Reply to referee-2 comments

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

- *The article is a very nice tutorial overview of the subject. The grammar and spelling need to be reviewed, an example: page 3, line 19 "useful took" presumably should be "useful tool". I will leave this for the editorial staff and authors to go through this instead of providing an incomplete list.*

  Reply: Thank you for the positive evaluation and a careful check of the manuscript text.

  - "useful took" was corrected into "useful tool" (page 4).
  - We went through the spelling check and the sentence check to eliminate errors in English.

- *For the physics discussion, last section should really be expanded a little more to be a review rather than a tutorial. I would like to see a little more discussion of the two dimensional treatment, turbulent diffusion, as well as pickup ion effects on pages 16 and 17. A comprehensive review should include a basic discussion of the models. Authors already have a lot of the references in there. Including the model equations and a basic discussion of how they incorporate the higher order effects would make this review a good one stop overview read. I would like to see an expanded section 3.*

  Reply: Agreed. We added the following text and explanations.

  - A model including the latitude dependence (Lima et al., 2001) is added to section 2.2.1. (page 12).

    "A model of latitudinal dependence of the magnetic field is constructed by employing the method of separation of variable for an axi-symmetric magnetohydrodynamic outflow (Lima et al., 2001). The radial and the azimuthal components of the magnetic field are proposed as

$$B_r = \frac{B_0}{r^2}\sqrt{1+\mu\sin^{2\epsilon}\theta} \tag{41}$$

$$B_\phi = \lambda B_0 \frac{\sin^\epsilon\theta}{r}\left(\frac{\frac{r^2}{R_\mathrm{s}^2}-1}{1-M_\mathrm{A}^2}\right), \tag{42}$$

    where ϵ is a free parameter, μ is the ratio of the flow kinetic energy (or energy density, strictly speaking) in the equatorial region to that in the polar region, and λ is the ratio of azimuthal to radial velocity (and also magnetic field) at the base of the wind. R_s is the radius of the star or the Sun. M_A is the Alfvén Mach number of the flow. The polar component of the magnetic field is assumed to vanish due to the assumption of the axial symmetry around the rotation axis."

– A model including the tilt angle and the solar cycle dependence (Burger et al., 2008) is added to section 2.2.4. (page 16 to page 18).

"A more refined magnetic field model is constructed by Burger et al. (2008), which offers an extension of the tilted heliospheric current sheet (with respect to the rotation axis) to the solar cycle dependence. The latitude-dependent magnetic field model is expressed as follows:

$$B_r = B_0 \left(\frac{r_0}{r}\right)^2 \tag{65}$$

$$B_\theta = B_r \frac{r}{U_{\rm sw}} \omega^* \sin\beta^* \sin\phi^* \tag{66}$$

$$\begin{aligned} B_\phi = B_r \frac{r}{U_{\rm sw}} \Bigg[& \omega^* \sin\beta^* \cos\theta \cos\phi^* + \\ & \sin\theta \left(\omega^* \cos\beta^* - \Omega_\odot\right) + \frac{{\rm d}\omega^*}{{\rm d}\theta} \sin\beta^* \sin\theta \cos\phi^* + \\ & \omega^* \frac{{\rm d}\beta^*}{{\rm d}\theta} \cos\beta^* \sin\theta \cos\phi^* \Bigg]. \end{aligned} \tag{67}$$

Here

$$\phi^* = \phi - \Omega_\odot t + \frac{\Omega(r - r_0)}{U_{\rm sw}} + \phi_0. \tag{68}$$

B_0 is again the radial component of the magnetic field at the reference radius r_0. The symbol $\beta_{\rm F}$ is the angle (the Fisk angle) between the virtual magnetic axis (p-axis) and the rotation axis of the Sun, and ω is the differential rotation rate of the Sun. Both the angle $\beta_{\rm F}$ and ω are generalized to the latitudinal dependent case by introducing the transition function $F_{\rm t}(\theta)$ in the following way:

$$\beta^* = \beta_{\rm F} F_{\rm t}(\theta) \tag{69}$$

$$\omega^* = \omega F_{\rm t}(\theta). \tag{70}$$

The transition function is constructed as follows (Burger et al., 2008):

