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The Active Centaurs

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Abstract

Centaurs are recent escapees from the Kuiper belt that have short dynamical lifetimes as a result of strong interactions with the giant planets. By definition, their perihelia lie outside Jupiter's orbit, where the sublimation rates of exposed crystalline water ice are too small to sustain cometary comae. Nevertheless, we find that 9 of 23 Centaurs observed in a recent survey show evidence for on-going mass-loss (e.g. Figure 1), the most distant being active beyond Saturn. The distribution of the orbital elements of the active Centaurs is different from that of Centaurs considered as a whole. In particular, the active Centaurs have perihelion distances (median 5.9 AU) systematically smaller than those of Centaurs as a group (12.4 AU), suggesting that the activity has a thermal origin (we have considered and rejected distance-related observational bias as an explanation for the observed perihelion systematics).

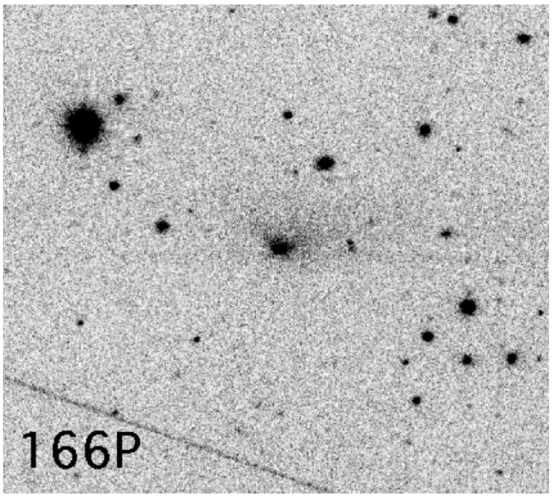

Figure 1: Centaur 166P (R = 8.5 AU) in a 2 arcmin wide field imaged UT 2002-Sep-07 and showing strong cometary characteristics.

While water ice sublimates too slowly to drive the observed activity, supervolatile ices (e.g. CO, CO2) instead sublimate too strongly. If exposed on the Centaurs these ices would sublimate and produce measurable comae at much larger distances than observed, even into the Kuiper belt beyond 30AU. Exposed sheets of supervolatile ice are further unlikely on physical and thermodynamical grounds (how could they form? and why would they not have long-since sublimated away?). Therefore, we have considered other possible explanations, including the possibility that Centaur activity is powered by *buried* (i.e. thermally insulated) supervolatiles and that activity is powered by the crystallization of gas-laden amorphous ice. By comparing the crystallization and Keplerian timescales, we derive a simple expression for the range of distances over which crystallization is to be expected and find broad agreement with the observed range. Therefore, we find that the data are consistent with activity resulting from the crystallization of amorphous ice. If it is correct, this explanation implies that the Centaur precursors (KBOs) and their derivatives (the Jupiter family comet nuclei) should also contain amorphous ice, with important implications for the temperature vs. time evolution of cometary ice.

Additional Information

This work is described in Jewitt, D. (2009). Astron. J. 137, 4296, which available here:

http://tinyurl.com/ccogpu