Planetary Orbit Simulator – Technical Manual

Description

The figure to the right shows the default configuration of the Planetary Orbit Simulator. There are three panes – the orbit pane (black pane),the settings pane (right pane), and the features pane (bottom). The orbit and settings pane are always visible. The features pane has four different views depending on which tab is selected. Switching tabs does not remove settings selected in other tabs.

Orbit Pane

The orbit pane shows the sun and a simulated planet viewed from above. The size of the simulated planet's orbit with respect to the orbit pane is fixed. Changing the orbit size (semimajor axis) changes the scale presented in the pane. This change in scale is indicated by the dynamic background grid. The simulated planet, which is always represented, can be clicked on and dragged by the user, even if animation is running.

The grid scale can be easily obtained by setting eccentricity to 0 and reading the scale size. The dynamic background grid will fade out minor grid cells in favor of major grid cells. When they fade from view depends, in part, on the brightness/contrast resolution of a user's monitor. For example, with a semimajor axis of 9 AU, minor grid cells of 1 AU scale might be visible with a major grid cells 5 AU wide being clearly visible. At 10 AU, the minor grid cells are faded from view.

It is not recommended that the dynamic background grid be used for calculation purposes. It's primary function is indicate a change in scale. However, it may be useful to note the “falseness” of the scaling as the sun and simulated planet do not scale in angular size with respect to the dynamic background grid.

Settings Pane

The sliders can be changed in three ways. The slider can be dragged, a number can be entered in the value box, or one can click n the slider bar directly. The last method increments the value by smallest digit and can be used for fine control.

The semimajor axis slider will accept values from 0.1 AU to 50 AU. Changing the size of the orbits semimajor axis does not change the depicted size of the orbit but only the scale. Change in scale is indicated by the dynamic background grid.

The eccentricity slider changes the eccentricity from 0 (a circle) to 0.7. While the eccentricity approaches the limit of 1 (a flat line), 0.7 was judged as sufficiently elliptical for the purposes of the Planetary Orbit Simulator.

The animation rate slider changes how fast the simulated planet is observed to orbit. It does not change the orbital period it represents. Clicking the “start animation” button starts the animation moving. The text of the button will change to “pause animation” and clicking again will stop the animation of the simulated planet. How fast the planet will move, depends in part, on the capability of the machine. Choosing a fast animation rate and small semimajor axis can result in aliasing effects.

The planetary presets drop down menu set the orbit of the simulated planet to match the orbit of one of our solar system's planets. However, inclination is suppressed.

The show solar system orbits options allow the user to compare the simulated planet's orbit to those of our solar system. A small dot showing a planet in those orbits can optionally be shown for comparison when animating the simulated planet. Optionally, labels showing the solar system orbits can be shown as well.

The clear optional features button will remove all checked boxes, including those in the features pane, and all sweep segments. It does not alter slider settings or animation status. To restore the default settings, refresh the browser window (F5 in many browsers).

Features Pane

The features pane has four tabs, “Kepler's 1st Law”, “Kepler's 2nd Law”, “Kepler's 3rd Law”, and “Newtonian Features”. Each tab brings up additional options.

The Kepler's 1st Law tab bring up features that allow the components of the ellipse to be clearly identified. In addition, the distance to the simulated planet from each focus is dynamically calculated showing that it is consistent with $r_1 + r_2 = 2a$.

The Kepler's 2nd Law tab is designed to dynamically demonstrate Kepler's 2nd law. Pressing the “start sweeping” button will animate the simulated planet (if not already animated) and sweep out an area equal to the sweep size indicated on the “adjust size” slider. The slider varies the denominator between 40 - 2. Checking the sweep “continuously” option button will create a series of adjacent sweep segments through one full period.

The sweep segments cycle through four different colors. They are partially transparent and may overlap. Clicking “erase sweeps” will erase all sweeps on the screen, but does not stop animation. Press and holding the “DEL” key and then clicking on a segment will erase an individual segment. The simulator limits the number of sweep segments to 50. Any segment created after 50 will cause the oldest segment to be erased.

The “use sound effect” option will play a tick sound every time a sweep finishes. Its usefulness is limited to large sweeps. When the sweep segments are small and continuous the mental correlation between the audio and visual becomes disjoint.

Clicking on individual sweep segments allows the user to place them where desired. They will snap to adjacent sweep segments if brought close enough. The “adjust size” slider adjusts all segments present. Moving the slider deletes any sweep segment in process and cancels a continuous sweep cycle.

The Kepler's 3rd Law tab shows the calculation of period squared (P^2) and the average orbital distance cubed (a^3). The location of the simulated planet on a period vs. semimajor axis plot is shown. The plot can be displayed as a linear plot or a logarithmic plot.

The Newtonian Features tab shows a graph of the simulated planet's acceleration (pink, m/s^2) and velocity (purple, km/s) magnitude. The x-axis, which is not labeled, is the phase of the planet's orbit. The vertical line indicates the current phase of the simulated planet in its orbit. The velocity and acceleration vectors can be shown on the graph by licking their respective check boxes. The acceleration vector scales linearly from a maximum length at perihelion to its minimum length at aphelion.