Direct Observation Of Extrasolar Planetary Spectra

Rajendra Vikram Singh

Five sub-Jupiter planets (m sin i = 0.4-0.9 m_J) orbiting very close (semi-major axes=0.4-0.11 AU) have been discovered by precise measurements of the Doppler shift of the stellar spectra which revealed periodic radial velocity variations of a few metres per second due to stellar reflex motion caused by its planet.

Direct observation of extrasolar planetary spectra is considered a formidable task. The infrared radiation of Earth or Jupiter, averaged over a 10% spectral bandpass, is a million times weaker than that of the Sun. Nulling interferometers are expected to decrease this flux ratio by a few orders of magnitude.

Differential Radial Velocity Spectroscopy (DRVS) may be used to extract the planetary spectrum, since it has a differential Doppler shift in relation to the stellar spectrum. Each planetary spectral line moves in a window of a few km/s as compared to a few m/s variation of the stellar spectrum. The precision of radial velocity measurements required for direct observation of planetary signals is much less than for stellar reflex motion.

A judicious selection of windows around spectral lines of a specific molecule postulated in the planetary environment narrows the total spectral bandpass and reduces the “noise” from the stellar radiation. A priori knowledge of the position of individual spectral lines and their separation, as a function of planetary radial velocity at the time of each one of several observations during one orbit, allows good correlation peaks and large signal processing gain. The same data set may be repeatedly examined for other postulated molecules in the extrasolar planetary environment.