Brightness variability on Planet 9 as a function of distance

And its impact on detection probability

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Background and Motivation

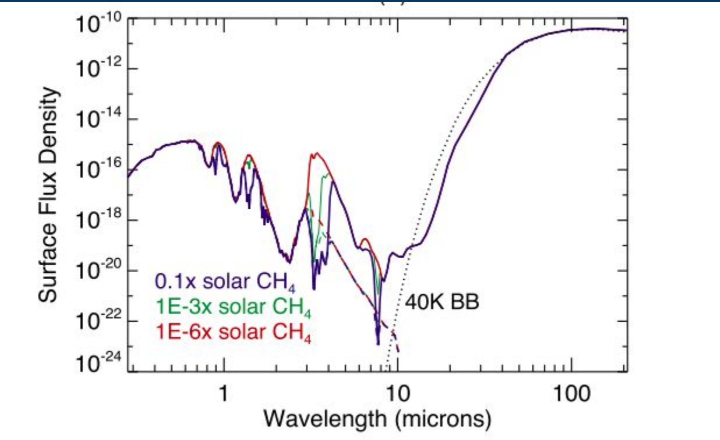
- A distant, Neptune-sized ice giant, “ Planet 9 “ is a possible perterber of KBO orbits [Batygin 2016]

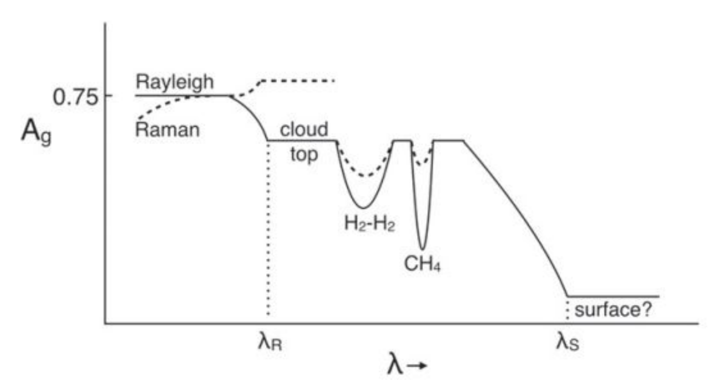
- Detectability is influenced by radial distance from the Sun, a function of true anomaly, v.

- Rayleigh scattering off a CH4 cloud allows an increase in brightness in V-band [Fortney 2016]

- How does varying orbital distance (true anomaly and semi-major axis) affect brightness? Which portions of orbit may be visible?

- Impact: A brighter planet will increase chances of detection





Fortney et al. 2016

Methods

$$r_{P9} = \frac{a(1 - e^2)}{(1 + e\cos\nu)}.$$

Step 1: Solve for Distance r (AU)

- e = 0.6 [Batygin 2016]
- Vary a p9 from 380- 980 AU, nu from 0 - 360 degrees [Brown 2016]
- Distance r increases with a and nu, although there is overlap (Fig 1).

Step 2: Solve for Magnitude

- Mass p9 = 10 Mearth [Batygin 2016]
- R_p9 = 3.46 Rearth [Fortney 2016]

$$V_{P9} = 7.8 + 5\log_{10}\left[\left(\frac{R_{P9}}{R_{Nep}}\right)^2\left(\frac{A_{P9}}{A_{Nep}}\right)\left(\frac{r_{P9}}{29\ \mathrm{au}}\right)^4\right],$$

