How Do We Find Planets Around Distant Stars?

What's this activity about?

Big Question:
How do we find planets around other stars?

Big Activities:
Spin "stars" to simulate star wobble (astrometry and radial velocity). Briefly explain transit method and direct imaging of planets

Participants:
From the club: A minimum of one person.

Visitors: One to six participants (per set of materials)

Duration:
5 to 10 minutes

Topics Covered:
- Two ways we are detecting planets around a star: the transit method and the wobble method

Background Information

Find a New World Atlas listing the **current tally all of the planets** discovered around other stars here:

http://planetquest.jpl.nasa.gov/atlas/atlas_index.cfm

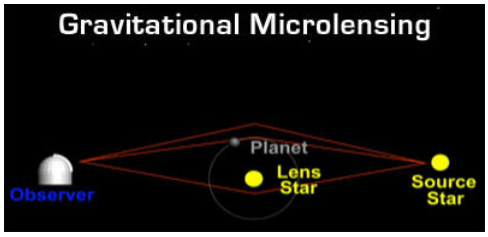
The **Wobble Method** actually uses *Radial Velocity* (or Doppler Shift). This involves measuring the redshift or blueshift of a star's spectral lines as it moves away from (redshift) and toward (blueshift) us along our line-of-sight ("radial" movement). The light is stretched out (longer wavelengths toward the red) when the star is moving away and gets bunched up (shorter wavelengths toward the blue) when the star is coming toward us.

See the Keys to the Rainbow activity for more information about spectra and how we see elements in a star's spectra.

The **Transit Method** relies on the extrasolar planet's orbit lining up directly between the star and Earth. The Kepler Mission uses this method to study one small area of the sky. You can find more information about the mission here:

Other methods for detecting planets are also quite useful, such as:

- **Microlensing:** Uses the gravity's effect on the light coming from as distant star when another star with planets passes in front. (see image on right)
- **Direct Imaging:** By blocking out the light from the parent star, it is sometimes possible to view the orbiting planets. This works best for large planets orbiting very distantly from their star.



A Note About Scale: On the scale where our Sun is the size of the foam ball (approx. 3"), one light year is about 330 miles. Jupiter would be about 150 feet away (halfway down a football field) and Earth would be 30 feet away. The nearest star (Alpha Centauri – at roughly 4 light years) is about 1300 miles away (about halfway across the USA). The distance of a star 10 light years away would be similar to the distance from Los Angeles to New York. A star 35 light years away would be halfway to the Moon. This demonstration uses shorter distances in the examples.

Detailed Activity Description

How Do We Find Planets Around Distant Stars?

Leader's Role	**Participants' Role (Anticipated)**
1) The Wobble Method *To Say:* How many people have heard that scientists have found planets around other stars? How do you think we can tell the difference between stars that have planets and stars that don't? *To Do:* Put the Star balls on a flat surface like a tabletop or blacktop with at least an area 2 feet by 2 feet clear of obstacles. Direct the participants to spin and observe the motion of the Star without a planet. *To Say:* What motion does it take? This is the motion a star without a planet has against the sky. *To Do:* Direct participants to spin the Star with a planet connected by the golf tee ("gravi-tee") and observe its motion. *To Ask:* What's different about the motion of this star? How do we know a star might have planets? *To Say:* Most methods for finding stars that have planets are dependent on detecting in some manner this movement (wobble) of a star caused by an orbiting planet. These methods cannot detect the planet itself, just the movement of the star as a result of its having one (or more!) planets in orbit around it.	Listen and respond. Participants spin the Star without a planet and observe its motion. Spin the Star with a planet connected by the golf tee and observe its motion. Answer: Its wobble; How it moves … etc.

Leader's Role	Participants' Role (Anticipated)
To Say: Do you suppose our star, the Sun, wobbles? Which planet do you think makes the Sun wobble the most? Which is our biggest planet? So do you think we've found any Earth-sized planets around other stars yet? We have. Do you think those small planets make the star wobble too? Let's see. *To Do:* Direct participants to spin the star with the small planet connected by the toothpick and observe its motion. *To Say:* What do you notice? Does it wobble? Yes it does, but that motion is harder to detect. Smaller planets like Earth are harder to detect, but we have found those too. Let's see another method we have used to detect planets around other stars. **2. The Transit Method or Photometry** *To Say:* "Photometry" is measuring the brightness of a star. The brightness of the star changes when a planet passes in front of the star from our perspective. This is also known as the Transit Method – because the planet transits the star from our perspective. *To Do:* Put the star with a large planet (foam ball with tee and ball) onto a skewer. Hold the star with a planet at eye level and orbit the planet in front of the star from the participant's perspective. *To Say:* Imagine this star being bright like the Sun. As the planet orbits in front of the star, the planet blocks a little of the star's light. Now, imagine this star as being a few hundred miles away in __(pick a city at least 300 miles away)___. We can't see the planet, just the change in the amount of light coming from the star.	Discuss the possibility that our Sun wobbles. Jupiter Discuss. Spin the star with the small planet Just a little

Leader's Role	Participants' Role (Anticipated)
To Say: The Kepler Mission uses this method to detect many planets in a small area of the sky, in the Summer Triangle. They are even finding small, Earth-sized planets, smaller than the planet we are using on this scale. *To Do:* Put the star with a small planet (foam ball with toothpick and small clay) onto a skewer. Show how it orbits in front of the star.  *To Say:* They are using very precise instruments to measure this small change in light. This is like detecting a flea crossing a big streetlight -- from all the way across the country!	

Materials

Where do I get additional materials?

1. Foam Balls: The ones you received in the kit are "stress balls." You may be able to find them at a local craft store, but generally, these can only be ordered in large quantities. Quantum Promotions will sell as few as 10 stress balls at once. They refer to these as "sample" shipments. You can order them by any of these methods:
    - EMAIL: sales@quantumpromotions.com or contact the sales rep, Steve Tallman, at: stallman@quantumpromotions.com.
    - CALL toll free at: 1-877-776-6674.
    - For 10 stress balls, the quoted price as of February 2011 is $2.23/ea, plus shipping.
2. Golf Tees: golfing supply store
3. Attached planet: Glue a small rubber ball or marble with super glue to a golf tee. Using super glue is the most effective and secure method. You don't want the ball flying off the tee and hitting someone. Alternatively, you can wrap a small ball of clay around the end of the golf tee
4. Clay: craft store non-drying clay