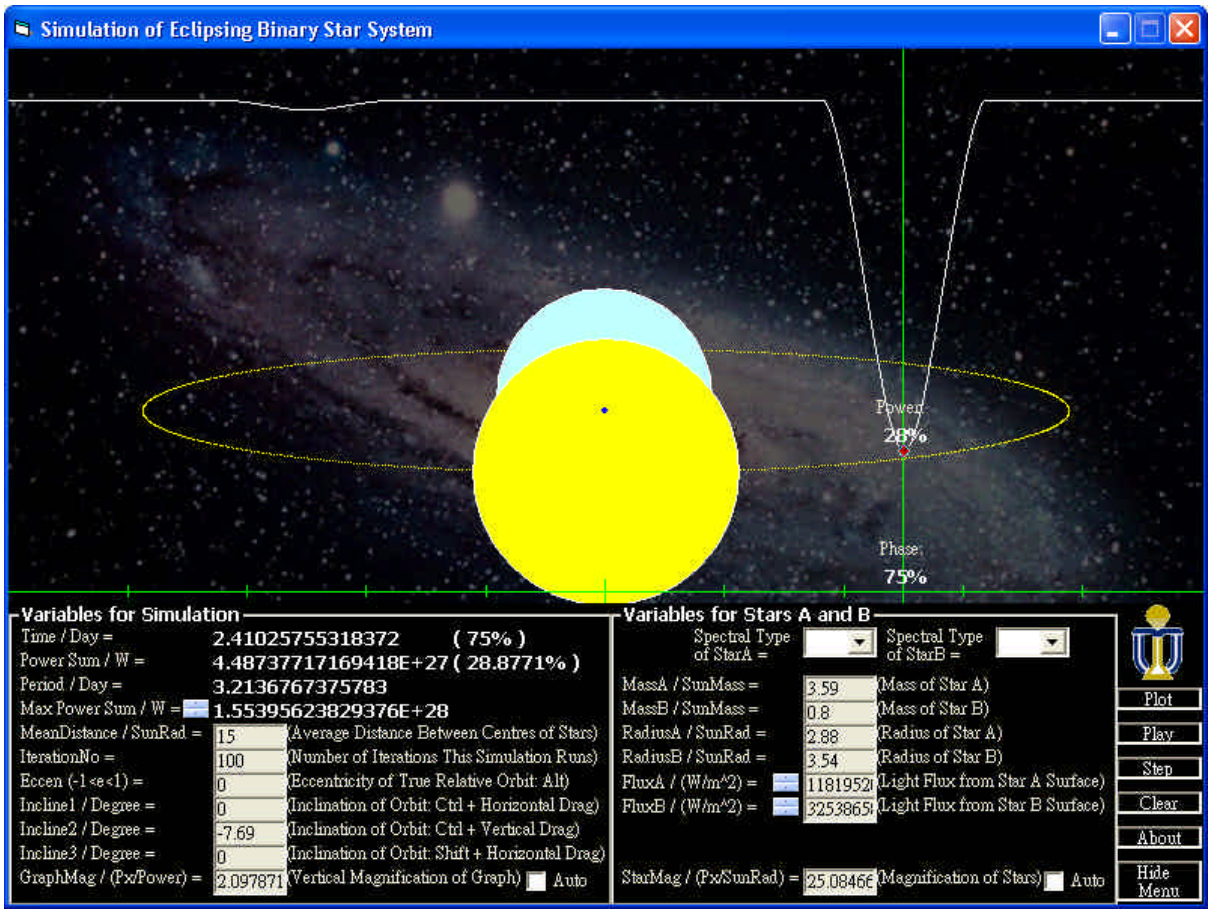
PRESS 2001 Project Program Manual

Simulation of Eclipsing Binary Star Systems



About This Manual

This manual refers to a specific version of the computer program, "Binary Star Simulation.exe", written for the PRESS project with the above layout. The default settings simulate an eclipsing binary star system called Algol.

Modes

In the 4th row under "Variables for Simulation", press up and down to select the desired mode.

- ***Power***

A power curve is plotted. “Power Sum / W”, “Max Power Sum / W” and “GraphMag / (Px/W)” is displayed in the 2nd, 4th and last row respectively under “Variables for Simulation”.

❖ ***Magnitude***

A logarithmic curve of absolute magnitude is plotted. The higher on the curve, the smaller the magnitude is, since smaller magnitude means greater power. “Abs Magnitude Sum”, “Max Abs Mag Sum” and “GraphMag (Px/Mag)” is displayed in the 2nd, 4th and last row respectively under “Variables for Simulation”.

Input

The data for Algol is entered by default. For other binary star systems, enter reasonable numbers in the boxes. Scientific notations such as 1e2 (=1x10^2 =100) and decimals are acceptable. Entering abnormal data including extremely large numbers and alphabets will result in program error and termination. The output updates itself only when the button “Plot” is pressed. If one or more data are uncertain, refer to the “Prediction” section. Some general guidance appears in brackets next to the boxes. Further details are illustrated below:

❖ ***Variables for Simulation***

■ ***MeanDistance / SunRad***

Enter the average distance between the centres of the stars A and B in solar radius. If the true relative orbit of the system is elliptical, enter the length of its semi-major

axis. The distance should be greater than the sum of the radii of the stars to produce a smooth light curve.

- ***IterationNo***

  Enter the number of iterations this simulation runs, i.e. the number of time slices across 1 period. The number of iterations does not affect the shapes of the curve or the orbit. To give a continuous simulation with respect to time, enter “793” iterations.

- ***Eccen (-1<e<1)***

  Enter the eccentricity of true relative orbit of the binary star system which must be greater than -1 and smaller than 1. Eccentricity can also be changed continuously from -0.95 to 0.95 by holding the key “Alt” while dragging horizontally on the output screen.