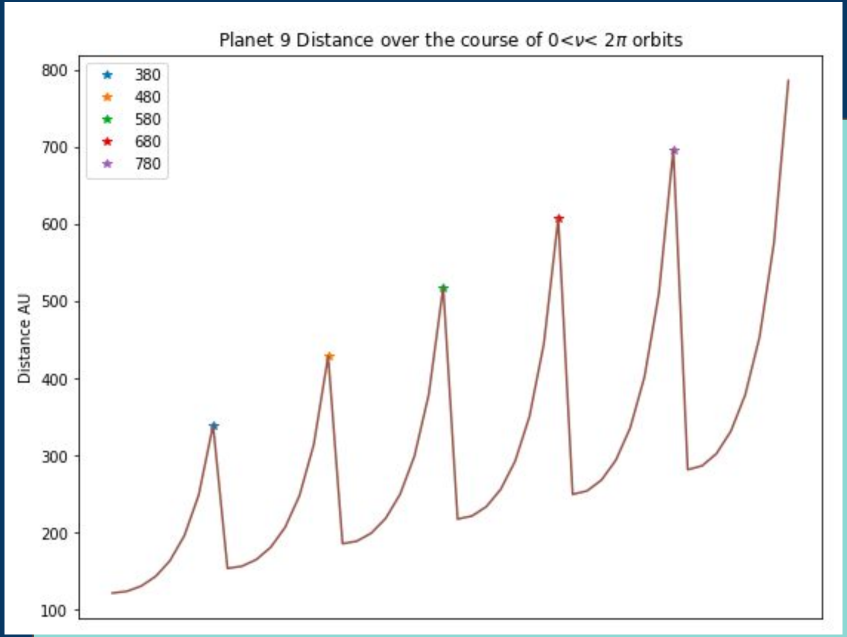


Fig 1: Distance of Planet 9 along its orbit. Each sloped peak is a different semi major axis

Results and conclusions

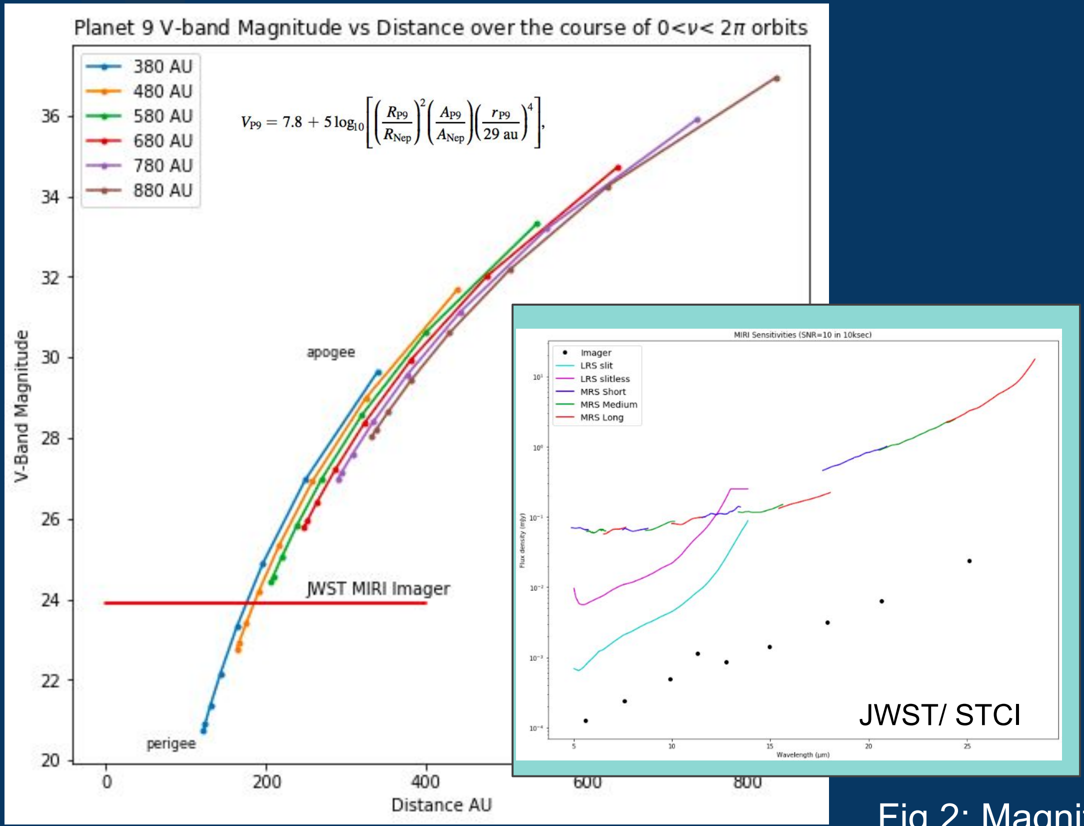


Fig 2: Magnitude ranges of Planet 9 for different orbits, contextualized by JWST.

- Fig 2: V-band magnitudes vs Distance for various semi-major axes over the course of an orbit. Plots are shifted for visibility.
- Brightness decreases with increased Distance, with increased semi major axis, with increased total anomaly.
- More constraints on position needed, but flux increases may make up for possible large distances.
- Orbits for small true anomalies and semi major axis < 480 AU may be visible with JWST's mid-infared imager