$$F_{\rm t} = \left|\tanh[\delta_{\rm pol}\theta] + \tanh[\delta_{\rm pol}(\theta - \pi)] - \tanh[\delta_{\rm eq}(\theta - \theta'_{\rm b})]\right|^2 \tag{71}$$

for the northern high-latitude region ($0 \le \theta < \theta'_{\rm b}$);

$$F_{\rm t} = 0 \tag{72}$$

for the equatorial or low-latitude region ($\theta'_{\rm b} \le \theta \le \pi - \theta'_{\rm b}$); and

$$F_{\rm t} = \left|\tanh[\delta_{\rm pol}\theta] + \tanh[\delta_{\rm pol}(\theta - \pi)] - \tanh[\delta_{\rm eq}(\theta - \pi + \theta'_{\rm b})]\right|^2 \tag{73}$$

for the southern high-latitude region. $\theta'_{\rm b}$ is the equatorward-limit polar angle of the coronal hole (characterized by open field lines) and is between 60° and 80° from the solar rotation axis in Burger et al. (2008). The symbols $\delta_{\rm pol}$ and $\delta_{\rm eq}$ are the control parameters of the transition from the high-latitude magnetic fields (Fisk-type model) into the low-latitude fields (Parker-type model), e.g., $\delta_{\rm pol} = \delta_{\rm eq} = 5.0$ proposed by Burger et al. (2008). The magnetic field model in Eqs. (65)–(67) represent a

natural extension of the Parker model in that the case $F_\mathrm{t} = 1$ reproduces the model proposed by Zurbuchen et al. (1997) and the case $F_\mathrm{t} = 0$ the Parker model. The associated polar and azimuthal components of the flow velocity are:

$$U_\theta = r_0 \omega^* \sin\beta^* \sin\phi_\Omega \tag{74}$$

$$U_\phi = r_0 \Bigg(\omega^* \sin\beta^* \cos\theta \cos\phi_\Omega + \omega^* \cos\beta^* \sin\theta + \frac{\mathrm{d}\omega}{\mathrm{d}\theta} \sin\beta^* \sin\theta \cos\phi_\Omega + \omega^* \frac{\mathrm{d}\beta^*}{\mathrm{d}\theta} \sin\theta \cos\phi_\Omega \Bigg). \tag{75}$$

The Fisk angle β_F is related to the tile angle of the heliospheric current sheet α_F by Burger et al. (2008):

$$\cos(\alpha_\mathrm{F} + \beta_\mathrm{F}) = 1 - \left(1 - \cos\theta'_\mathrm{mm}\right) \frac{\sin^2\alpha_\mathrm{F}}{\sin^2\theta_\mathrm{mm}}, \tag{76}$$

where θ_mm and θ'_mm are the equatorward (low-latitude) boundary of the polar coronal hole on the level of photosphere source surface in heliomagnetic coordinates, respectively. The boundary angles are expressed in heliographic coordinates as $\theta_\mathrm{b} = \theta_\mathrm{mm} - \alpha_\mathrm{F}$ and $\theta'_\mathrm{b} = \theta'_\mathrm{mm} - \alpha_\mathrm{F}$, respectively.

The tilt angles α_F and β_F and the boundary angles θ_b and θ'_b can be modeled in a time-dependent way when constructing the Fisk-Parker-hybrid model (Burger et al., 2008) as a solar cycle dependent one: The time dependence of the tilt angle α_F is modeled as

$$\alpha_\mathrm{F} = \alpha_\mathrm{min} + \left(\frac{\pi}{4} - \frac{\alpha_\mathrm{min}}{2}\right) \left[1 - \cos\left(\frac{\pi}{4} T[\mathrm{yr}]\right)\right] \tag{77}$$

for $0 \leq T[\mathrm{yr}] \leq 4\mathrm{yr}$, and

$$\alpha_\mathrm{F} = \alpha_\mathrm{min} + \left(\frac{\pi}{4} - \frac{\alpha_\mathrm{min}}{2}\right) \left[1 - \cos\left(\frac{\pi}{7}(T[\mathrm{yr}] - 11)\right)\right] \tag{78}$$

for $4 < T \leq 11\mathrm{yr}$, where $\alpha_\mathrm{min} = \pi/18$ is an offset tilt angle. Time T is measured in units of years after a solar minimum. The time dependence of the boundary angles is

