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The Music of the New Spheres?

by Michael C. LoPresto

As the list of extra-solar planets orbiting sun-like stars (exoplanets.org/planet_table.shtml) continues to grow, more and more members of multiple-planet systems (exoplanets.org/mult.shtml) are being discovered.

These planets are not observed directly, they are much too far away and lost in the glare of their stars. Rather they are detected indirectly, by the effects they have on the light coming to us from the their stars. A planet doesn't actually orbit a star; rather both orbit a point between the two objects. This point is closer to the more massive object by an amount equal to ratio of the masses of the two objects. For instance, the Sun is about a thousand times as massive as Jupiter, so the mass center of the system is about one-one thousandth the way from the Sun to Jupiter. As the planet and the star orbit this point, minute Doppler-shifts in the star's light can be detected. Blueshifts when the star is coming towards the Earth in its orbit and redshifts as it heads away (see Figure 1). These variations in the Doppler –shifts will repeat themselves over the period of the orbit. This is also the orbital period of the planet around the point, which can then be used to determine the orbital radius and mass of the planet (for more details try; exoplanets.org/doppframe.html).

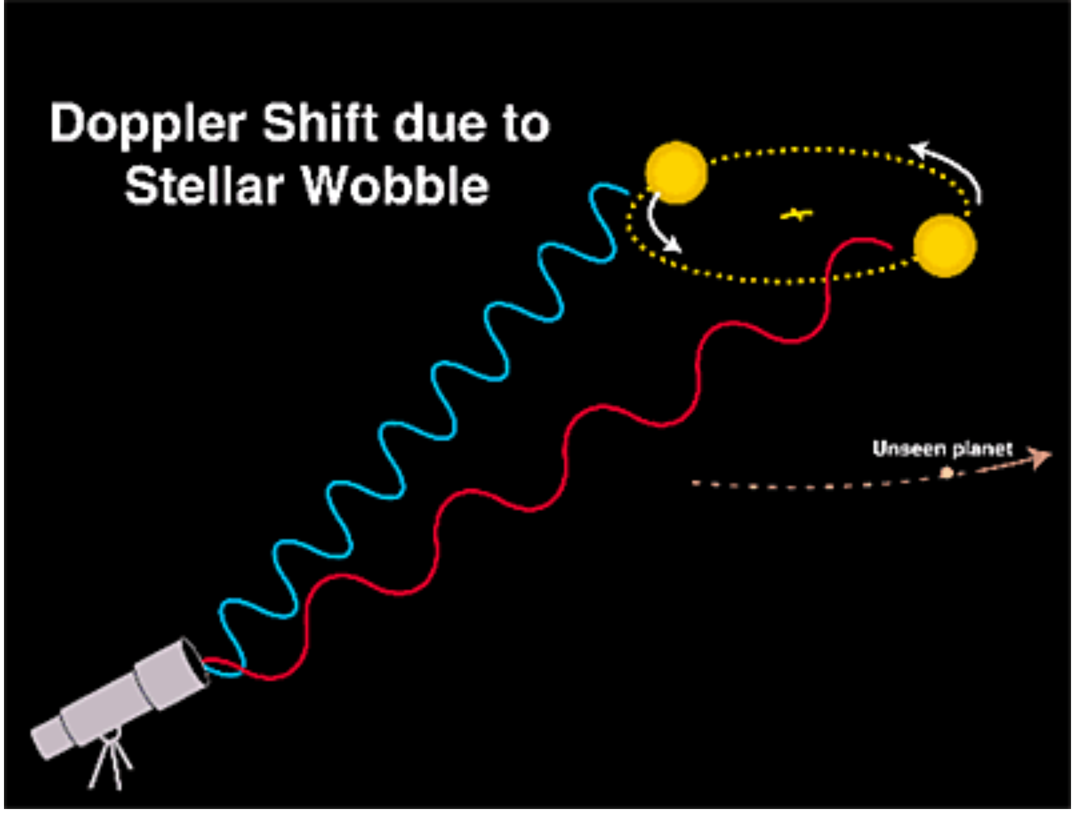

Figure 1- Redshifts and blueshifts in a star's light as it moves away from and then towards the observer.

