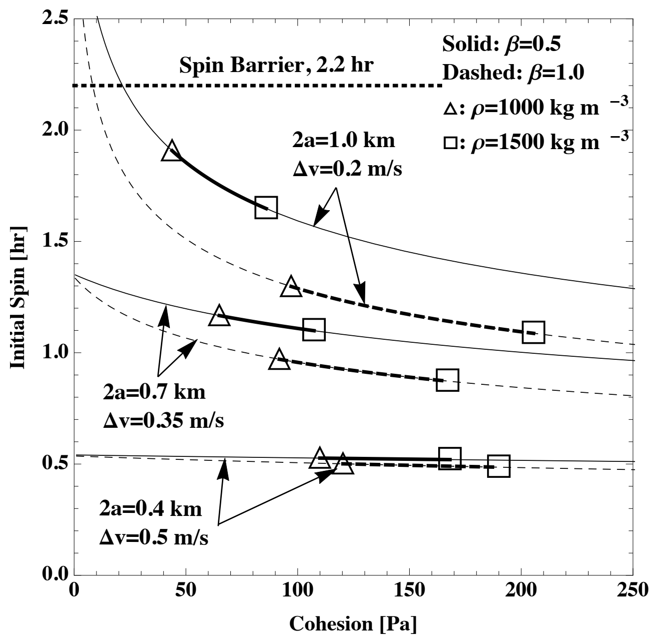
Constraints on the Physical Properties of Main Belt Comet P/2013 R3 from its Breakup Event

Masatoshi Hirabayashi,[1] Daniel J. Scheeres,[2] Paul Sánchez,[1] Travis Gabriel[1]

[1] *Aerospace Engineering Sciences, 429 UCB, University of Colorado, Boulder, CO, 80309-5004 United States*
[2] *Aerospace Engineering Sciences, 429 UCB, University of Colorado, Boulder, CO, 80309-0429 United States*
masatoshi.hirabayashi@colorado.edu

Abstract. Main belt comet P/2013 R3 recently experienced a breakup, probably due to rotational disruption. Because of this event, the small components with an effective radius, *a*, of 0.2-0.5 km were escaping with a dispersion velocity, Δ*v*, of 0.2-0.5 m/s in October through December 2013[1]. In this study, using these observational estimates, we propose a technique for constraining physical properties of the proto-body, especially the initial spin period and cohesive strength. The proto-body is assumed to be a biaxial ellipsoid and the breakup conditions are determined based on a combination of the failure condition of the proto-body and mutual orbit dynamics of the smaller components. The figure shows the possible initial spin period as a function of cohesion with different Δ*v* (0.2-0.5 m/s), *a* (0.2-0.5 km), and the aspect ratio of the proto-body, *ß* (> 0.5, the asteroid LCDB by Warner, Harris, and Pravec, 2012). The solid lines show the initial spin period with *ß* =0.5, while the dashed lines describe that with *ß* =1.0. The actual spin period should be laid between the fastest and slowest spin periods. The empty triangles and squares indicate the typical range of a bulk density of a C-type asteroid (1000 to 1500 kg/m^3), and the bold lines give the initial spin period between these bulk densities. From the range of the bold lines, it is found that the cohesive strength and the initial spin period range from 40 Pa to 210 Pa and from 0.48 hr to 1.9 hr, respectively. From this result, we conclude that although the proto-body could have been a rubble pile, it was likely spinning beyond its gravitational binding limit and would have needed cohesive strength to hold itself together. Additional observations of P/2013 R3 will enable stronger constraints on this event, and the present technique will be able to give more precise estimates of its internal structure. This study was accepted for publication in the Astrophysical Journal Letters on June 3, 2014.



[1] D. Jewitt, J. Agarwal, J. Li et al., *The Apj Letters* 784, L8 (2014).