$$\theta_\mathrm{b} = \frac{\theta_\mathrm{b(min)}}{2} \left[1 + \cos\left(\frac{\pi}{4} T[\mathrm{yr}]\right)\right] \tag{79}$$

$$\theta'_\mathrm{b} = \frac{\theta'_\mathrm{b(min)}}{2} \left[1 + \cos\left(\frac{\pi}{4} T[\mathrm{yr}]\right)\right] \tag{80}$$

for $0 \leq T \leq 4\mathrm{yr}$, and

$$\theta_\mathrm{b} = \frac{\theta_\mathrm{b(min)}}{2} \left\{1 + \cos\left[\frac{\pi}{7}(T[\mathrm{yr}] - 11)\right]\right\} \tag{81}$$

$$\theta'_\mathrm{b} = \frac{\theta'_\mathrm{b(min)}}{2} \left\{1 + \cos\left[\frac{\pi}{7}(T[\mathrm{yr}] - 11)\right]\right\} \tag{82}$$

for $4 < T \leq 11\mathrm{yr}$."

– A more detailed explanation of the two-dimensional MHD model by Sakurai (1985) is included in section 3.1, subsection "two-dimensional treatment". (page 19–20)

"It is useful to introduce the poloidal-toroidal expression of the magnetic field in the two-dimensional MHD treatment:

$$\vec{B} = \nabla \times (a\vec{e}_\phi) + B_\phi \vec{e}_\phi, \tag{90}$$

where a denotes the magnetic stream function and $\vec{e}_\phi$ is the unit vector in the azimuthal direction around the rotation axis. The poloidal fields B_p (the first term in Eq. 90) are obtained by a family of curves under $a = const$. We introduce the barred radius which is the distance from the rotation axis, $\bar{r} = r \sin\theta$. The flow velocity is decomposed by referring to the local magnetic field as

$$\vec{U} = \frac{\alpha_\mathrm{m}(a)}{\rho}\vec{B} + \bar{r}^2\Omega(a)\vec{e}_\phi, \tag{91}$$

where the first term (denoted by U_p) is the flow velocity component parallel to the magnetic field in the frame rotating with the angular velocity Ω, and the second term (denoted by U_ϕ) is perpendicular to the magnetic field. The toroidal component of magnetic field is determined by the angular momentum conservation,

$$\bar{r}\left(U_\phi - \frac{B_\phi}{\mu_0 a}\right) = l = \Omega \bar{r}_\mathrm{A}^2(a), \tag{92}$$

where l is the specific angular momentum and $\bar{r}_\mathrm{A}$ is the Alfvén radius at which the poloidal component of the flow velocity becomes equal to the Alfvén speed for the poloidal component of the magnetic field. Equation (92) is obtained from the (steady-state) MHD momentum equation and the flow velocity expression in Eq. (91). The magnetic stream function needs to be determined for the flow velocity and the poloidal component of the magnetic field. The magnetic stream function is numerically evaluated from the momentum equation (or force balance) perpendicular to the magnetic field by solving the following equation (Sakurai, 1985):

$$\begin{aligned}\nabla \cdot \left[\left(\frac{\alpha_\mathrm{m}^2}{\rho} - \frac{1}{\mu_0}\right)\frac{\nabla a}{\bar{r}^2}\right] &= \rho\left(E' - \frac{1}{\gamma_\mathrm{p} - 1}\frac{p}{\rho}\frac{K'}{K} + \bar{r}^2\Omega\Omega'\right) + \\ &\quad \frac{B_\mathrm{p}^2}{\rho}\alpha_\mathrm{m}\alpha_\mathrm{m}' + \\ &\quad D\left[\frac{D}{\mu_0}\Omega^2\bar{r}^2\alpha_\mathrm{m}\alpha_\mathrm{m}' - \alpha_\mathrm{m}^2\Omega^2(\bar{r}_\mathrm{A}^2)' - \alpha_\mathrm{m}^2\Omega\Omega'\left(\bar{r}_\mathrm{A}^2 - \bar{r}_\mathrm{A}^2\right)\right],\end{aligned} \tag{93}$$

where

$$D = \frac{\mu_0\rho\left(\bar{r}_\mathrm{A}^2 - r^2\right)}{\bar{r}^2(\mu_0\rho\alpha_\mathrm{m}^2 - \rho)} \tag{94}$$

