

Detecting Extra Solar Planets using Doppler Shifts and Computer Modeling.

Team members: _____



1. The first detections of planets orbiting other stars (“extra-solar planets”) were made by measuring the very tiny Doppler shifts of the star.
2. Computer simulations help us understand the possible structure of other solar systems.

Learning Goals

1. Understand how the presence of one or more planets causes a star to move.
2. Try building several possible solar systems.

IMPORTANT NOTE: Many labs are like cookbooks –they tell you exactly what to do. That is not the way real science works. *Real science* (as opposed to boring classroom science) is all about using your imagination and creativity.

Procedure

Part I. Go to the website of the CU-developed PHeT, phet.colorado.edu. Select “Physics Simulations” (at upper left), then “My Solar System,” and run the applet. (<http://phet.colorado.edu/en/simulation/legacy/my-solar-system>)

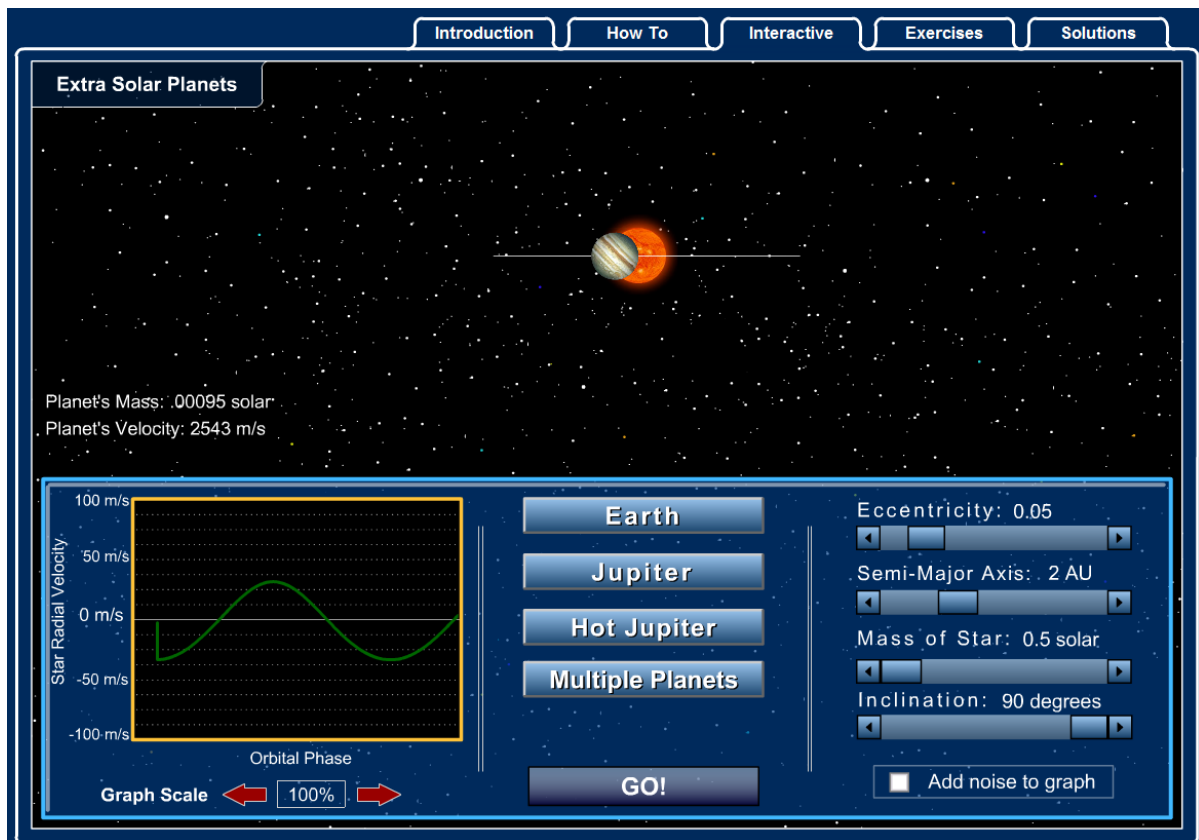
The default is to have a “Star” of mass 200 and a planet of mass 10.

1. When the planet moves, does the star move? What is the ratio of their distance from the center of mass? What is the ratio of their speeds?
2. The actual ratio of the masses of the sun and Jupiter are about 1,000 to one. What is the ratio of the speed Jupiter causes the sun to move, compared to Jupiter’s orbital speed?

