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MHD wave-driven mass loss from gas giants and effects on atmospheric structure

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Recently a number of exoplanets have been found, and some of them are close-in gaseous planets. Such planets are called hot Jupiters, and their surface temperatures are ˜1000K due to strong irradiation from central stars.

Information of radius and orbital period of exoplanet can be observed by transit method which is the one of method to detect exoplanets. Additionally, atmospheric composition can be estimated by variation of spectrum between transiting and non-transiting, and atmospheric structure can be estimated by multi-wavelength transit observation. From these observations, inflated hydrogen atmosphere of hot Jupiters and atmospheric escape are suggested. It is observed that escaping atmospheric flow is very fast, and mass loss rate is also estimated. However, detailed mechanism of mass loss from hot Jupiters are still unknown.

We propose a new mechanism of mass loss, which is mass loss driven by magneto-hydrodynamic wave, same as solar wind. Atmosphere is weakly ionized because surface temperatures of hot Jupiters are about 1000K, but it is good to treat as ideal MHD at upper atmosphere. If gas giant have magnetic field and turbulence exist on the surface of planet, magneto-hydrodynamic wave will be generated. The wave propagates upward and dissipates in upper atmosphere, then gas flow is accelerated. In this work, we apply numerical calculation of solar wind to mass loss from hot Jupiters. In consequence, mass loss by this magnetically driven wind is comparable to observed mass loss rate, therefore magnetically driven wind can be important role in mass loss from hot Jupiters.

We also derive an analytical solution for radius and mass dependence of mass loss rate, and it shows a good agreement with numerical results. Dissipation of MHD wave in the atmosphere also affects on atmospheric structure. The gas flow is accelerated to supersonic at upper atmosphere, and temperature become several tens of thousand kelvin. In this talk, we will discuss the possibility of mass loss from general gaseous planet and effects on atmospheric structure.

Keywords: exoplanet, atmospheric escape