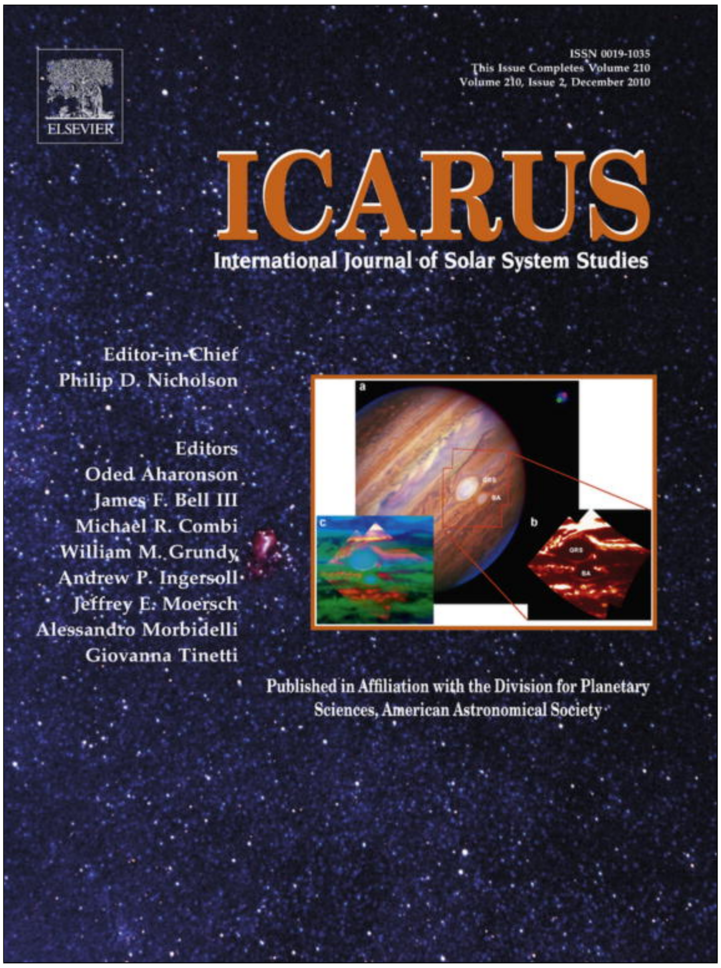
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Note

Updated results of a search for main-belt comets using the Canada–France–Hawaii Telescope Legacy Survey

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ABSTRACT

The results of a search for main-belt comets using Canada–France–Hawaii Telescope Legacy Survey data are updated. The remaining observations in the Very Wide segment of data, taken in the g' or r' filters, are visually inspected for cometary activity. The number of main-belt objects in the original and new data sets are 11,438 and 13,802, respectively, giving a total number of 25,240. This is the largest, and least biased, search for main-belt comets to date. One object is observed to show cometary activity, and a new upper limit for strongly active main-belt comets is derived to be 40 ± 18.

1. Introduction

Main-belt comets (MBCs), or activated asteroids, are objects that reside in the main-belt but show intermittent cometary activity (Hsieh and Jewitt, 2006). These objects may be native to the asteroid belt (Fernández et al., 2002), and activated by collisions (Boehnhardt et al., 1998; Toth, 2000), or they may be cometary objects that have dynamically transferred into the main-belt from the outer Solar System (Levison et al., 2009). Studying the MBC population is important to understanding the volatile component of objects in the main asteroid belt, the formation and evolution of the small bodies in the Solar System, as well as planetary formation and migration.

The known MBC population is small, with only five being discovered to date: 133P/Elst-Pizarro (Elst et al., 1996), P/2005 U1 (Read et al., 2005), 176P/LINEAR (Hsieh and Jewitt, 2006), P/2008 R1 (Garradd) (Jewitt et al., 2009), and P/2010 A2 (LINEAR) (Birtwhistle et al., 2010). These objects have a semi-major axis range of 2.29–3.19 AU, indicating MBCs may occur anywhere in the main-belt.

In this paper, the results of a search for MBCs using the Canada–France–Hawaii Telescope Legacy Survey (CFHTLS) are updated (Gilbert and Wiegert, 2009). In the initial study, approximately half of the Very Wide segment of data was visually inspected for cometary activity (see Section 3.2 of Gilbert and Wiegert (2009) for more details). The entire data set has now been analyzed, with 25,240 objects in the main asteroid belt being visually examined. This survey is less biased than previous studies (noted above), because it does not focus on particular objects or asteroid families. New upper limits for strongly active MBCs are derived and are compared to those expected by asteroid collisions.

2. Observations and analysis

All images were acquired between April 2003 and January 2008 with MegaCam on the 3.6 m CFHT in Hawaii as part of the CFHTLS. In this analysis, only images taken in the g' (4140–5590 Å) and r' (5640–6850 Å) filters of the Very Wide data segment were used. The average seeing size was 1″ in both filters. The observations were taken at opposition and had a particular cadence (three images taken 45 min apart the first night, with an additional image taken either 24 h before or after, weather permitting) that allowed for a reasonable determination of orbital parameters. For more details on the observations and data reduction methods, see Gilbert and Wiegert (2009).

The new data set consists of 13,802 objects in the whole main-belt (1.5–5.0 AU), 5584 of which reside in the outer main-belt (3–5 AU). These objects are visually examined as in Hsieh (2009) and Gilbert and Wiegert (2009) (Section 3.2). The original data set includes 11,438 main-belt objects, having 2667 located in the outer main-belt. Therefore, there are a total of 25,240 and 8251 objects in the whole and outer main-belt, respectively. It should be noted that the data sets include both one- and two-night detections. The orbit determination of the former is less certain, and may inflate the fraction of outer main-belt objects.

3. Results

The objects in this study range in size down to $D \sim 1$ km. Using the cumulative size distribution given in Cheng (2004) and the de-biased number of asteroids as a function of magnitude derived by Jedicke and Metcalfe (1998), it is estimated there are $\sim 1 \times 10^6$ and $\sim 3 \times 10^5$ asteroids of this size in the whole and outer main-belt, respectively.

In the initial study, one object located in the main-belt is seen to display cometary activity. It is still unclear whether this object is an MBC or a true comet (for more details, see Gilbert and Wiegert, 2009). There are no other objects in either data set that display cometary activity.

Assuming MBCs can occur anywhere in the main-belt, an upper limit of 1/25,240 (0.004%) currently active MBCs is derived. Using the number of asteroids expected in this region (1×10^6) gives an upper limit of 40 ± 18 active MBCs, where the uncertainty is $\pm 3\sigma$ (assuming a Poisson distribution). If it is instead assumed that MBCs can only occur in the outer main-belt, this limit becomes 36 ± 18. These limits agree with the 15–150 range derived by Hsieh and Jewitt (2006), and are also consistent with what is expected from collisional activation of asteroids (as derived in Gilbert and Wiegert (2009)).

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4. Conclusions

The results from the CFHTLS search for MBCs are updated. The upper limits of currently active MBCs are improved from 87 ± 28 and 110 ± 31 to 40 ± 18 and 36 ± 18 in the whole and outer main-belt, respectively. These results are consistent with activation caused by collisions with other small main-belt objects.

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