

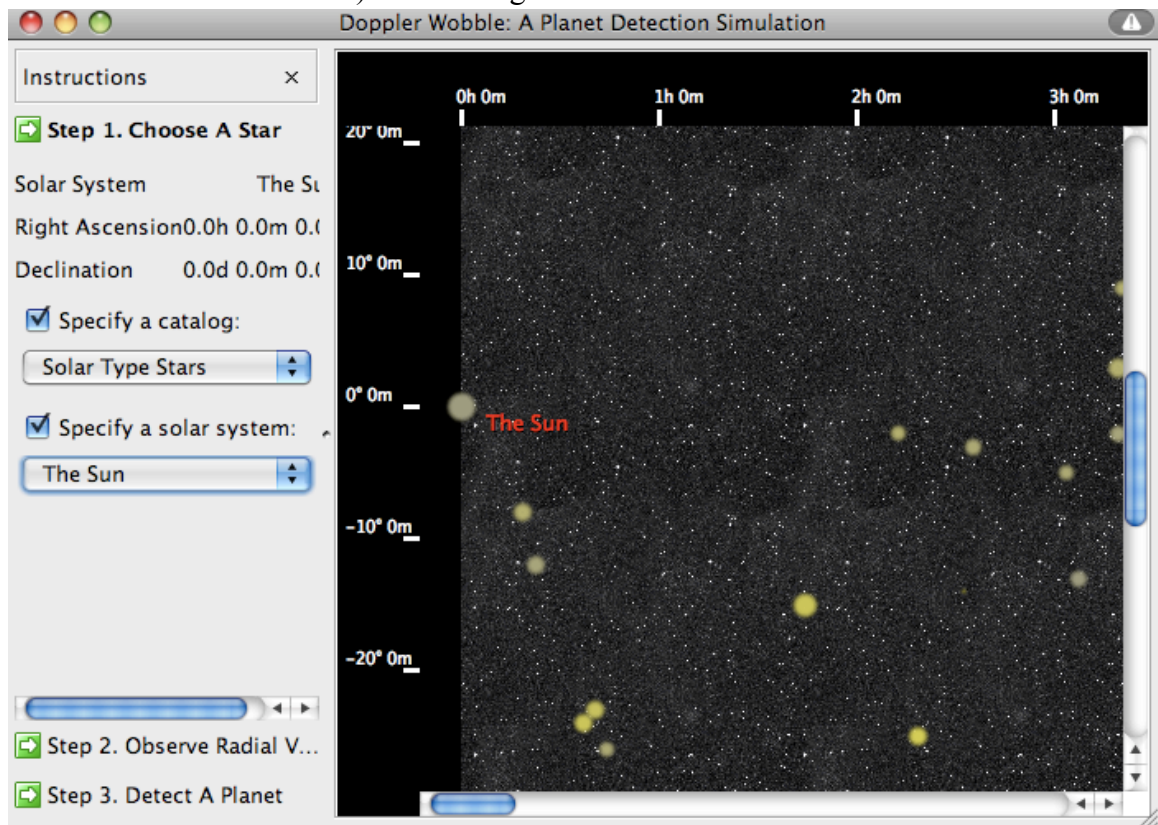
## Doppler Wobble

### Discovering exoplanets

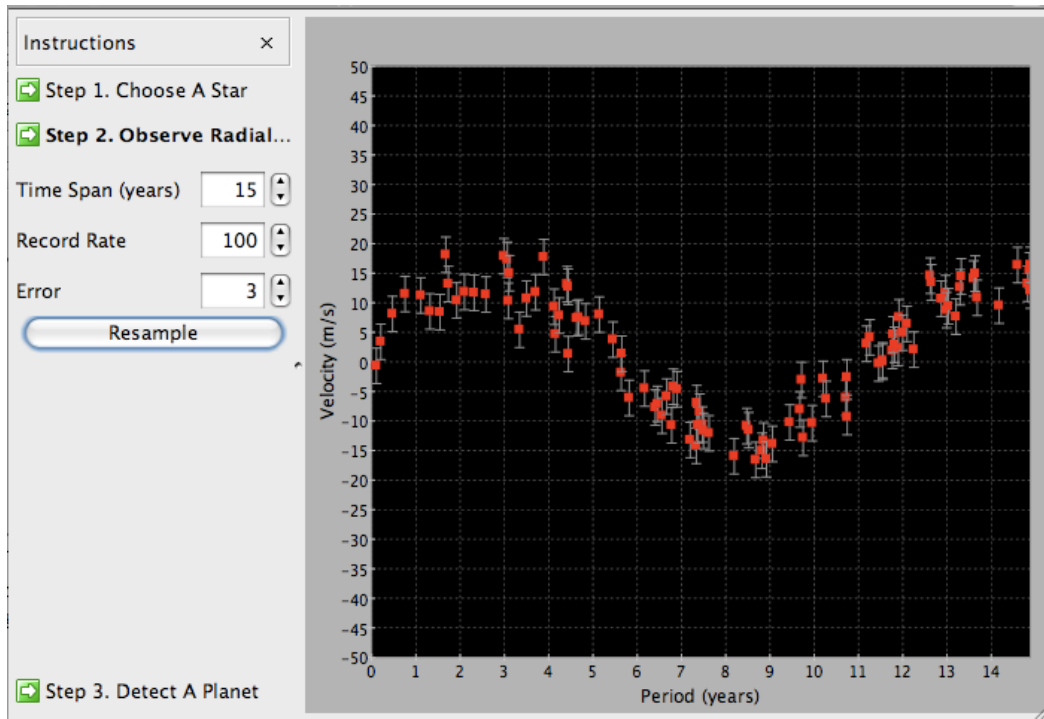
Summary: You will “observe” several stars for a 15 year period and determine which stars have a detectable planet.

### Procedure:

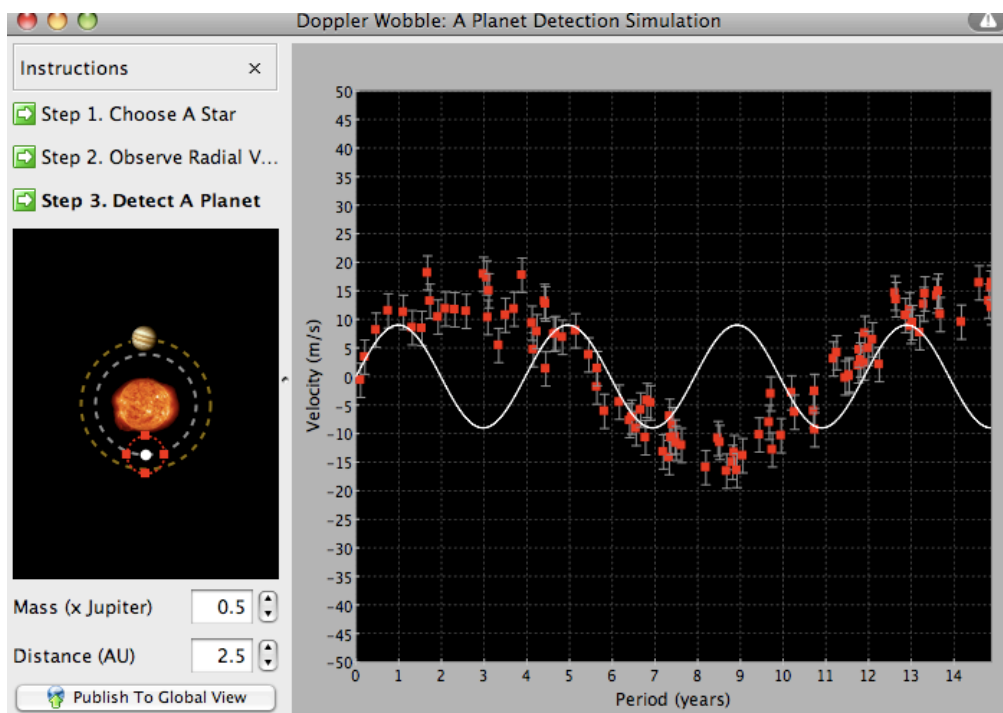
1. Open the simulation: <http://homework.uoregon.edu/demo/wobble/wobble.jnlp>
2. It should look something like this:
3. Click on the box: “Specify a catalog”
4. Under the drop down menu, select “Solar Type Stars” (it should already be selected for this)
5. Click on the box: “Specify a solar system”
6. Using the scroll bars to pan all the stars on the widget, randomly select a star (Here we have chosen the Sun) on the image.



