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Relationship between solar wind speed and coronal magnetic field parameter through solar cycle 23 and 23/24 minimum

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Solar wind acceleration mechanism is one of the most important issues to be solved in solar wind physics. We have been studied the relationship between velocity of solar wind which comes from coronal holes and coronal magnetic field parameter. Precedence researches in our group showed that solar wind speed, V had been in proportion to a parameter Bp/f from solar minimum in cycle 22/23 to solar maximum in cycle 23, where Bp and f are magnetic field strength and expansion factor of the magnetic flux tube, respectively [1]. In solar minimum in the cycle 23/24, however, polar magnetic field gets weaker and solar wind has lower density, lower temperature, and lower mass flux than the previous minimum [2]. For this reason, we examined the relationship between V and Bp/f from 22/23 to 23/24 solar minima. In this analysis we used following data set. Solar wind velocity map in each Carrington rotation was derived from the interplanetary scintillation measurements at Solar-Terrestrial Environment Laboratory. Coronal magnetic field in each Carrington rotation was calculated by potential field source surface model using synoptic photospheric magnetic field data observed at Kitt Peak National Solar Observatory. As results, we found that V always correlates positively Bp/f over the solar cycle. Then we focused on the difference of slopes of the regression lines between two solar minima. The slope in the 23/24 minimum becomes larger, in other words, the fast solar wind in the 23/24 minimum has smaller Bp/f compared to that in the 22/23 minimum. This result was compared with a theoretical model of solar wind acceleration [3] by taking account of the declining of solar wind parameters. We confirmed that the difference of regression lines in two solar minima is consistent with global trend of solar and solar wind variations.

Reference
[1] Fujiki et al., Adv. Space Res., Volume 35, Issue 12, 2185, (2005)
[2] McComas et al., Geophys. Res. Lett., 35, 18103, (2008)
[3] Suzuki,T. K., Astrophys. J. Lett., 640,75, (2006)

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