Magnetospheres of Hot Jupiters

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Planetary magnetosphere appears as an obstacle, which interacts with the stellar wind, declining it, and protecting planetary ionosphere, upper atmosphere against the direct impact of stellar plasmas and energetic particles (e.g., cosmic rays). The closer the planet is to the star, the more important becomes magnetospheric protection of a planet. The weak intrinsic magnetic dipole moments of tidally locked close-orbit giant exoplanets (Hot Jupiters) have been shown in previous studies to be unable to provide an efficient magnetospheric protection of their expanding upper atmospheres, leading to significant non-thermal mass loss of the planets. On the other hand, the detection of a large number of such exoplanets indicates that Hot Jupiters nevertheless survive in the extreme conditions of their close-in orbits and are probably better protected, than the present day theories predict. Recently, a more generic view of the Hot Jupiter magnetosphere based on the Paraboloid Magnetospheric Model (PMM), has been proposed. A key element of the developed approach consists in taking into account the major specifics of the Hot Jupiter conditions, such as intensive thermal escape of the planetary atmospheric material heated and ionized by the stellar X-ray/EUV radiation and the presence of a rotating intrinsic magnetic dipole field of the planet. These lead to the formation of an equatorial current-carrying plasma disk which strongly influences the size and topology of a Hot Jupiters magnetosphere. A slower, than the dipole-type decrease of magnetic field with the distance comprises the essential specifics of magnetodisk-dominated magnetospheres of Hot Jupiters. This results in their larger scales, as compared to those provided only by the planetary dipole. The role of magnetodisks in the scaling of exoplanetary magnetospheres, as well as the processes which control formation of magnetodisks will be discussed in the lecture.