Numerical study on the stellar atmosphere & wind of Cool Stars

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Cool stars offer the good opportunities to investigate what environments the Earth-like exoplanets are in, and how they are affected by the host star. TRAPPIST-1 is an ultracool dwarf; the spectral type is M8V (T_{eff} =2559K) with the lower mass of 0.08M_{sun} (radius = 0.11R_{sun}). The star is confirmed to have seven planets (Gillon et al. 2017) and thus greatly interested in not only by stellar astrophysics but also by astrobiology. Here, we report the results of one-dimensional magnetohydrodynamic (MHD) simulation of the stellar wind from TRAPPIST-1. Several solar wind theories, which have been examined observationally, are applied to the case of TRAPPIST-1. Among them, it is the plausible idea that the dissipation of the incompressible MHD wave leads to the heating and driving the stellar wind. For instance, Garraffo et al. 2017 succeeded in the three-dimensional MHD simulation of the stellar wind from TRAPPIST-1, by extending their solar wind model in which the incompressible MHD wave is exhausted by the turbulent dissipation. The incompressible MHD wave, on the other hand, is also affected not only by the turbulent dissipation but also by the nonlinear mode coupling, which leads to the formation of the shock wave and consequently contribute to heating the wind. This nonlinear process has been well investigated to account for the dynamics of the lower solar atmosphere (Kudoh & Shibata 1999) and driving the solar wind (Suzuki & Inutsuka 2005), but not discussed for the stellar wind from TRAPPIST-1. In this study, therefore, we performed the one-dimensional MHD simulation to consider the nonlinear process of the incompressible MHD wave leading to the shock formation, and succeeded in reproducing the stellar wind from TRAPPIST-1.

Keywords: stellar wind, cool stars, TRAPPIST-1

