ASTEROID ROTATIONS AND BINARIES

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Rotations of asteroids are determined by mechanisms and properties with importance varying with asteroid size. Asteroids larger than about 50 km are affected primarily by collisions. Their spin rate distribution close to Maxwellian suggests that they are either original bodies of the asteroid main belt, or their largest, collisionally evolved remnants. Rotations of asteroids smaller than 50 km are significantly affected by a non-collisional mechanism, with the most probable candidate being the Yarkovsky-O'Keefe-Radzievskii-Paddack (YORP) effect that causes a radiative spin up or spin down of asteroids.

The YORP effect theory gives a consistent explanation for a few different features seen in the smaller asteroids population: 1) Excess of both fast and slow rotators. 2) Alignment of spin axes of members of the Koronis family. 3) Abundant population of small, close binary systems with a total angular momentum confined to values near critical.

Internal structure does not have a significant effect on rotations of larger asteroids which are in a gravity regime, but it is a key property for smaller asteroids. Asteroids in the size range 0.2 to about 10 km show a barrier against spins faster than 11/d that shifts to slower rates with increasing equatorial elongation. They are predominantly bodies with tensile strength too low to withstand a centrifugal acceleration for rotation faster than the critical spin rate. A scaled tensile strength of cracked but coherent rocks suggests that that a cohesionless structure is predominant among asteroids with $D = 0.2$ to 3 km.

The spin barrier disappears at sizes less than 0.2 km where most asteroids rotate too fast to be held together by self-gravitation only, so a cohesion is implied in them. They may be single fragments of the rubble that make up larger asteroids from which the smaller ones are derived.

An abundant population of binary systems has been found among asteroids in the size range 0.3 to 10 km in heliocentric orbits from near-Earth to the main belt. The fact that they appear exactly in the same size range where there is observed the spin barrier is not a mere coincidence, but the two things actually appear related. Primaries of the binary systems concentrate at fast spin rates, in a pile up just below the cohesionless spin barrier. Angular momentum content of the binary systems is close to the critical limit for a single body in a gravity regime, suggesting that they formed from parent bodies spinning at the critical rate by some sort of fission or mass shedding. The YORP effect is a candidate to be the dominant source of spin-up to instability. Gravitational interaction during close approaches to the terrestrial planets cannot be a primary mechanism of formation of the binaries, but it may affect properties of the NEA part of the binary population. For example, estimated short lifetime and its strong dependence on semi-major axis of the NEA binaries, together with the strength of the YORP effect being inversely proportional to the square of diameter, may be a reason that binaries in near-Earth orbits concentrate among NEAs with $D < 2$ km and that the fraction of binaries decreases among larger NEAs, as well as for their tendency to smaller relative separations (shorter periods) in comparison with main belt members of the binary population.