Observational constraints on the catastrophic disruption rate of main-belt asteroids

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We have calculated 90 % confidence limits on the steady-state rate of impact-generated catastrophic disruptions (CD) of main-belt asteroids in terms of the absolute magnitude at which one CD occurs per year (H_0^{CL}) as a function of the post-disruption increase in brightness (Δm) and subsequent brightness decay rate (τ). The confidence limits were calculated using the brightest unknown main-belt asteroid ($V = 18.5$) detected with the PanSTARRS1 telescope. We measured the system's CD detection efficiency over a 453-day interval using the PanSTARRS moving object processing system (MOPS) and a simple model for the CD event's photometric behavior in a small aperture centered on the CD event. We then calculated the H_0^{CL} contours in the ranges from $0.5\,\mathrm{mag} < \Delta m < 20\,\mathrm{mag}$ and $0.001\,\mathrm{mag\,d^{-1}} < \tau < 10\,\mathrm{mag\,d^{-1}}$ encompassing measured values from known cratering and disruption events and our model's predictions. Our simplistic CD model suggests that $\Delta m \sim 20\,\mathrm{mag}$ and $0.01\,\mathrm{mag\,d^{-1}} < \tau < 0.1\,\mathrm{mag\,d^{-1}}$ which would imply that $H_0 > 28$ — strongly inconsistent with the $H_0 = 23.26 \pm 0.02$ predicted by Bottke *et al.* (2005). However, if we assume that $H_0 = 23.26$, our results suggest that $11.0\,\mathrm{mag} < \Delta m < 12.4\,\mathrm{mag}$ which is entirely inconsistent with our simplistic impact-generated CD model. We think the solution to the discrepancy is that about 99.9% of main-belt catastrophic disruptions in the size range to which this study was sensitive ($\sim 100\,\mathrm{m}$) are rotation-generated and not impact-generated. We estimate that current and upcoming asteroid surveys may discover up to about 10 CDs/year brighter than $V = 18.5$.

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References: Bottke *et al.* (2005) *Icarus* 179, 63–94.