- ***Incline / Degree***

  Enter, in degree, the inclinations for three different directions (refer to the diagram) of the true orbit of the binary star system in incline1, incline2 and incline3 respectively. In this way, the true orbit can be tilted in any orientations. While incline1 and incline3 are “0”, set incline2 to “0” and “90” to observe the orbit edge on and face on respectively. With the key “Ctrl” held, incline1 and incline2 can be changed continuously by dragging horizontally and vertically respectively on the

output screen. Incline3 can be changed continuously by holding the key “Shift” while dragging horizontally on the output screen. The density of white dots appeared changes according to the number of iterations.

- ***GraphMag***

  Enter the vertical magnification of the light curve, i.e. how many pixels on the curve represent 1W in power mode, or 1 in absolute magnitude mode, from the binary star system. Selecting “Auto” best fits the curve on the output screen. When “Auto” is deselected, the axis in the power mode represents 0W while that in the magnitude mode represents 0 and moves to the centre of the output screen.

❖ ***Variables for Stars A and B***

- ***Spectral Type***

  Choose the spectral types of the stars from the followings:

  O5V, B0V, B5V, A0V, A5V, F0V, F5V, G0V, G5V, K0V, K5V, M0V, M5V, M8V.

  The mass, radius and temperature of the stars concerned is automatically entered and locked. To unlock them, choose nothing in the spectral type.

- ***Mass / SunMass***

  Enter the mass of the stars in solar mass. A star with greater mass revolves closer to the centre of mass.

- ***Radius / SunRad***

Enter the radius of the stars in solar radius. The sum of the radii of the stars should be smaller than their average distance to produce a smooth light curve.

- ***Flux / (W/m^2), Luminosity / W, Temperature / K, AbsVisMag***

  Choose one among light flux in watt per metre squared, luminosity in watt, and temperature in kelvin on the surface of the stars as well as its absolute visual magnitude to enter by pressing up and down. When the 4 parameters are switched among each other, their values are automatically exchanged. However, when "absolute visual magnitude" is selected, its value is emptied, the "radius" input box is locked, and the "temperature" input box which should also be entered appears below. This is normal because the program calculates absolute bolometric magnitude and radius from absolute visual magnitude and temperature.

- ***StarMag / (Px/SunRad)***

  Enter the magnification of the stars, i.e. how many pixels on the orbit simulation represent 1 solar radius. Selecting "Auto" best fits the orbit simulation horizontally on the output screen.

Output

The program has a full screen display under the resolution of 800x600. After the button "Plot" is pressed, the light curve and the orbit draw again without erasing the previous ones for comparison of different binary star systems. Other features are stated below:

- ***Time / Day***

  Display the time for the simulation in number of days, i.e. it is 0 when the simulation begins on the left of the output screen, and has the value of a period when the simulation ends on the right of the output screen. The bracket next to it shows its percentage period.

- ***Power Sum / W, Abs Magnitude Sum***

  Display the total power of the stars in watt in power mode, or the total absolute magnitude in magnitude mode. The bracket next to it shows its percentage of maximum total power or minimum total absolute magnitude.

- ***Period / Day***

  Display the period of the binary star system in number of days.

- ***Max Power Sum / W, Min Abs Mag Sum***

  Display the maximum total power of the stars in watt in power mode, or the minimum total absolute magnitude in magnitude mode.

- ***Axis***

  Display the 0 level of the light curve when the “Auto” next to “GraphMag” is not selected. If the “Auto” is selected, it stays at the bottom of the output screen.

- ***Orbit Simulation***

  Display the positions and orbits of the stars in their respective colour calculated

automatically. The dot in inverted colour represents the centre or mass. Right click on the output screen to adjust the position of the centre of mass, but adjustment is limited to vertical action if the “Auto” next to “StarMag” is selected.

- ***Light Curve***

  Display the total power or the total absolute magnitude in course of time across 1 period.

- ***Inclination***

  total power or minimum total absolute magnitude truncated to the nearest integer is above the red dot which follows the light curve, while the percentage period is at the bottom. Clicking or dragging on the output screen controls the position of the time line and hence the positions of the stars on their orbits at the time concerned.

Buttons

- ***Plot***

  Press “Plot” to plot the light curve and orbit using the input data. The time of simulation returns to 0.

- ***Play, Stop***

  Press “Play” to run a simulation. A greater number of iterations gives a smoother simulation, while a smaller one makes the simulation faster. The button changes to “Stop”, and the simulation repeats itself until “Stop” is pressed.

- ***Simulate***

  Press “Simulate” to move the time line one step forward. This enables the time line to move less than 1 pixel when the number of iterations is great.

- ***Clear***

  Press “Clear” to erase the light curve and orbit.

- ***About***

  Press “About” to know more about us and the program. Double click the box to close it.

- ***Hide Menu, Show Menu***

  Press “Hide Menu” to hide away the input frames and enlarge the light curve. The buttons also disappear unless the mouse pointer is over them. The button changes to “Show Menu” and clicking on it recovers the input frames.

Prediction

If the light curve of the binary star system under study is known by observation, the program can predict one or more missing input data.

- ***Eccentricity***

  Holding the key “Alt” while dragging horizontally on the output screen to change the eccentricity continuously. Stop dragging when the desired separation between the two minima on the light curve is obtained. Read off the “Eccen” predicted.

- ***Inclination***

  Move the time line to a minimum point on the light curve. Holding the key “Ctrl” while dragging vertically on the output screen to change “Inline2”. Stop dragging when the desired minimum power or magnification is reached. Read off the “Incline2” predicted. Other orientations of inclination can be predicted similarly.

- ***Others Input Data***

  Adjust the missing input data until the light curve satisfactorily fits the observed one.