An analytical model of radial dependence of temperature in the fast solar wind

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Past observational studies have clarified that radial dependence of temperature in the solar wind plasma is not adiabatic and heating of plasma in the interplanetary space occurs. Since the solar wind plasma is nearly collisionless, kinetic damping of waves such as Landau damping plays an important role in heating of the solar wind plasma. As a matter of fact, since plasma beta ratio in the solar wind is finite, kinetic treatments are necessary to describe wave characteristics.

On the other hand, one-fluid magnetohydrodynamic models have also been applied to describe large scale phenomena such as radial dependence of temperature in the solar wind. The specific heat ratio/polytropic index in the MHD model is usually assumed to be constant, although kinetic theories show that specific heat ratios depend on wave characteristics. In the present study, an empirical model of the specific heat ratio in the presence of Alfven waves is applied to describe the radial dependence of solar wind temperature. It is shown that the resultant radial dependence is controlled by some parameters such as temperature ratios and can be in good agreement with the observational studies. The other applications of the empirical model are also discussed.

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