



Rotation

Because of gravitational tidal forces, binary stars in circular orbits typically exhibit *synchronous* rotation, *i.e.*, their rotation and revolution periods are the same. If one or both stars do not rotate synchronously, then that star or stars are said to rotate *asynchronously*. The rotation parameters (F_1 and F_2) represent the ratio of the angular velocity of rotation of the star ($\omega_{1,2}$) to the mean angular velocity of revolution (ω) of the system, *i.e.*,

$$F_{1,2} \equiv \frac{\omega_{1,2}}{\omega}$$

Thus a value of $F = 1$ for both stars in circular orbits corresponds to synchronous rotation, the default setting of *Binary Maker 3*. If the binary has an eccentric orbit, the idea of synchronism is muddled somewhat because of the continually varying orbital velocities of both stars as they orbit each other. Hut (1981) has shown that tidal forces between the stars, greatest at periastron, will eventually bring the stars into a "sort of" synchronism that makes the angular rotational velocity of the stars equal to their revolution angular velocities at periastron. This condition is commonly known as *pseudo-synchronism*. On the **Rotation** input pane within the **User Input** dialog is a check box that toggles the *pseudo-synchronism* feature. Hut (1981) demonstrated that the periastron-synchronized rotation value is given by the following equation:

$$F^2 = \frac{1+e}{(1-e)^3}$$

This equation is built into *Binary Maker 3*, and it is the default value for any binary whose parameters are input manually. Note for circular orbits ($e = 0$) that the rotation parameter becomes unity (*i.e.*, synchronous). When an

eccentricity is entered into the program, pseudo-synchronous values of **F** are automatically calculated and placed into the **Rotation** input boxes if the *pseudo-synchronous* box is checked (checked is the default condition). To enter your own value into the input boxes, uncheck the *pseudo-synchronous* box and the input boxes will be enabled.

To make a star rotate *asynchronously*, for example to make it rotate twice as fast as it revolves, uncheck the *pseudo-synchronous* box and make the star's **F** value equal to 2.