Simulation of the Interaction of a Binary System with a Third Star

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Introduction

A celestial binary system was simulated to analyze how its orbit is disrupted by a third body passing through the center of the system at various angles in the x-y plane. While unlikely to occur for most stars, encounters like this may play a role in the evolution of binary systems in dense groups of stars called globular clusters.

The two initial bodies had masses that were one half and one and a half times that of the sun. The foreign body had a mass equal to that of the sun. The extent of the disruption of the system was strongly dependent upon the incident angle of the third body.

Initial Conditions

1st Star – **Black**, Half the mass of the Sun
2nd Star– **Red**, Twice the mass of the Sun
3rd Star – **Blue**, Mass of the Sun

The simulation began with the 1st and 2nd star 1000 A.U. apart, locked in a binary orbit. The third star began 100,000 A.U. from the center of mass of the system and approached with a velocity of 1km/s. (1 A.U. is equal to the distance between the Earth and the Sun.)

Each simulation modeled a time span of a million years, producing snapshots every 1000 years.

The angle of approach of the third star was varied by increments of 20° so the effect of the angle of approach could be analyzed.

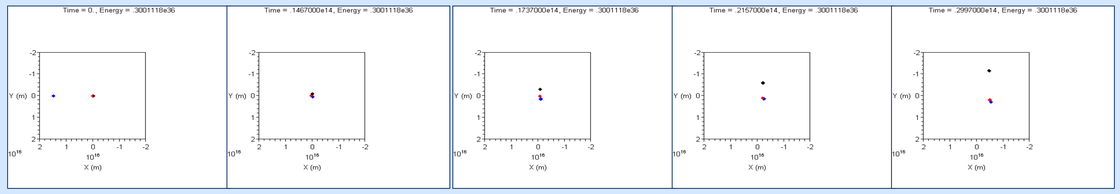
Results

All encounters resulted in the binary orbit of two stars. The two stars that made up the system after the event was dependent upon the angle of approach of the third star.

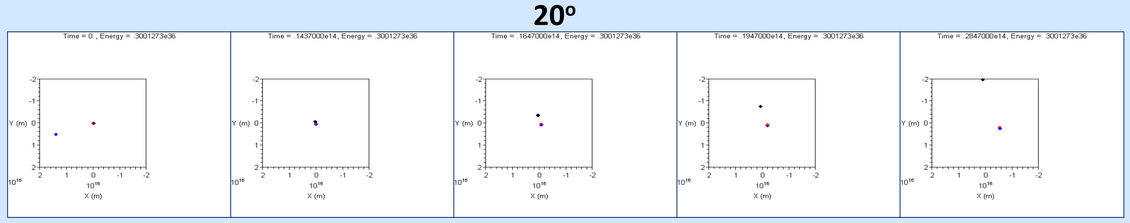
Angles of 0° through 100° resulted in the binary orbit of the second and third star while the first body was ejected from the system.

Angles of 120° through 180° resulted in the binary orbit of the first and third star while the second body was ejected from the system.

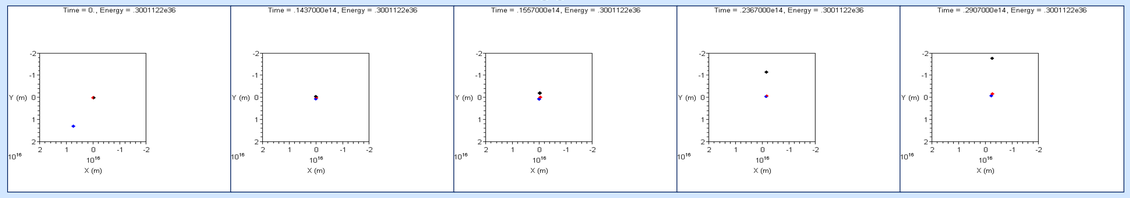
0°



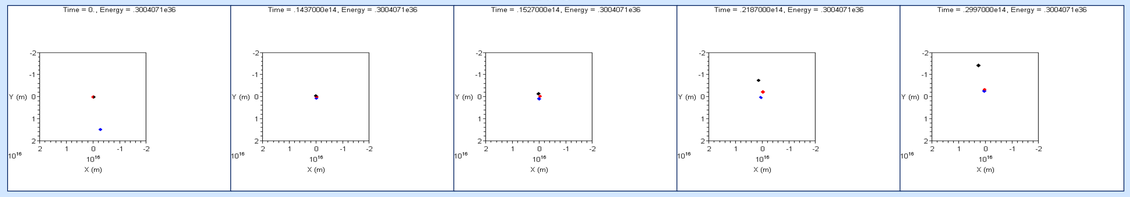
20°



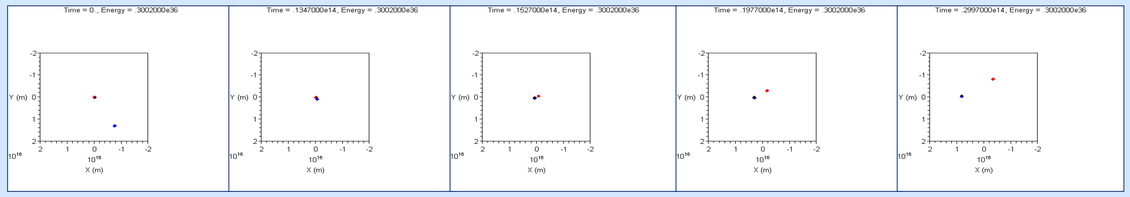
60°



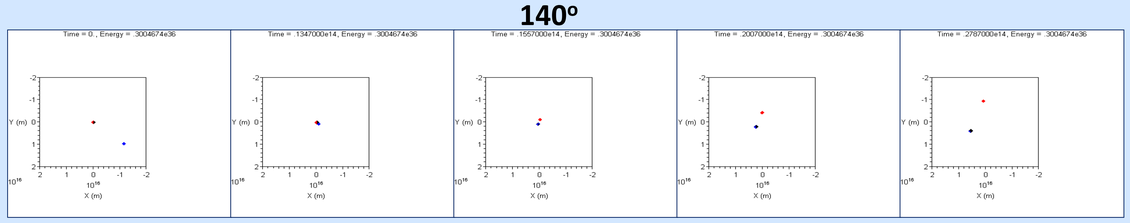
100°



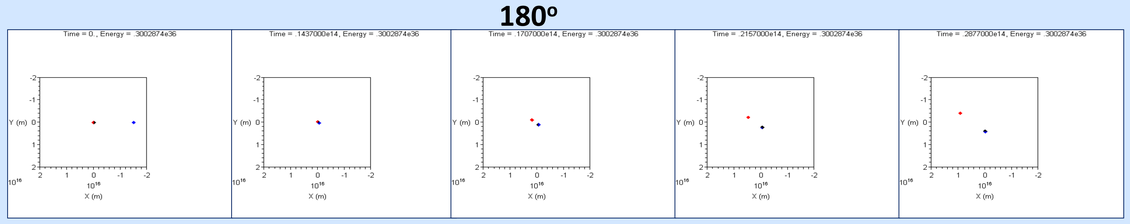
120°



140°



180°



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