Geophysical Research Abstracts
Vol. 20, EGU2018-8411, 2018
EGU General Assembly 2018

Are Supermassive Hot Jupiters Providing More Favourable Conditions for Generation of Radio Emission via the Cyclotron Maser Instability? - A Case Study based on Tau Bootis b

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We check if supermassive Hot Jupiters can maintain source regions for radio emission, and whether the emission can propagate to an observer outside the system. Planets identical to the Hot Jupiter Tau Bootis b are investigated, but located at different orbital distances, starting at the actual orbit of 0.046 AU up to 0.2 AU. We find that due to the strong gravity of the supermassive planet Tau Bootis b additional coolings would become very effective. Including these cooling effects, the exobase is very close to the planet, which makes Tau Bootis b a good candidate for radio observations. The case of hydrodynamic escape without cooling effects is considered as well for comparison and we check at which orbital distance the upper atmosphere is in the hydrodynamic rather than in the hydrostatic regime, i.e. where conditions for the Cyclotron Maser Instability (CMI) are favourable. In the hydrodynamic regime the ionosphere is extended up to the magnetopause and can constitute an obstacle for possibly generated radio waves, or the generation via the CMI might even be prevented completely. We find that the transition to more favourable conditions for the CMI occurs at 0.056 AU, where the exobase distance is already close to the magnetosphere standoff distance. Another interesting finding is that, even though the exobase is more extended for smaller orbits, the stronger stellar wind of the young star Tau Bootis causes a higher outflow velocity for the planetary mass loss due to the higher XUV flux. This effect lowers the electron density peak for the actual orbit of Tau Bootis b compared to the larger orbits and could thus make generation and escape of radio waves possible. In a further step of this investigation the star Tau Bootis is replaced by a Sun-like star. In this case the highest electron density peak is found for the closest orbit.