For single planet systems, like 51 Pegasi, the first extra-solar planet to be discovered (1995), the variations in the Doppler-shifts in the star's light repeat as a simple sine-wave (see Figure 2 for the fit of the data for 51-Pegasi or; exoplanets.org/esp/51peg/51peg.shtml). When more than one planet is present, the variations in the shifts caused by all planets are superimposed and repeat with a more complex waveform over a longer period (see Figure 3 for the plot fit to the data for 47-Ursa Majoris or; exoplanets.org/esp/47uma/47uma.shtml).

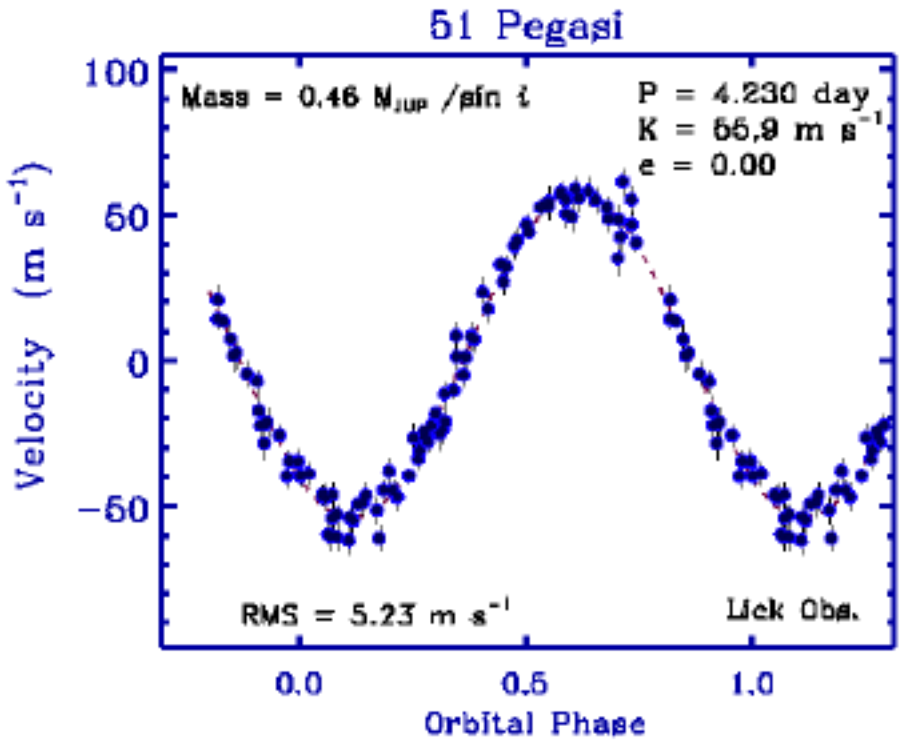

Figure 2- One planet in a circular orbit around 51-Pegasi causes Doppler-shift variations that repeat with a simple waveform.

