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Exploplanets: Worlds around other suns

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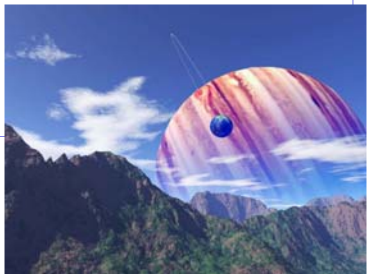

Exoplanet research

453 other planets have been found outside our solar system

Special points of interest:

More planets out there

Triton Fun stuff

Superfluous questions

The search for extrasolar planets, which are also known as *exoplanets*, is a fast-paced exciting field of astronomy which seemingly has new discoveries every week. The quest of searching for exoplanets is relatively recent, with the first exoplanet found in 1994 around a neutron star core; the next one was discovered a year later orbiting around *51 Pegasi*, a star much like our own Sun. Don't let this fool you though: the planet, called *51 Pegasi b*, is unlike anything in our solar system. It has half the mass of Jupiter and orbits 7 times closer to its star than Mercury does! Since those early discoveries, the number of extrasolar planets found has skyrocketed to 453. The drive to find these exoplanets has gotten so strong that NASA has developed an entire mission, called Kepler, dedicated to searching for exoplanets. Kepler, which launched in early March of 2009, is a satellite that is searching for planets in a candidate pool of over 156,000 stars. As of now, July 2010, Kepler has discovered 5 confirmed extrasolar planets, with around 400 additional unconfirmed candidates. This is such a large catch for Kepler that, even if half of those candidates turn out to be true planets, it will be a substantial increase to our catalog of known extrasolar planets.

However, many scientists are not content with just discovering new planets. There are still a number of pressing questions which can be answered with the exoplanets we already have. One major question concerns how planetary orbits relate to their star's spin axis. In our solar system, all of the planets orbit nicely in one plane, called the *ecliptic plane*, and in one direction, following the Sun's rotation. In addition, this plane is also very well-aligned with the Sun's equator. This makes one wonder whether our solar system is the exception or the rule in this regard. Are most planetary orbits aligned with their star's rotation, or are most of them skewed at an angle? Are there planets that appear to revolve around their star backwards (against their parent star's rotation)? These stars are too far away for us to directly observe the planet's orbit; we also cannot see the surface of the star to measure its rotation (though Kepler might change that). However, these problems don't stop clever scientists from finding the answers. They are able to use an indirect, but highly ingenious, method of determining the angle between a planet's orbit and the equatorial plane of its star. This is done by utilizing a phenomenon known as the *Doppler shift*.

The Doppler shift describes how waves behave when emitted by a moving source; a familiar example is a siren on a moving car. As the car moves toward you, the sound waves are pushed toward each other and the siren sounds higher in pitch; as the car moves away, the sound waves are pulled farther apart and the siren sounds lower in pitch. A similar process happens with light, except instead of having a higher pitch, light appears bluer (called a *blueshift*, which means its light has a shorter wavelength) and similarly instead of having a lower pitch, light appears redder (called a *redshift*; longer wavelength). This property becomes extremely helpful with rapidly rotating stars. Due to their rotation, half of their surface appears to be moving away from us while the other half appears to be moving toward us.

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We are always looking for **contributors** to the Science Newsletter. If you would like to write an article about a science subject you are excited about, or contribute a superfluous question, or if you would like to be on our **mailing list** for future newsletters, please e-mail us at:

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Extrasolar planets: ***continued***

