/\mu_0)$ is the magnetic field intensity, and $\mathbf{B}$ the magnetic field density.
μ_0 is the magnetic permeability of the vacuum. (We assume no magnetization.)
R_{FRcore} is the cross section radius of the FR modeled.
R_{cFR} is the distance from the center of the Sun to the axis of the flux rope modeled.
$A(t) = j_0/R_{\mathrm{FRcore}}$, where j_0 is the first node of the grade 0 cylindrical Bessel function '$\mathcal{J}_0(A(t, \rho, \varphi))$' of the first kind.

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$B_x = B_0(t_0/t)^2 \mathcal{J}_0\ (A(t,\rho,\varphi))$ is the axial field of the flux-rope, where B_0 is the magnetic field strength parameter in the MHD flux-rope solution at the initial time t_0 in its evolution. Finally, the argument of the Bessel function $\mathcal{J}_{0(1)}$ is

$$A(t,\rho,\varphi) = A(t)\rho\big[1 + \rho/R_{\mathrm{cFR}}\big(\cos(\varphi) - |\sin(\varphi)|\big)\big],$$

which is given in Equation 7 of the paper. (ρ, φ are polar radial and angle coordinates.)

The other two corrected components are

$$J_{c\rho} = -A(t)/\mu_0 H B_\phi \rho/R_{\mathrm{cFR}}\big[\sin(\varphi) + \partial_\varphi|\sin(\varphi)|\big]$$
$$J_{c\phi} = A(t)/\mu_0 H B_\phi\big[1 - 2\rho/R_{\mathrm{cFR}}\big(\cos(\varphi) - |\sin(\varphi)|\big)\big]$$

where $B_\phi = H B_0(t_0/t)^2 J_1\ (A(t,\rho,\varphi))$ is the polar component of the magnetic field density $\mathbf{B}$.

The relevance of the previously missing term Δj_{cx} is that it dominates the axial current contribution within the FR plasma located in the region defined by $0.93 R_{\mathrm{FRcore}} < \rho < 1.07 R_{\mathrm{FRcore}}$.

It is straightforward to check that $\mathbf{div}(\mathbf{J}_c) = 0$ is well satisfied up to $n = 1$ in a perturbation expansion in ε^n of our 3D MHD analytical solution of a FR evolution, where $\varepsilon \equiv R_{\mathrm{FRcore}}/R_{\mathrm{cFR}}$ is a small quantity.

References

Jackson, D.: 1963, *Classical Electrodynamics, Section 5.8*, 3rd edn. Wiley, New York.