The Three-Body Problem: A Stability Analysis of Multiple Star Systems

Holmqvist, Simon (School: Polhemskolan)
Sjogren, Albin (School: Polhemskolan)

There is no general closed-form solution for the long-term dynamics of stars in systems where three or more stars are orbiting each other. When considering only the effects of Newtonian gravity, this becomes an example of the three-body problem. The unpredictability of the orbits can theoretically result in stars colliding or being ejected. In contrast to binary stars, which are stable under these simple conditions, multiple star systems with more components are often less so. We have numerically simulated the triple star system 2 Camelopardalis (2 Cam) for over 600 000 years into the future to study its stability. The simulation was performed by a program that we developed ourselves. Starting with the initial positions and velocities as input, it uses leapfrog integration to calculate the future motion of the stars according to Newton's Law of Gravitation. The vectors used as input values were calculated from orbital elements, using another program that we developed. During the simulation, 2 Cam did not collapse, neither by collision nor ejection. Therefore, the system's exoplanets are not at immediate risk of suffering the consequences of a collapse. By analyzing periodic patterns in 2 Cam’s orbits and comparing them to similar patterns found in additional, shorter simulations of other multiple star systems, we investigated what makes a multiple star system stable. In conclusion, our research suggests that 2 Cam likely won’t collapse any time soon, and provides powerful tools for further research into the enigmatic constellations that are multiple star systems.

Awards Won:
Second Award of $2,000