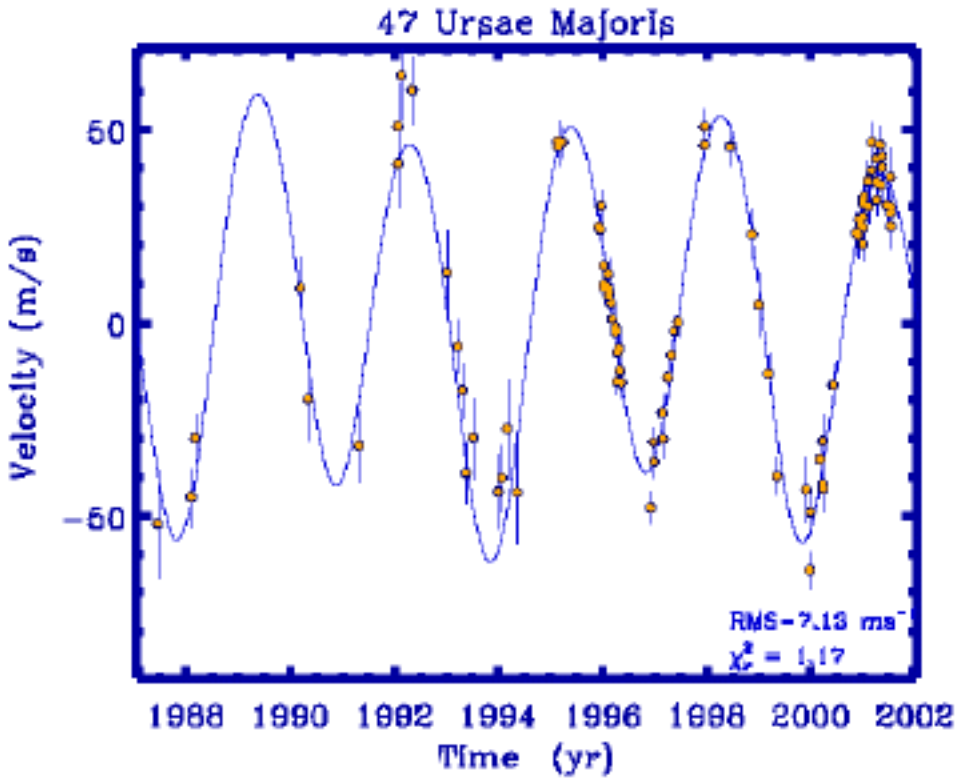

Figure 3-Two planets in orbit around 47-Ursa Majoris produce more complex variations in the Doppler-shift data.

HD 82943 (see [Figure 4](#) or; [obswww.unige.ch/~udry/planet/hd82943syst.html](#); also find it at [exoplanets.org/mult.shtml](#)), has two planets with a ratio of orbital periods very near 2:1. Because of this the fit of its data yields a waveform very similar to that of a musical octave. Two musical pitches that are an interval of an octave apart also have a frequency ratio of 2:1. The interval between two musical notes of the same name, like C-C', the first and last note of a musical scale, is an octave. [Figure 5](#) shows the waveform produced by two tuning forks of frequencies C-256 Hz and C'-512 Hz sounding simultaneously. Note the similarity to the waveform for HD 82943 in Figure 4.

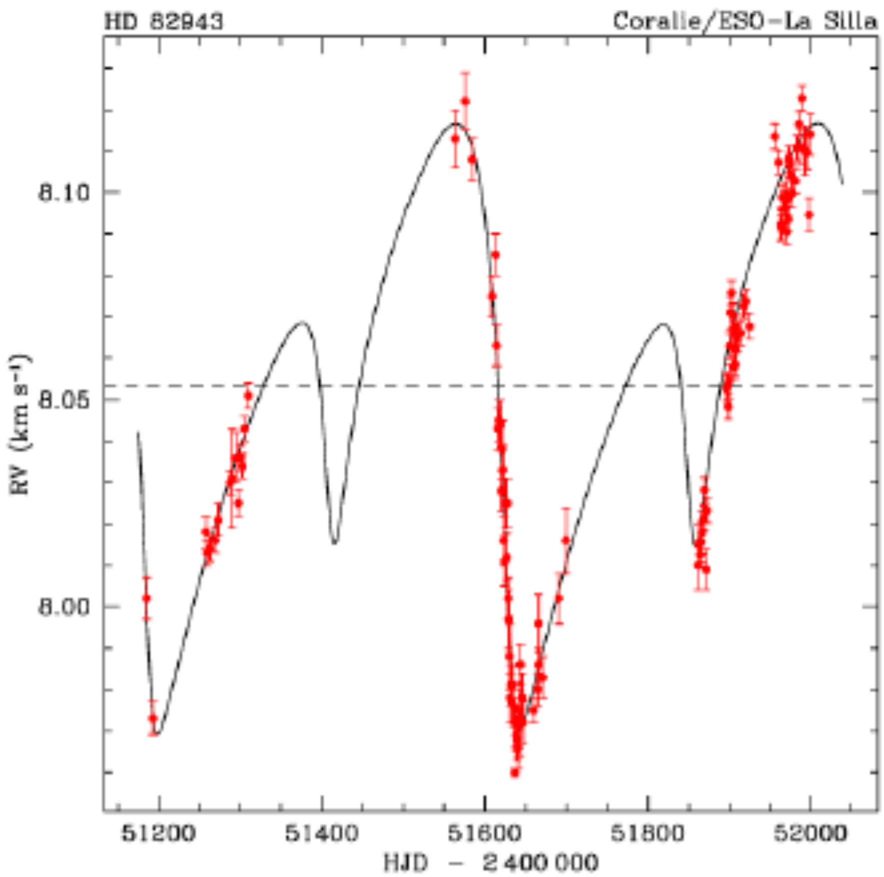

Figure 4- HD 82943 has two planets that orbit with periods in a ratio of 2:1.

