LABORATORY EXPERIMENTS OF ROTATIONALLY DEPENDANT CATASTROPHIC DISRUPTION.

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Introduction: Catastrophic disruption of minor bodies is a major evolutionary process for rocky bodies in the asteroid belt, e.g. see [1] for a general review and [2] for a typical recent paper (concerning the Themis family). Two tools are available for its study, hydrocode simulations and laboratory experimentation. Both offer advantages. In the latter case it is possible to control key parameters and see how they influence the outcome of impact events (albeit at laboratory, i.e., cm scale). Previous studies have paid attention to areas concerning gravity or impact related disruption [2] and the use of hydrocode modelling to ascertain internal faults and their effects on disruption [3] thresholds to mention a few variables usually investigated. But although spin is a feature of asteroids, it is rarely considered in impact experiments. Here we use laboratory impact experiments to study the influence of target spin on the outcome of the impact event. Accordingly, we examine the effects governing hypervelocity impacts on solid cement spheres.

Method: The target spheres were made in-house and had (on average) a diameter and mass of 75 mm and 367 g respectively. A rotating target holder was used which had an average rotation rate of 3.44 revs^{-1}. Two datasets were obtained for stationary (0 rev^{-1}) and rotating shots (3.44 revs^{-1}) with 22 impacts in total. Impacts were obtained using a two stage light gas gun [4] firing stainless steel spheres (dia. 1 to 3 mm) at speeds between 1 and 7.5 km s^{-1}. This gave impact energy densities Q (kinetic energy / original target mass) in the range 7–2600 J kg^{-1}. This spanned the regime of cratering to disruption defined by m_f/m_i (mass largest fragment / original target mass) being greater than or less than 0.5 respectively, with Q* being the energy density at $m_f/m_i = 0.5$. The m_f/m_i results ranged from 0.99 to 0.04 in each of the data sets. For stationary targets it was found that Q* = 1500 J kg^{-1}, and we noted that m_f/m_i fell below 0.8 at Q = 750 J kg^{-1}. For the rotating targets we found that whilst Q* = 1450 J kg^{-1}, m_f/m_i fell below 0.8 at Q = 450 J kg^{-1}.

Discussion: From the present data we found that the stationary and rotating targets had similar Q* values and thus the level of rotation in these experiments is insufficient to affect the overall disruption threshold. There may however be a difference in behaviour at low Q values with rotating targets removing more spall material from craters – this is being investigated further.

References: [1] Ryan E. V. 2000. Ann. Rev. Earth Planet. Sci. 28:367–389. [2] Leliwa-Kopystynski J. et al. 2009. *Meteoritics & Planetary Science* 44:1929–1935. [3] Michel P. et al. 2004. Icarus 168 420 – 432 [4] Stewart S. T. et al. 2009. The Astrophysical Journal 691:L133 – L137 [5] Burchell M. J. et al. 1999. Meas. Sci. Technol. 10:41-50.