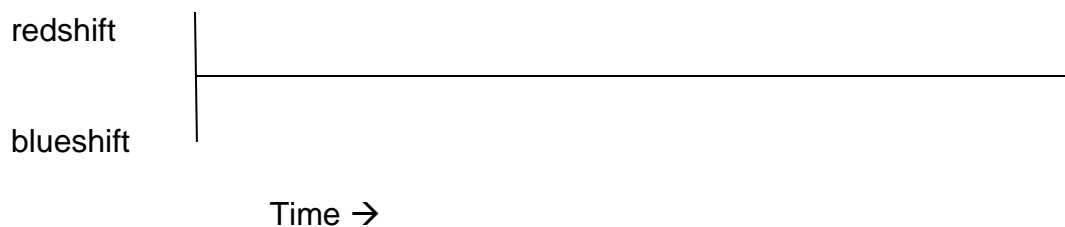
Jupiter causes the sun to move at about 13 m/s. What common motion in your daily life is approximately that speed? This tiny Doppler shift of the star is what astronomers measure to detect extra-solar planets.

Part 2. Now go to the website:

http://spiff.rit.edu/classes/phys230/lectures/planets/ExtraSolar_Nav.swf It looks like this:



Set the eccentricity to 0 (a circle), the semi-major axis to 2 AU (2x earth's distance from the sun), the mass of the star to 0.5 solar mass, and inclination to 90 degrees (edge on). Predict (sketch) how you think the Doppler Shift (also called "radial velocity") will change as time passes.



Hit "Go" and see how it actually changes. Change your sketch if it is different than expected but please **do not** erase your prediction.

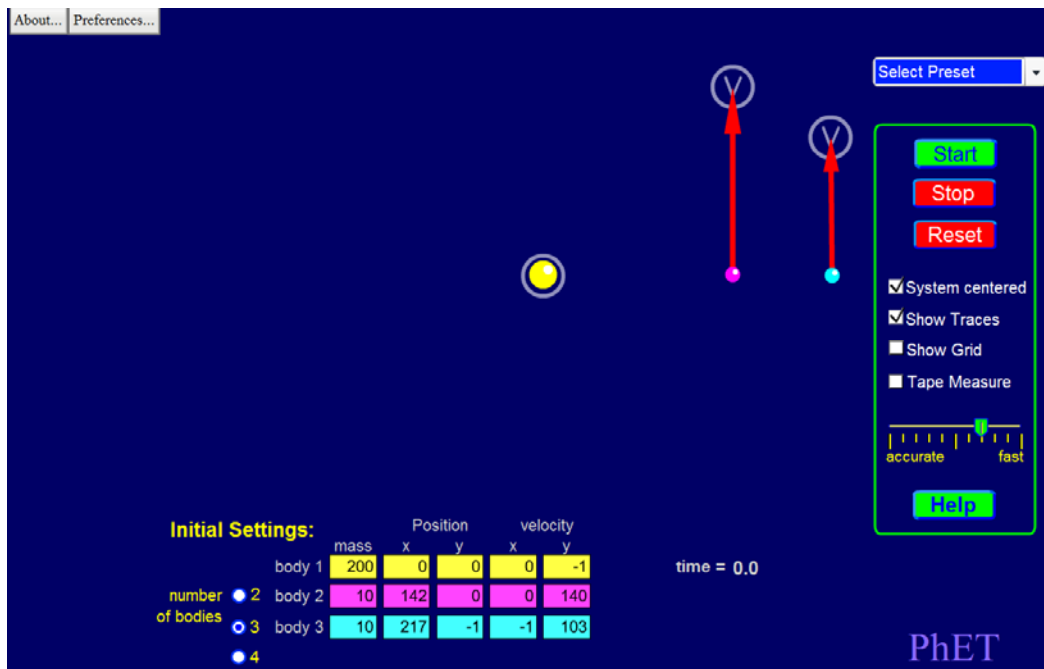
Change the inclination to 0 degrees (top view) and watch the orbit. What does the Doppler Shift look like now? Why?

Can the Doppler Shift method find planets around any star, or only orbits with certain orientation towards earth?

Set the inclination to 90 degrees and choose multiple planets. Do you understand why the Doppler Shift changes the way that it does? Explain:

Part 3.

Go back to the “My Solar System” PHeT and choose 2 planets, each of mass 10, arranged like the photo:



Is your “solar system” stable? Why or why not?

Can you make it stable? How? (Show your LA or TA if you can).

Can you add a 3rd planet, also of mass 10, and make a stable solar system? Try it. Show your LA or TA what happens....