Geophysical Research Abstracts
Vol. 12, EGU2010-11927, 2010
EGU General Assembly 2010

The advection / tide steady state in irradiated gas giants

Frederic Pont (1), Suzanne Aigrain (2), Tim Jupp (1), and Thomas Smith (2)
(1) University of Exeter, United Kingdom (fpont@astro.ex.ac.uk), (2) University of Oxford, United Kingdom (suzanne.aigrain@astro.ox.ac.uk)

The anomalously large radii of many close-in transiting giant planets have so far eluded a comprehensive explanation. Various mechanisms have been proposed, invoking additional internal energy sources or additional energy deposition or retention mechanisms operating within the atmosphere, but none has been successful in explaining all the available data without resorting to missing physics or special circumstances.

In this contribution, we propose a new solution, which combines elements of previous theories. We treat the atmosphere as a heat engine, carrying heat from the day to the night side of the planet in the form of a super-rotating jet, and doing work in the process. On the other hand, tidal interaction with the host star tends to synchronise the planet's rotation with its orbit. The key insight is that these two processes are coupled through downwards momentum diffusion due to turbulent viscosity, leading to a balance between the radiative forcing and tidal damping, and to the establishment of deep meridional currents that inject a sufficient amount of kinetic energy into the interior to account for the observed radii. We present a simple toy model to evaluate the amount of energy deposited in the interior and the resulting increase in radius depending on the fraction of incident radiation redistributed to the night side. We then compare the model's predictions to observed radii as a function of stellar irradiation, finding remarkable qualitative and quantitative agreement.