Light Curve Physics of Extrasolar Planets

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Extrasolar terrestrial planets may exhibit changes in reflected or emitted flux along their orbits as a consequence of the changing phase angle and seasonality. Future space-based observatories may detect such changes and monitoring of these objects along their orbits may prove informative about their atmospheres, surface properties and potential habitability. We calculate rotationally-averaged infrared light curves for planets with different obliquities, orbital eccentricities, and viewing geometries using an analytic energy-balance model. This model assumes globally uniform values of the thermal inertia and meridional heat transport coefficient, and a linear relationship between surface temperature and emitted IR flux. We investigate the effects of thermal inertia and meridional heat transport of any atmosphere or ocean on the IR light curve of an Earth-like planet and compare these calculations with the output of a 3-dimensional climate model (*Williams and Pollard*, 2003). The infrared emission of blackbody objects with high obliquities can vary by an order of magnitude along the orbit, depending on the viewing geometry. We show that the thermal inertia and meridional heat transport of an ocean and/or atmosphere significantly reduces the amplitude of the light curves. Thermal inertia also introduces a phase lag of the emitted infrared light curve relative to the incident stellar flux. These effects would be detectable by envisioned Terrestrial Planet Finder (TPF) missions. We also present preliminary results for optical light curves for both terrestrial and giant planets. Information on the reflected light curves of hot Jupiters may be extracted from Kepler photometry.

[a] Williams, D.M., and Pollard, D., Extraordinary Climates of Earth-like Planets: Three-dimensional Climate Simulations at Extreme Obliquity, *Int. J. Astrobio.*, **2**, 1–19, 2003.