Photos/Info: NASA /Oklo.org/SpaceJunction

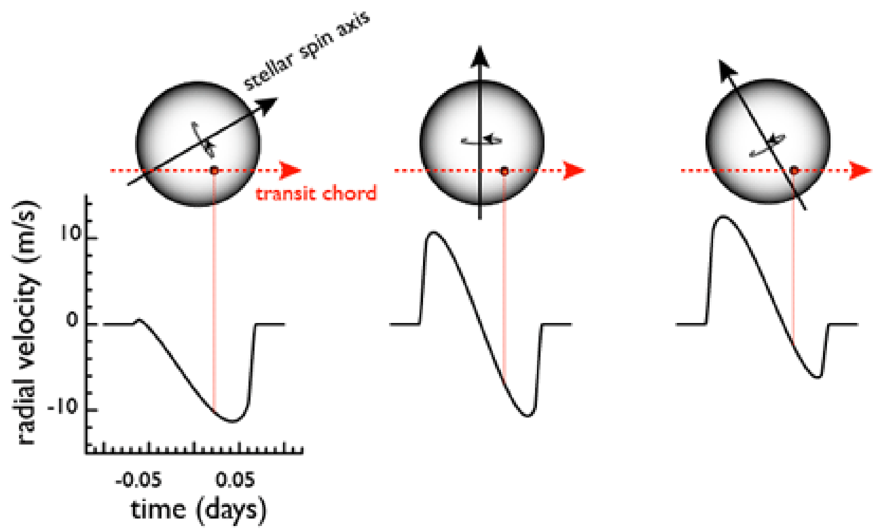

Figure: **Mapping the Doppler shift of extrasolar planets**
If the radial velocity (redshift) curve is symmetrical, as in the middle graph, the planet orbits in its star's ecliptic plane; if the curve is lopsided, as in graphs 1 and 3, the planet orbits at an angle to the plane.

This is called the *Rossiter-McLaughlin effect*, because it was discovered independently by Richard Rossiter and Dean McLaughlin in 1924 using eclipsing binary stars. Normally, when we take a star's spectrum, the redshift and the blueshift cancel each other out, leaving no net shift in their wavelength of light. However, if some object were to block out part of the blue-shifted half of the star, we would see a net redshift and vice versa. When Rossiter and McLaughlin demonstrated this phenomenon, they used an incredibly complex system with two stars, each with a different spectrum, revolving around and blocking each other out.

Astronomers today looking for extrasolar planets are thankful that their systems are much simpler: they use a big bright object with a small dim object. This means when the planet transits across its star (and does an *occultation*), it first blocks out the blue-shifted region and then moves to the redshifted region. When we look at the star from Earth, it would look normal until the planet occulted it. Once it did, the star would appear redshifted, and then would seem more blueshifted as the planet moved across the star's face before finally crossing all the way. Some examples of these are shown in the accompanying Figure. If the plane of the planet was perfectly aligned with the star's rotation (like in our solar system), the planet would pass through each half of the star equally and the redshift curve would look like the middle graph in the Figure. If the planet's orbit was skewed however, as in the first and last diagrams, the two lobes in the graph would be lopsided in different ways. By measuring how lopsided the graph is, astronomers can calculate the angle between the star's rotation and the planet's orbital plane.

This method has become extremely productive in the field of extrasolar planets. When the method was first employed, the initial exoplanets studied were found to be in the ecliptic plane. However, as more stars were studied, planets with larger and larger tilts were found. This began to make astronomers wonder whether some planets have orbits so tilted that they would appear to be traveling backwards (called a *retrograde orbit*). This began an informal race to see who could find the first retrograde exoplanet.

On August 11, 2009, European astronomers at the South African Astronomical Observatory found a planet called WASP-17b. This planet, WASP-17b, ended up being notorious for other reasons: the principal one being its remarkable density. It is a very light planet, having the density about that of Styrofoam. However, when the astronomers looked at its orbital tilt, they noticed that its orbit is tilted 150° from its star's rotational plane. In other words, it's orbiting *backwards*.

This was the very first case of a retrograde planet being found. As luck would have it, right after this announcement, the very next day a joint US/ Japanese team announced they had found a second retrograde planet named HAT-P-7b. Since then, we've been finding many more extrasolar planets in retrograde orbits. A recent survey from the European Southern Observatory found that, out of the 27 exoplanets they surveyed, six of them actually were in retrograde. So retrograde planets may not be so rare. As we keep searching for planets outside our solar system, we'll probably find more and more of these worlds orbiting other suns. These planets will tell us more about our own solar system and the distribution of systems like it throughout the universe.

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References:

1. Kepler mission:
http://planetquest.jpl.nasa.gov/missions/keplerMission.cfm

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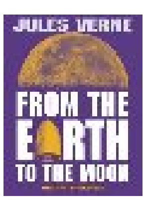

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Superfluous Questions:

1) The Hyblaeus Extension is found *where* ?

a) England b) Australia c) Canada d) Mars

2) Who is the first catcher in baseball ever to hit for the cycle *and* have a grand slam in the same game ?

a) Yogi Berra b) Russell Martin c) Bengie Molina d) Mike Napoli

3 When was the 50th star added to the U.S. flag?

a) 1945 b) 1952 c) 1959 d) 1960

4) What constellation points to the south celestial pole (rotation axis line) in the sky ?

a) Orion b) Southern Cross c) Canis Major d) Boötes

—> ANSWERS in next months issue of the Science Newsletter ! <——-

** ANSWERS to June's Superfluous Questions: 1. b) Fizzbin 2. c) baseball 3. a) hallux 4. b) Pekingese