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On the outbursts and primitive nature of comet 29P/Schwassmann-Wachmann 1

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Abstract

Comet 29P/Schwassmann-Wachmann 1 (hereafter SW1) is a primitive Centaur that exhibits continuous changes in its coma appearance and brightness [1]. Our team has recently completed a decade of photometric monitoring in order to infer the physico-chemical processes behind the observed activity.

1. Introduction

Several sample return missions are being planned for *in situ* sampling of undifferentiated bodies. Such missions wish to bring back to Earth pristine samples to get clues on the formation, and environment conditions in which the solar system formed. Many chondritic asteroids and periodic comets could have been subjected to important collisional and space weathering processing since their formation. Centaurs, suggested to be transition objects scattered from the Kuiper Belt, could have escaped significant irradiative heating and impact processing being objects of great physico-chemical interest. These bodies located so far away from the Sun have surface temperatures below the sublimation of water ice so their inner structure should remain probably unaltered. Detection of cometary outbursts could be a good way to remotely identify good candidates to be explored in future space missions with the goal of sampling pristine solar system materials. In this sense, SW1 is a great candidate to be carefully considered.

2. Observations and data reduction

We have continued during 2011 our continuous follow-up of Centaur SW1 from different observatories listed in Table 1. By performing multi-band photometry in different Johnson-Kron-Cousin standard filters for a standardized 10-arcsec aperture we are able to notice subtle changes in SW1 activity. Images in each filter are calibrated using standard stars given by the Landolt and Stetson calibration fields, in a similar way as was implemented in our recent paper on the 2008-2010 SW1 monitoring [3].

Observatory (MPC code)	**Instrument**
Gualba, Barcelona (442)	SC 36.0 f/7
Guadarrama, Madrid (458)	SC 25 f/10
La Cañada, Ávila (J87)	RCT 40.0 f/10
Teide, IAC80	C 82.0 f/11.3

Table 1. Observatories involved in SW1 coverage.

During 2011 the most noticeable activity experienced by comet SW1 is a series of consecutive outbursts experienced during May 2011, precisely around Julian Dates (JD) 2455684, 2455693, and 2455704 (Fig. 1). The first of them is shown in Fig. 2 where two images taken on consecutive nights nicely exemplify the chameleonic change in comet brightness and appearance during an outburst.

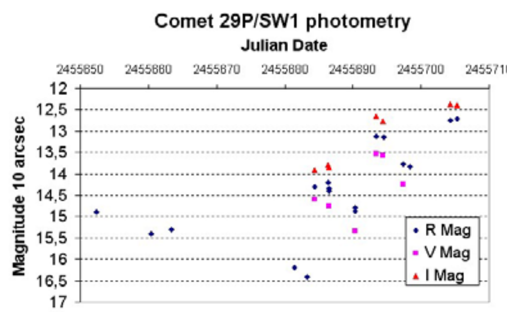

Figure 1: April to May 2011 JKC multiband photometry obtained for a 10 arcseconds standardized aperture.

3. Dust production

As we previously pointed out, the magnitude increase is probably dominated by fragmentation of mm-sized dust released from active regions in the surface [3]. Once the dust reaches the coma, the volatile components are sublimated by solar radiation, fragmenting the particles, and producing μm-sized dust grains that evolve outwards under the effect of gas drag and radiation pressure.

Information about dust production for the different particles sizes can be obtained by measuring the rate of nuclear activity *Afρ*, typically given in cm. This parameter defined in [4] measures the dust production rate, which does not attempt to disentangle the effects of albedo *A*, filling factor *f* and aperture *ρ*, hence allowing direct comparison between data sets obtained with different instruments. This parameter can be computed from equation [4]:

$$Af\rho = \left(\frac{(2\Delta r)^2}{\rho}\right)\frac{F_{com}}{F_{\otimes}}$$

where *Δ* and *r* are the geocentric and heliocentric distances in AU; *ρ* is the diameter of the photometric aperture in km, and F_{com} and F_o are the cometary and solar fluxes in the respective filters. The measured *Afρ* values for R, and I filters for the JD 2455704 outburst were respectively $(4.0\pm0.5)\times10^4$ cm, and $(2.5\pm0.5)\times10^4$ cm. As we noted in [3] the I magnitude increases significantly during an outburst, and precedes the increase in other bands. During quiescent SW1 activity the *Afρ* values in the R and I bands tend to become similar [3].

3. Summary and Conclusions

Cometary outbursts are produced by the massive release of comet particles from active regions in the nucleus and later disintegration in the coma [see 3 for additional references]. The 2-3 days decay of particles into μm-sized dust is probably driven by CO sublimation [6] and suggests that SW1 is a pristine comet, similar to fine-grained materials collected by Stardust mission from 81P/Wild 2 [5]. Additional studies of the magnitude increase and decay, plus spectroscopic observations could provide additional insight into the sublimation processes. As a by-product of SW1 monitoring we plan to predict future outbursts in order to have enough time to perform accurate spectroscopy with larger instruments.

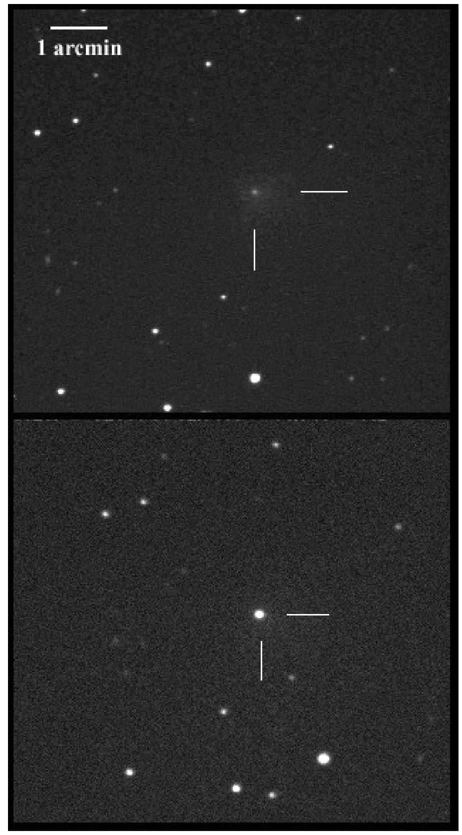

Figure 2. SW1 imaged on May 1.839 (top) and May 2.842 (bottom, during outburst) from MPC442.

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