Minimum Energy Configurations for Deformable Rubble Pile Asteroids.

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The theory of minimum energy rubble pile configurations is taken to the deformable limit, analyzing the rubble pile model under the continuum limit. This theory will provide useful insight into the formation mechanics of binary asteroids and multi-body systems under fission mechanics.

In previous research [1,2,3] the spin fission of rubble pile asteroids has been investigated using an idealized model of rigid bodies resting on each other. For that work a crucial concept is the amended potential of the system, which can be used to track minimum energy configurations, fission points and when binary asteroid systems are possible. This function is

$$\mathscr{E} = \frac{H^2}{2I_H} + \mathscr{U}$$

where H is the total system angular momentum, I_H is the system moment of inertia about its spin axis and $\mathscr{U}$ is the total potential energy of the system. For a given level of angular momentum the amended potential is only a function of the system's relative positions and attitudes, under the rigid body assumption. Analysis of this function can be used to find equilibrium configurations, fission conditions and to track the minimum energy configurations as a function of angular momentum.

In the current discussion we will generalize the analysis of the amended potential to continuum distributions of inviscid material, restricted to ellipsoidal shapes. This, of course, will yield the classical stable shapes of a Maclaurin and Jacobi ellipsoids for single collections. We also analyze the amended potential for Darwin ellipsoids, and the approximate Roche ellipsoids, which enable us to evaluate the relative energies and fission points for binary bodies relative to the stability transition and bifurcation points of the Maclaurin and Jacobi ellipsoids. We base our studies on the classical results presented in [4].

The results of the analysis show that the inclusion of deformable mass distributions changes the details of the transitions seen in rigid body collections, but keeps the overall qualitative conclusions conserved.

References:

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