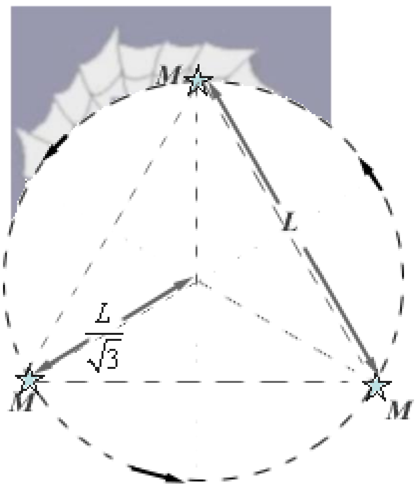
98.

<u>Problem 16.73 (RHK)</u>

Three identical stars of mass M are located at the vertices of an equilateral triangle with side L. We have to find the speed with which they all revolve under the influence of one another's gravity in circular orbit circumscribing, while still preserving, the equilateral triangle.



<u>Solution:</u>

It is a three-body problem, which lends itself to a solution. Three stars each of mass *M* revolve under the influence of one another's gravitational field in circular orbit. Let *v* be the speed of each star while revolving in a circular orbit of radius $L/\sqrt{3}$. The required centripetal force for circular motion is

$$F_{centripetal} = \frac{Mv^2}{L/\sqrt{3}}.$$

The centripetal force on each star is provided by the resultant gravitational force due to the other two stars, which is

$$F_{gravitational} = 2 \times \frac{GM^2}{L^2} \cos\frac{\pi}{6} = \frac{GM^2\sqrt{3}}{L^2}.$$

Equation of motion of each star is

$$F_{gravitational} = F_{centripetal},$$

or

$$\frac{GM^2\sqrt{3}}{L^2} = \frac{Mv^2\sqrt{3}}{L},$$

or

$$v = \sqrt{\frac{GM}{L}}.$$