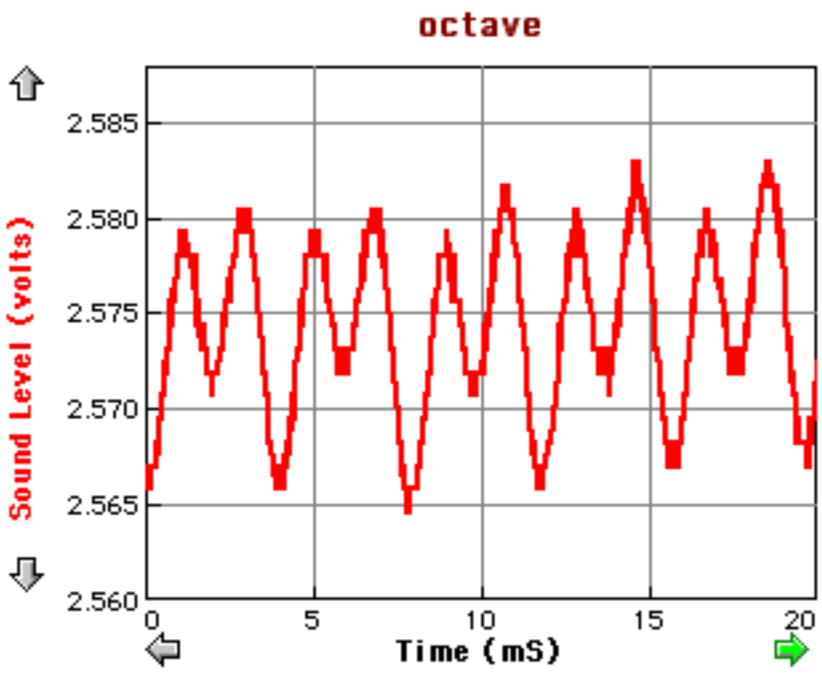

Figure 5-The waveform produced by simultaneously sounding two tuning forks having a frequency ratio of 2:1 (a musical octave apart).

Gleise 876 (exoplanets.org/esp/gj876/gj876.html) also has two planets with periods in a 2:1 ratio, but the periods are very short which makes the waveform harder to see.

Could these be examples of "The Music of the NEW Spheres"? In the 6th century BC, Pythagoras discovered that when portions of a plucked string that correspond to simple fractions of the entire string, i.e. 1/2, 2/3, 3/4, etc. were sounded together, the pitches formed consonant or "harmonius" musical intervals. Since that time, the search for simple numerical relationships, or harmonies, in nature has been an undercurrent of much scientific investigation. It is well know that Johannes Kepler (Figure 6) believed in "Cosmic Harmony". This belief led him to conclude that each planet "sung" as it orbited the Sun. That, as the planets' speed varied in the elliptical orbits he had discovered, the frequencies of their orbits and therefore the pitches of their musical notes also changed (see Figure 7).

Figure 6-Kepler

Figure 7-Kepler believed in "Cosmic Harmony".

Kepler discovered his third or "Harmonic" law as a result searching for a simple or "harmonious" relationship between fundamental quantities in a planetary orbit, a search that took him ten years. This relationship, the square of a planet's period being equal to the cube of it's average distance from the Sun, is how we determine the orbital radius of the extra-solar planets once their period is known.

There have been other examples of "Musical Spheres" or "Cosmic Harmony" since the time of Kepler. For instance, the pitch of sound is analogous to the color of light; they are both caused by the frequencies of their waves. Because of this, the ratios between the frequencies of the four visible lines in the Hydrogen spectrum have been compared to the intervals in a musical chord. Hydrogen makes a dissonant chord, but a chord none-the-less. There is no doubt that any harmonies found in the Cosmos would have interested Kepler, but it is likely that this music of these new spheres that we are finding, partially through the use of the laws he discovered so long ago, would have been among his favorites.

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