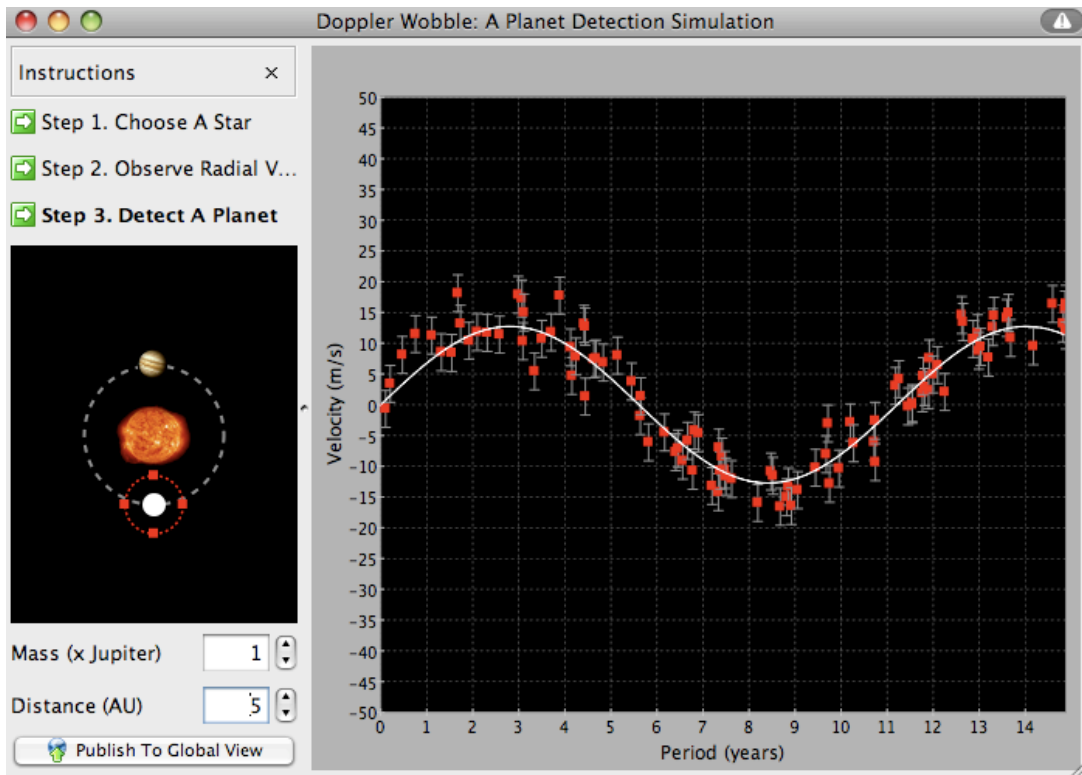
7. Now click on “Step 2. Observe Radial Velocity”
8. you will see the following:



9. Set the Time Span to 15 years
10. Set the error to 3
11. Leave the record rate at 100
12. Click Resample and you should have something similar to above image. If you keep clicking resample, it will change the data a bit because it is simulating new data points.
13. Now click on the “Step 3. Detect a planet” and a white sine wave appears



14. Fit the sine wave to the curve by changing the Mass and Distance in the small boxes below the image if the sun and planet



Then read off the Mass of the planet (1 Jupiter sized planet that is 5AU from the sun) which obviously is Jupiter's size and distance.