and the prime $(\cdot)'$ denotes the differentiation with respect to the magnetic stream function, $\mathrm{d}/\mathrm{d}a$. Equation (93) is the generalized Grad-Shafranov

equation for the two-dimensional centrifugally-driven wind. The density ρ follows the Bernoulli equation:

$$\frac{U_{\rm p}^2}{2} + \frac{1}{2}(U_\phi - \Omega\bar{r})^2 + \frac{\gamma_{\rm p}}{\gamma_{\rm p}-1}\frac{p}{\rho} - \frac{GM.}{r} - \frac{\Omega^2\bar{r}^2}{2} = E(a) \tag{95}$$

under the polytropic or adiabatic equation of state

$$p = K(a)\rho^{\gamma_{\rm p}}. \tag{96}$$

In the two-dimensional MHD treatment of the flow, the wind becomes collimated toward the rotation axis by the pinch of toroidal fields (Sakurai, 1985), causing a non-zero poleward (northward or southward) component of the magnetic field.

– A more detailed explanation about the effect of turbulent diffusion and a model construction for the turbulent diffusion are added to section 3.3, subsection "Turbulent diffusion". (page 20–22)

"Turbulence on smaller spatial scales serves as an energy sink to large-scale mean fields, which leads to the notion of turbulent diffusion (mean-field electrodynamics). To see this more clearly, one may decompose the magnetic field into a large-scale mean field $\vec{B}_0$ and a fluctuating field $\delta\vec{B}$ (with the zero mean value); and the flow velocity likewise:

$$\vec{B} = \vec{B}_0 + \delta\vec{B} \tag{97}$$

$$\vec{U} = \vec{U}_0 + \delta\vec{U}. \tag{98}$$

The induction equation for the large-scale magnetic field has then the frozen-in term for the large-scale fields $\vec{B}_0$ and $\vec{U}_0$ and the electromotive force term $\mathcal{E}_{\rm em}$:

$$\frac{\partial\vec{B}_0}{\partial t} = \nabla\times\left(\vec{U}_0\times\vec{B}_0\right) + \nabla\times\vec{\mathcal{E}}_{\rm em}. \tag{99}$$

The electromotive force is an averaged electric field coming from the coupling of the fluctuating with the fluctuating magnetic field by the cross product:

$$\vec{\mathcal{E}}_{\rm em} = \left\langle\delta\vec{U}\times\delta\vec{B}\right\rangle. \tag{100}$$

A widely-used model in the mean-field electrodynamics is that the electromotive force depends on the large-scale quantities such as the large-scale magnetic field, the curl of the large-scale magnetic field, and the curl of the large-scale flow velocity. By introducing the proper transport coefficients $\alpha_{\rm t}$, $\beta_{\rm t}$, and $\gamma_{\rm t}$, the electromotive force is modeled as

$$\vec{\mathcal{E}}_{\rm model} = \alpha_{\rm t}\vec{B}_0 - \beta_{\rm t}\nabla\times\vec{B}_0 + \gamma_{\rm t}\nabla\times\vec{U}_0. \tag{101}$$

After some algebra using Eqs. (99) and (100), one identifies that the term $\beta_{\rm t}\nabla\times\vec{B}_0$ becomes nothing other than the diffusion term for the

large-scale magnetic field (under the condition that the coefficient $\beta_{\rm t}$ is not negative):

$$\frac{\partial \vec{B}_0}{\partial t} = \nabla \times \left(\vec{U}_0 \times \vec{B}_0\right) + \nabla \times \left(\alpha_{\rm t} \vec{B}_0\right) + \beta_{\rm t} \nabla^2 \vec{B}_0 + \nabla \times \left(\gamma_{\rm t} \nabla \times \vec{U}_0\right). \quad (102)$$

