

## Reply to referee-1 comments

Thank you very much for the positive evaluation. Here are our reply comments.

- *This draft reviews basic concepts of the large-scale heliospheric magnetic fields mainly from the kinematic framework. I have the following (mostly minor) comments:*

1. *Fig.2 The blue, red, and gray lines should be defined in the caption.*

**Reply:** Done.

- Fig. 2 caption (page 8 in the revised manuscript):

“Streamlines in the Parker spiral model of interplanetary magnetic field around the Sun (a filled circle in yellow) in the heliospheric ecliptic plane up to 5 astronomical units (au) under different conditions of the solar wind speed. The orbit of the Earth is marked by a blue curve at a radius of 1 au, that of Mars by a red curve (1.5 au), and that of Jupiter by a green curve (5 au).”

- 2. *The caption of Fig. 3 The authors should explain the line types and the numbers (24.47h, etc.: Rotational period) in the caption or in the panel.*

**Reply:** Agreed. Done.

- Fig. 3 caption (page 9):

“Heliocentric distance  $r$  in astronomical units (au) at which the spiral angle of the interplanetary magnetic field reaches  $45^\circ$  to the radial direction from the Sun ( $B_r = B_\phi$ ). The curves are plotted as a function of the solar wind speed in units of  $\text{km s}^{-1}$  for 3 different rotation rates, a period of 26.24 hours (upper curve), 25.38 hours (middle curve), and 24.47 hours (lower curve). A typical value of the solar wind speed is  $430 \text{ km s}^{-1}$  (shown by a vertical thin line).

- 3. *Fig. 4 and Section 2.1.4 In the section 2.1.4, it seems that the authors focuses on the situation, in which  $B_{\theta} = 0$  (eq.20). But Figure 4 shows field lines with non-zero  $B_{\theta}$ . Probably, the formulation of eqs. (22) - (25) in the same section takes into account  $B_{\theta}$ . I think more explanations are necessary, which is friendly to readers.*

**Reply:**

We agree that more explanations are necessary to clarify the polar component issue. The axial component of the spiral (or helical) field lines in Fig. 4 is due to the radial component, and does not represent the polar component. The vanishing polar component of the magnetic field holds in the Parker model; the polar component  $B_\theta$  has the axial component like the radial component, but the polar component differs from the radial one in that the polar component is pointing towards the rotation axis (whereas the radial component is pointing

away from the rotation axis). The radial direction and the polar direction are orthogonal to each other.

We add the following text and changed the figure 4 caption.

- Main text, section 2.1.4 (page 10):

“It is worth mentioning that the spiral magnetic field lines are constructed with the radial component from the Sun and the azimuthal component around the rotation axis, and do not contain the polar component (in the direction towards the rotation axis and perpendicular to the radial direction) as in Eqs. (28)–(30). The Parker spiral field lines have an axial component along the rotation axis but this is due to the radial component of the field line which has the axial component.”

- Figure 4 caption (page 11):

“Note that the spiral magnetic field lines are constructed with the radial component from the Sun and the azimuthal component around the rotation axis, and do not contain the polar component (in the direction toward the rotation axis and perpendicular to the radial direction). The spiral field lines have an axial component along the rotation axis but this is due to the radial component of the spiral field line (in the sense of being away from the rotation axis).”

- 4. *eq.(49) The scaling should be  $r^{-1}$ , instead of  $r$ . (I think this is simply a typo.)*

**Reply:** Right! Thank you. (page 18)

- $B_\phi \propto r^{-1}$ .

- 5. *eq.(50) It is probably better to refer to old works (Alazraki & Couturier 1971; Belcher 1971), in addition to the recent works that are already cited in the present paper.*

**Reply:** Agreed. Done. (page 18)

- **Other changes**

- Analysis and extension of the Parker model by Summers (1978,1982) are cited in section 2.1.1. (page 5)
- All equations in separate lines have the equation numbers.
- Mathematical symbols have been re-assigned by using capital letters, small letters, caligraphic letters, asterisk, subscripts, to avoid confusion. Also, a circle is used instead of “degree” for the units of angles.
- The following reference items are added.

- \* Alazraki and Couturier, *Astron. Astrophys.*, 1971.
- \* Belcher, *Astrophys. J.*, 1971.
- \* Isenberg, J. *Geophys. Res.*, 1986.
- \* Johnstone et al., *Astron. Astrophys.*, 2015.
- \* Keppens and Goedbloed, *Astron. Astrophys.*, 1999.
- \* Krticka et al., *Astron. Astrophys.*, 2016.
- \* Lima et al., *Astron. Astrophys.*, 2001.
- \* Summers, J. *Inst. Maths. Applics*, 1978.
- \* Summers, *Astrophys. J.*, 1982.
- \* Thirumalai and Heyl, *Mon. Not. R. Astron. Soc.*, 2010.
- \* Yoshizawa, *Hydrodynamic and Magnetohydrodynamic Turbulent Flows: Modelling and Statistical Theory*, 1998.