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Sunskirting comets discovered with the LASCO coronagraphs (1996-2008)

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Abstract

In addition to an unprecedented number of Kreutz sungrazing comets, the LASCO coronagraphs aboard SOHO have discovered some 238 unrelated "sunskirting" comets from 1996 to 2008. This new family is organized in several groups, and two comets have further been found periodic. We present the photometry and the heliocentric light curves of these sunskirting comets. The bulk of them exhibit a continuous increase of the brightness as the comet approaches, reaching a peak before perihelion and then progressively fading with a large variety of brightness gradients. However, some of them have peak brightness either at or post-perihelion whereas a quite large number are approximately flat. We finally characterize the different groups of sunskirters on the basis of their distribution of peak magnitudes and of their fragmentation history.

1. Introduction

About 90% of the comets discovered by the LASCO coronagraphs aboard the SOlar and Heliospheric Observatory (SOHO) launched in December 1995 are members of the Kreutz family [1,2]. The remaining ~10% form the family of sunskirting comets which is presently divided into three groups, Meyer, Marsden and Kracht, and 34 unrelated comets called "sporadic". The members of these three groups approach the Sun to 6.5-12 R_{sun}, substantially larger than the upper limit of ~2 R_{sun} for the Kreutz family and contrary to them, many survive their perihelion passage. Strictly speaking, 32 of the sporadic comets have their perihelion distance in the range 1.1 to 33 R_{sun} and thus represent a mix of sungrazing and sunskirting comets. Dynamical arguments indicate that the Marsden and Kracht comets belong in fact to a same group that is associated to comet Machholz, hence they are merged in the "Machholz" group in our analysis.

2. Detection and photometry

It has become very popular among several internet users to hunt for comets on publicly available LASCO images, and in fact the bulk of the sunskirting comets have been detected by individuals who examine the data in their own unique way. Proeminent contributors are K. Cernis, S. Hoenig, R. Kracht, M. Meyer, and several of them maintain their own website. Possible detections are reported on the LASCO "sungrazer" website and are then carefully checked by the LASCO team. Measured positions are then officially reported and the orbital elements were calculated by B. Marsden under the assumption that the orbits are parabolic.

In broad terms, the processing of the images follows the procedure developed for the Kreutz sungrazing comets [1, 2]. However the pipeline processing has been continuously improved and the calibration of the point-source response of LASCO-C2 and C3 instruments has been regularly completed using stars present in their field-of-view. Indeed, with only a few exception, all sunskirting comets appear stellar on the LASCO images so that the prescriptions for point-source photometry. Almost all images used in the present study are full frame, which is 1024^2 pixels. A critical aspect is the determination of the background and we used the median of five images, the four immediately adjacent to the processed image (two before and two after) and the image itself, followed by a median filtering with a window of 7 × 7 pixels.

The heliocentric light curves of 238 sunskirting comets are plotted as the apparent Johnson V magnitudes as a function of heliocentric distance calculated from the published orbital elements and corrected for the light-time effect. The presence of outliers very close to each processed comet has been removed from the measurements (less than 1 % of images). The effect of the varying SOHO-centric distance has not been removed in those light curves,

but it is negligible for most of them since that distance remains close to 1 AU. Unlike the Kreutz comets, the light curves of the sunskirters exhibit a large variety of behaviours, but this proeminently results from the differences in the distance ranges in which the measurements were performed. In addition, many light curves are limited to a few data points so that it is difficult to extract a trend. The most common behavior is characterized by a continuous increase of the brightness as the comet approaches, reaching a peak before perihelion and then progressively fading. The best example is given by the superb light curve of SOHO-46 (Fig. 1): the bulk of the data has been acquired with LASCO-C3 insuring the consistency of the measurements and showing that this comet reached its peak brigtness of V ~ 2.5 at about 10 R_{sun} pre-perihelion. We note that the eight measurements acquired with LASCO-C2 at perihelion fit extremely well the C3 data points.

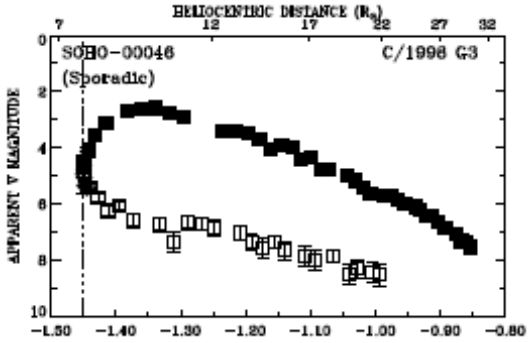

Figure 1: The light curve of comet SOHO-46 for the inbound (filled symbols) and outbound (open symbols) branches of the trajectory.

3. Summary and Conclusions

We have performed accurate photometric measurements benefiting from the latest instrumental corrections and calibrations and have obtained the light curves for 238 sunskirting comets discovered in the years 1996-2008.

Unlike the Kreutz comets, the light curves of the sunskirters exhibit a large variety of behaviors, but this prominently results from the tremendous differences in the distance ranges where the measurements could be performed. Only a handful display a canonical behavior where the brightness continuously increases on the inbound leg, reaches a maximum at or near perihelion (either pre or post), and then decreases on the outbound leg.

The cumulative distribution of peak magnitudes which is related to that of the nucleus size is conspicuously different for the three groups, implying different distributions of fragments.

The light curves of C/1999 J6 and C/2004 V9 are strikingly similar, confirming that LASCO has re-observed a periodic comet with a period of 5.3 year.

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References

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