The terms with $\alpha_{\rm t}$ and $\gamma_{\rm t}$ in turn may amplify the large-scale magnetic field when the coefficients are in favor of field amplification (dynamo mechanism). The transport coefficients are theoretically estimated as follows:

$$\alpha_{\rm t} = C_\alpha \tau (-h_{\rm kin} + h_{\rm cur}) \quad (103)$$

$$\beta_{\rm t} = C_\beta \tau \left(e_{\rm kin} + e_{\rm mag}\right) \quad (104)$$

$$\gamma_{\rm t} = C_\gamma \tau h_{\rm crs}, \quad (105)$$

where C_α, C_β, and C_γ are dimensionless scalar factors, and are estimated as (Yoshizawa, 1998),

$$C_\alpha \simeq 0.02 \quad (106)$$

$$C_\beta \simeq 0.05 \quad (107)$$

$$C_\gamma \simeq 0.04. \quad (108)$$

The symbol τ denotes the turbulent correlation time length, and h and e represent the helicity and the energy quantities: $h_{\rm kin}$ the kinetic helicity density, $h_{\rm cur}$ the current helicity density, $h_{\rm crs}$ the cross helicity density, $e_{\rm kin}$ the turbulent kinetic energy density, and $e_{\rm mag}$ the turbulent magnetic energy density. The helicity density quantities and the energy density quantities are defined for the fluctuating field,

$$h_{\rm kin} = \left\langle \delta\vec{U} \cdot \left(\nabla \times \delta\vec{U}\right) \right\rangle \quad (109)$$

$$h_{\rm cur} = \frac{1}{\mu_0 \rho_0} \left\langle \delta\vec{B} \cdot \left(\nabla \times \delta\vec{B}\right) \right\rangle \quad (110)$$

$$h_{\rm crs} = \frac{1}{\sqrt{\mu_0 \rho_0}} \left\langle \delta\vec{U} \cdot \delta\vec{B} \right\rangle \quad (111)$$

$$e_{\rm kin} = \frac{1}{2} \langle |\delta\vec{U}|^2 \rangle \quad (112)$$

$$e_{\rm mag} = \frac{1}{2\mu_0 \rho_0} \langle |\delta\vec{B}|^2 \rangle. \quad (113)$$

Note that different definitions are possible for the helicity and energy density quantities. In the definition above (Eqs. 109–113) the fluctuating magnetic field is converted into the velocity dimension such as $\delta\vec{B}/\sqrt{\mu_0\rho_0}$ and the energy density is represented as that per unit mass. The correlation time length τ can in the simplest case be modeled or represented by the eddy turnover time,

$$\tau_{\rm ed} = \frac{\ell}{\delta U} = \frac{e_{\rm kin} + e_{\rm mag}}{\varepsilon}, \quad (114)$$

where ε is the dissipation rate which needs to be obtained by solving an equation in the similar fashion to the turbulence energy (Yokoi, 2008). The estimate of time scale can be extended by including the Alfvén time

effect into a synthesized time scale $\tau_{\rm s}$ in the additive sense in the frequency domain as

$$\frac{1}{\tau_{\rm s}} = \frac{1}{\tau_{\rm ed}} + \chi \frac{1}{\tau_{\rm A}}, \tag{115}$$

where $\tau_{\rm A}$ denotes the Alfvén time

$$\tau_{\rm A} = \frac{\ell}{V_{\rm A}} = \frac{|e_{\rm kin} + e_{\rm mag}|^2}{\varepsilon V_{\rm A}^2} \tag{116}$$

with the length scale ℓ and the Alfvén speed $V_{\rm A}$. The symbol χ is the weight factor for the Alfvén time, and is estimated to be of the order 10^2 in the solar wind application (Yokoi, 2008). A more rigorous treatment is to solve two sets of equations, one for the large-scale mean fields and the other for the small-scale turbulent fields. This task can be achieved either analytically using the two-scale direct interaction approximation (Yokoi, 2006; Yokoi and Hamba, 2007; Yokoi et al., 2008) or numerically (Usmanov et al., 2012, 2014, 2016)."

– Subsection "Pickup ions" is extended by showing model equations. (page 22–23)

"Pickup ions from interstellar neutral hydrogen atoms are one of the ingredients to the solar wind, and contribute to additional mass of the plasma, which results in deceleration of the solar wind expansion and in increase in the plasma temperature. Pickup ions originate in (1) charge exchange with the solar wind protons and (2) photoionization by the solar radiation. Steady-state MHD equations for the wind including pickup ions are introduced by Isenberg (1986) and Whang (1998), and are numerically implemented to simulation studies for a three-component fluid (thermal protons, electrons, pickup protons) by Usmanov and Goldstein (2006); Usmanov et al. (2014) and for a four-component fluid by adding interstellar hydrogen (Usmanov et al., 2016).

