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The Dust Environment of Long Period Comets

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Abstract

We present optical observations and a preliminary study focused on the characterization of the dust environments of a sample of Long Period Comets (LPC). The targets of this study are C/2009 P1 (Garradd), C/2008 N1 (Holmes), C/2011 L4 (PanStarrs), C/2012 F6 (Lemmon) and the so-called "comet of the century" C/2012 S1 (ISON) (see Table 1). In order to determine the dust parameters of these comets during their perihelion passages we use our Monte Carlo dust tail code. The dust parameters that we obtain are the mass lost rate, ejection terminal velocities, size distributions, and ejection morphology. In addition, we will compare the $Af\rho$ curves as a function of the heliocentric distance derived from the models with the ones provided by the astronomical association *Cometas-Obs*.

Table 1: Long-Period Comets under study

Comet	Perihelion date	q (AU)	e
Garradd	2011-Dec-23	1.55	1.00
Holmes	2009-Sep-25	2.78	0.99
ISON	2013-Nov-28	0.01	1.00
PanStarrs	2013-Mar-10	0.30	1.00
Lemmon	2013-Mar-24	0.73	0.99

1. Introduction

LPC come from the hypothetical region of the Oort Cloud so that their orbital period are over 1000 years. In consequence, they will show the least processed material of the Solar System, mainly in comparison with Short-Period Comets (SPC). In addition, it is well know that LPC are usually much more active than SPCs at the same heliocentric distances [2]. The comparison of dust properties could lead us to understand the compositional and structural differences between them and between other comet families as the SPCs. In order to report an accurate characterization of the LPCs dust environments we used our Monte Carlo dust tail modeling procedure developed by [3] which was used successfully applied previously (see e.g. [4]). This model allow us to derive the essential dust parameters: mass lost rate, ejection velocities, size distribution, and ejection morphology. In addition, we benefited from $Af\rho$ data from amateur observers (the Spanish astronomical association *Cometas-Obs*) and we use it as a model input to constraint the dust parameters as [1] in the study of the dust environment of comet 67P/Churyumov-Gerasimenko.

2. Observations

The observations were taken by 1.52 m telescope of Sierra Nevada Observatory (OSN) in Granada, Spain. We used a 1024×1024 pixel CCD camera with a Johnson-Cousins red filter. The pixel size on the sky was 0."46 so the field of view was 7'.8×7'.8. To improve the signal-to-noise ratio the comets were imaged several times using integration times in the range 30-120 seg. Thus, for Garradd, we have post-perihelion observations a few days after perihelion passage, for Holmes the observations are post-perihelion on different nights, for ISON and PanStarrs the observation campaign is not finished yet (here we show the first images available), and for Lemmon the observations will start on June 2013. The log of the observations is shown in table 2, where unfilled cells correspond to planned observations. In Fig. 1 we show some of those observations with isophotes levels.

3. Expected Results

The aim of this study is to improve the knowledge of the LPC and their physical properties, given an accurate characterization of the dust environment as some previous works for SPCs [3], and [4]. We expect to obtain the size distribution of particles, ejection velocities, mass loss rate and the ejection pattern. The $Af\rho$

Table 2: Log of observations.

Comet	Obs. date	r_h (AU)	Δ (AU)
Garradd	2012-Jan-3	1.558	1.901
	2012-Jan-4	1.560	1.890
	2012-Jan-5	1.561	1.879
	2012-Jan-6	1.563	1.879
Holmes	2010-Apr-8	3.410	2.555
	2010-Apr-20	3.479	2.670
	2010-May-15	3.628	3.088
ISON	2013-Feb-14	4.775	4.008
	2013-Mar-20	4.389	4.130
	2013-May-1	3.887	4.325
	....	....	....
PanStarrs	2013-May-1	1.314	1.537
	....	....	....
Lemmon	....	....	....

curves can be derived from the models and compare with *Cometas-Obs* $Af\rho$ curves, providing us a useful tool to constraint the models. In addition, we can also calculate the contribution of the dust from these comets to the interplanetary dust cloud and compare them to typical SPC's contribution.

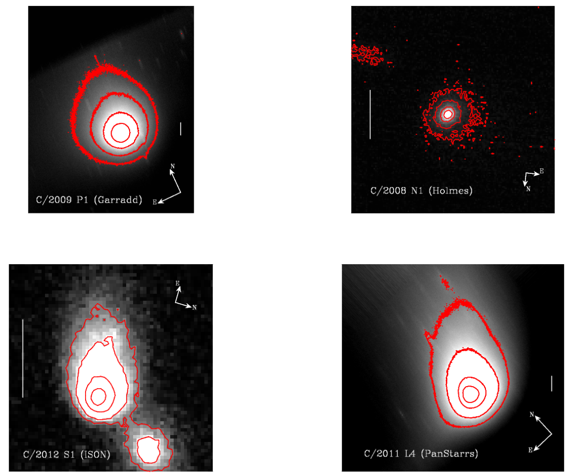

Figure 1: Single examples of observed images. The observation date and isophotes levels of each image are as follows: C/2009 P1 (Garradd): 2012-01-03, 2×10^{-12}, 1×10^{-12}, 0.5×10^{-12}, and 0.25×10^{-12} SDU. C/2008 N1 (Holmes): 2010-04-08, 1×10^{-13}, 0.5×10^{-13}, 0.20×10^{-13} and 0.85×10^{-13} SDU. C/2012 S1 (ISON): 2013-02-14, 0.5×10^{-12}, 0.25×10^{-12}, 1×10^{-13} and 0.5×10^{-13} SDU. and C/2011 L4 (PanStarrs): 2013-05-01, 0.5×10^{-11}, 0.25×10^{-11}, 1×10^{-12} and 0.5×10^{-12} SDU. In all cases, the images are oriented to the (N,M) system, indicating also the the E-N orientation. The vertical bars indicate 30000 km.

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