Criteria for detection:

- Observation time must span at least  $\frac{1}{2}$  a period (trough to peak, peak to trough or bigger)
- Must be able to fit a Mass with in  $\pm 0.5$  Jupiter masses
- Must be able to fit a distance within  $\pm 0.3$  or so AU. Any greater range of fit with the mass or distance is really not a detection.

15. Randomly select stars from the simulation by clicking on stars in the image.

16. Be sure to select different colors and sizes although there isn't a significant range in stellar sizes.

17. Do the same process as outlined for the sun using

time=15 years

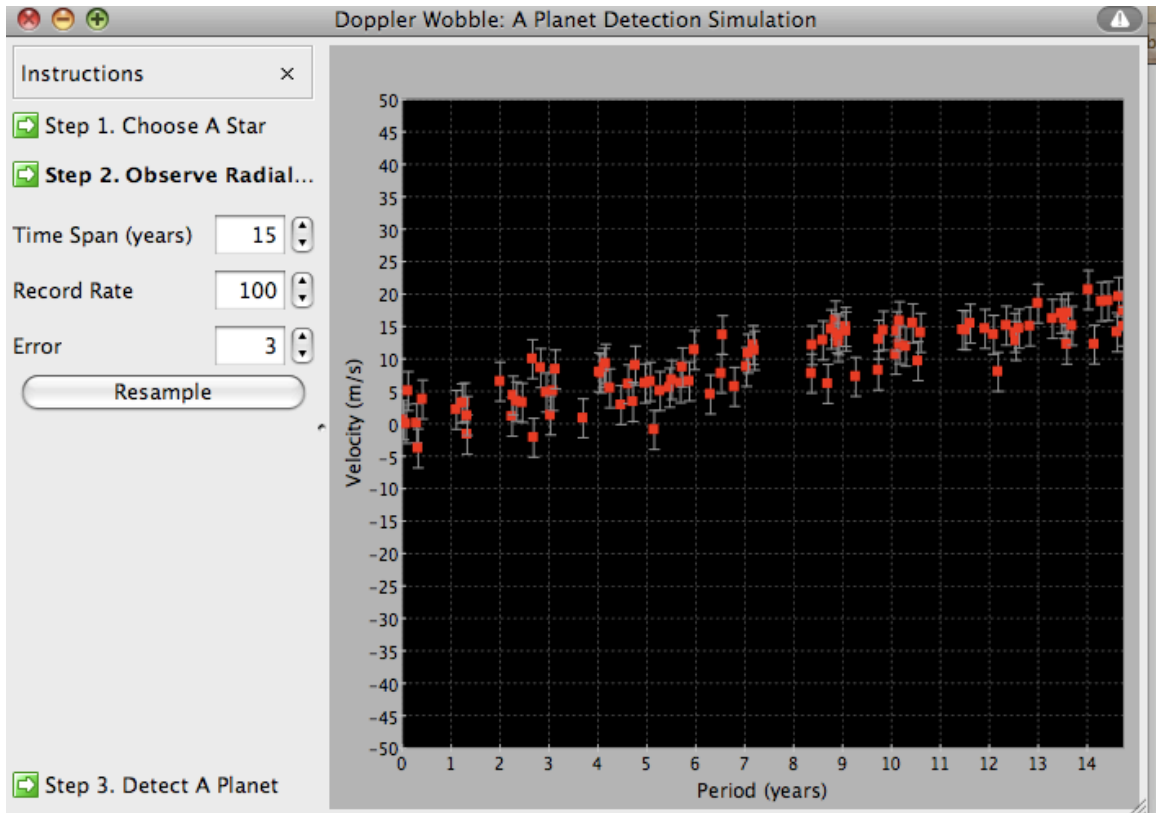
Record rate=100

error =3.

18. Try to get at least 3 detections. You might end up going through several stars before you can find planets.

19. Report the star name, planet mass and distance.

Here is an example of a non-detection:



The observational time is too short in comparison to length of the planet year. Also if the mass is too small, the amplitude of the peak will be smaller than the error in the measurement – which is also a non-detection. See lecture 40 for examples of other non-detections.