Main Belt Comets

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Main Belt comets (MBC) are recently discovered objects that are orbiting in the Main Belt and are showing cometary activity [1], [2]. These objects are peculiar because their cometary activity is coupled with a Tisserand invariant Tj>3, implying an asteroid-like orbit stable since very long time. Four of them are known until now: 133P/Elst-Pizarro, P/2005 U1 Read, 176P/LINEAR, and P/2008 R1 (Garradd). Many more, currently inactive or faintly active, are probably existing. Dynamical transition from outer Solar System is nowadays infrequent, and the orbits of MBCs are stable: this implies that MBCs have been formed in the Main Belt, or be there since a lot of time. A widely accepted explanation for the triggering of observed activity is an impact in a recent past. Following a method described in [3] the average time of formation of a crater on Main Belt bodies with sizes similar to the known MBCs can be estimated. For a porous body with a diameter of 5 km and a density of $1 g/m^3$, the crater formation rate in the size range 10-20 m is 281 years, while in the size range 100-200 m is 0.11 Myr. If we assume that MBCs are comet-like bodies, that is they are composed by a mixture of ice and refractory particles, the formation of such craters should be able to expose fresh material buried at a depth of several 10s of meters (ice must have been stabilized against sublimation losses). In order to have an idea of the consequences of an impact and of how long can the activity last, thermal evolution models developed for classical comets can be applied [4], [5]. These models can also be applied to define a "buried snow line", that is the depth, depending mainly on heliocentric distance, at which ice must be buried in order to survive for billions of years. It is well known that under a devolatilized, low-conductivity mantle ice-rich layers can survive for a very long time. If many more MBCs exist, a very faint, mostly gaseous activity could not be infrequent in the Main Belt. It would be triggered by small impacts, unable to directly expose fresh ice but able anyway to bring the heat wave closer to an ice-rich layer.

References

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