HAT-P-2b: Eccentric Hot Jupiter

**Planetary Parameters**

- \(M_p = 9.09 \, M_J\)
- \(R_p = 1.157 \, R_J\)
- \(a = 0.06878 \, \text{AU}\)
- \(e = 0.5171\)
- \(g_p = 16827 \, \text{cm/s}^2\)
- \(P_{\text{orb}} = 5.6334729 \, \text{days}\)
- \(P_{\text{rot}} = 1.8927016 \, \text{days}\)

**Stellar Parameters**

- F8 (\(T_{\text{eff}} \sim 6290 \, \text{K}\))

\[F_{\text{periastron}} = 10 \times F_{\text{apastron}}\]

* Parameterization from Hut (1981)

*\(P_{\text{rot}}\) Parameterization from Hut (1981)

* figure credit G. Laughlin (oklo.org)
Over 135 hours (12,150,000+ subarray frames) in each channel
Data Reduction

• Intrapixel sensitivity variations
  ➡ Utilize low-pass gaussian filter (ala Ballard et al. (2010))

• Flux ‘ramp’ at start of observations
  ➡ Weak in channels 1 and 2
    (discard first 10 minutes of data)

• Transit and eclipse events
  ➡ Simultaneous fit of both channels using routines of Mandel & Agol (2002)
  ➡ Limb darkening (Sing (2010))

• Phase variations
  ➡ \[ F \sim A \cos(f + \Phi) \]
Peak Flux

14 hours after periapse

Phase Amplitude
0.084±0.026 %
$\Delta T > 560$ K

Eclipse Depth
0.068±0.015 %
$T_B \sim 1970$ K

Channel 1 (3.6 $\mu$m)
Eclipse Depth

0.096±0.017%

$T_B \sim 2065$ K

Phase Amplitude

0.096±0.012%

$\Delta T > 930$ K

Peak Flux

12 hours after periapse

Channel 2 (4.5 $\mu$m)
SPARC Model Atmosphere
(Substellar and Planetary Atmospheric Radiation and Circulation Model)

Dynamics
- MIT General Circulation Model (MITgcm)
- Solves 3D primitive equations

Radiative Transfer
- Based on Marley & McKay (1999) radiative transfer model
- Plane-parallel two-stream non-gray radiative transfer scheme
- Opacities calculated assuming local thermochemical equilibrium
Peak flux ~ 5 hours after periapse

Phase amplitude

~ 0.084 %
What’s going on here?

- Phase lag between periastron passage and peak temperatures (12-14 hours)
- Solar metallicity models underpredict this phase lag, which could point to a metal-poor atmosphere

What’s next?

- Continue to improve data reduction methods
- Test other possible phase curve functional forms
- Use 3D atmospheric models to probe how changes in atmospheric chemistry, rotation rate, tidal heating, gravity, drag, etc. might affect phase variations in planetary temperature