The continuity equation in the one-fluid sense (mixture of electrons, solar wind protons, and pickup ions of interstellar origin) has a contribution from the photoionization as a source term. and is written for the steady state as (Whang, 1998)

$$\nabla \cdot (\rho \vec{U}) = m_{\rm p} q_{\rm ph}, \tag{117}$$

where ρ and $\vec{U}$ denote the mass density and the flow velocity in the one-fluid sense, $m_{\rm p}$ the proton mass, and $q_{\rm ph}$ the pickup ion production rate by the photoionization process,

$$q_{\rm ph} = \nu_0 \left(\frac{r_0^2}{r} \right) n_{\rm nt}. \tag{118}$$

Here $\nu_0 = 0.9 \times 10^{-7}\ {\rm s}^{-1}$ is the photoionization rate per hydrogen atom at the Earth orbit distance as reference $r_0 = 1\,{\rm au}$, and $n_{\rm nt}$ is the number density of neutral hydrogen (of interstellar origin). The one-fluid momentum equation in the steady state is approximated into (by neglecting

higher-order terms) (Whang, 1998)

$$\rho\vec{U}\cdot\vec{U}+\nabla P-\rho\nabla\left(\frac{GM_{\odot}}{r}\right)-\frac{1}{\mu_0}(\nabla\times\vec{B})\times\vec{B}=-(q_{\rm ex}+q_{\rm ph})m_{\rm p}\vec{U}. \quad (119)$$

Here $q_{\rm ex}$ is the pickup ion production rate by the charge exchange process,

$$q_{\rm ex}=\sigma_{\rm ex}n_{\rm sw}n_{\rm nt}U, \quad (120)$$

where $\sigma_{\rm ex}$ is the cross section of charge exchange between a hydrogen atom and the solar wind protons, $n_{\rm sw}$ is the number density of solar wind protons."

– Section 3.3 (Stellar wind and interstellar space) is extended by referring to the models by Johnstone et al. (2015), Keppens and Goedlbloed (1999), Thirumalai and Heyl (2010), and Kriticka et al. (2016). (page 23)

"Various outflow models have been proposed for the stellar wind. For example, a wind model is constructed and numerically studied for the thermallly-driven hydrodynamic outflow from low-mass stars (Johnstone et al., 2015). A dead zone due to the magnetic dipole field effect can arise in the equatorial region (Keppens and Goeldbloed, 1999). A model is also constructed for the stellar winds around asymptotic giant branch (AGB) stars with dust grains by employing the MHD equation for the stellar wind plasma and the Euler equation for the dust grains under the gravity, the radiation pressure, and the drag force (Thirumalai and Heyl, 2010), showing the possibility of a stellar wind driven by dust grains. Mass-loss rate is observationally studied via stellar winds for subluminous stars (Krtička et al., 2016), in which the following flow velocity model is used for fitting with three parameters U_1, U_2, and $\gamma_{\rm sw}$:

$$U=\left[U_1\left(1-\frac{R_{\rm s}}{r}\right)+U_2\left(1-\frac{R_{\rm s}}{r}\right)^2\right]\left\{1-\exp\left[\gamma_{\rm sw}\left(1-\frac{r}{R_{\rm s}}\right)^2\right]\right\}, \quad (121)$$

where $R_{\rm s}$ is the stellar radius."

– A paragraph is added at the end of section 4 (Summary and conclusions) on page 25. We add only one paragraph in section 4 to keep the manuscript concise.

"It is also worth noting the limits of the models. First, the magnetic fields are highly structures in the solar corona and at the solar surface. At some distance sufficiently close to the Sun, the interplanetary magnetic field should smoothly be connected to the coronal magnetic field. Second, the outer heliosphere has the termination shock and the heliopause, which are not included in the models in this review. Third, the solar variability includes not only the 11-year sunspot number variation or the 22-year magnetic structure variation, but also modulations of the solar cycle on long time scales such as 100 or even 1000 years."

- *I had minor comments on figures and captions but the other referee has already discussed them in more detail than I was planning.*

  Reply: We went through the manuscript text check again. All changes are marked in blue in the revised manuscript.

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 Goedlbloed, 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.