POST-DISCOVERY PHOTOMETRIC FOLLOW-UP OF SUNGRAZING COMET C/2012 S1 ISON.

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Introduction: Sungrazing comets are very relevant objects that result from the dynamic evolution of long period comets and that end typically their lifes colliding with the Sun [1]. They are though to be fragments of primitive ice-rich bodies gravitationally dispersed during the early stages of solar system evolution [2]. Comet C/2012 S1 ISON was discovered on Sept. 21st, 2012 by Russian amateur astronomers Vitaly Nevski and Artyom Novichonok in the framework of a monitoring program called International Scientific Optical Network (giving the acronym ISON from which the comet has been named). At that point of its orbit the comet was at an heliocentric distance of 6.29 A.U. and its magnitude was +18.8. Once the arc of astrometric observations was wide enough to accurately compute its orbital parameters, it was found that this comet follows a nearly parabolic orbit. In fact, current orbit brings C/2012 S1 ISON to an extremely short perihelion distance of about 1 milion km for next Nov. 28th, 2013. Moreover, J. Bortle noticed that its orbital elements are surprisingly similar to those of the magnificent Great Comet of 1680 [3]. In any case, is very remarkable for our current understanding of the origin on sungrazing comets that the geometric circumstances in which this comet will be observed are extremely favourable. Typically sungrazers are briefly detected by Sun's monitoring spacecrafts like the Solar and Heliospheric Observatory (SOHO), but C/2012 S1 ISON is a big sungrazing comet that will be observable until his perihelion. It is even possible that this object will become one of the most spectacular comets in this century being about 10 times brighter than Venus during its perihelion. For the previously mentioned reasons, we have selected this comet to be studied by our team inside the CSIC-IEEC program of multiband photometric monitoring of comets. In this sense, we focus here in the 3-months follow-up made by our team from Nov. 2012 until mid Jan. 2013. We think that observations of the apparent comma diameter and multi-aperture photometry can be very relevant to compute several physical parameters associated with the activity of this comet, particularly once the size of the comet will be better established from future studies with larger instruments. Another key reason to keep our telescopes following this object is its possible primeval chemical nature that could produce episodes of unexpected outbursts in its luminosity during its approach to perihelion. Such events are extremely interesting and are sometimes associated with cometary disruptions that need to be studied carefully to infer information on the internal structure of these objects [4]. Our team has demonstrated the importance to keep a continuous follow up of pristine comets like e.g. the 29P/Schwassmann-Wachmann 1, among others [5-6]. In the basis of our observational experience, a monitoring of this type of primitive comets can give clues on their nature, inner structure, and the physico-chemical processes playing a role in driving their cometary activity. The degree of primitivity of comets, and carbonaceous has been suggested to be associated with their bulk physico-chemical properties [7].

Methods: We have been conducting a monitoring program of ground-based photometry of C/2012 S1 ISON by using standard Johnson-Cousin filters following the same methodology explained in [5]. Due to our interest in learning about the development of the comma we have stacked guided exposures to achieve good signal/noise ratios to determine the presence or absence of cometary activity. This is done basically from the FWHM statistics of the imagery and building the respective photometric growth curves.

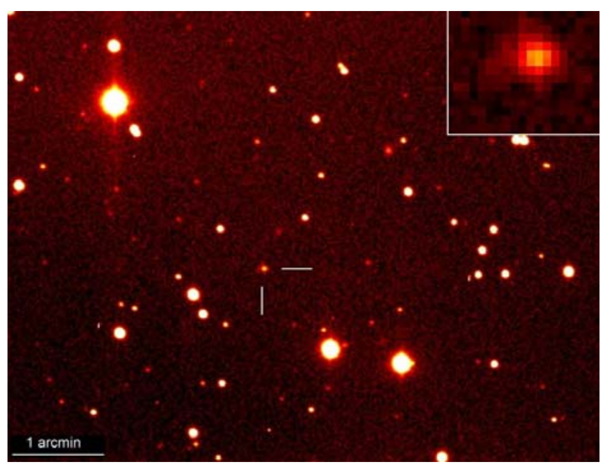

Figure 1. C/2012 S1 ISON imaged on Nov. 20.184 from MPC442 when the comet was in +16.65 R magnitude. The small inset in the upper-right corner is a 10X magnification of the comet region where a tail elongation starts to be visible.

We have been monitoring this object on different nights from four observatories (see Table 1, and Fig.

1-2). All astrometric and photometric observations have been reported to the Minor Planet Center (MPC). In here we will discuss our photometric coverage focusing in the measurements in the R band. Photometry is standardized to an aperture of 10 arcsec, and the photometric growth curves are studied using increasing photometric apertures to infer clues on the cometary activity. It is well known that the growth curve of an extended object soon departs from that of a point like source. Using that simple approach we will cover the cometary evolution during its approach to the perihelium.

Fig. 3 compiles our photometric observations in the R band. A 10 arcsec standard aperture was used in all cases. This figure shows a clear increase in R magnitude when the comet crossed the 5.7 AU that we attribute to the point where solar heating is enough to produce efficient water ice sublimation from its surface [8]. A plateau of quite uniform activity is observed (with gaps) after that (see Fig. 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
Lowell Observatory (688)	C 183.0
Montseny (B06)	T 20 f/6
Obs. Ast. Del Montsec (C65)	RCT 80.0 f/9.6

Table 1. Observatories involved in this follow-up.

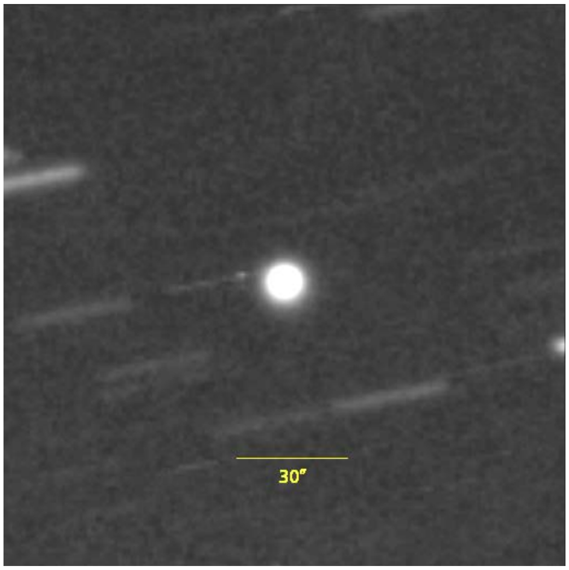

Figure 2. A magnified image of C/2012 S1 ISON with a resolution of 1.2 arcsec/pixel. From stacked images taken from J87 observatory on Jan. 6.034 when the comet was observed in +15.7 R (not listed in Fig. 3).

Results and discussion: So far we have monitored the comet since a month after its discovery when it was at a heliocentric distance of 6.2 AU until its approach to 5.2 AU. Little cometary activity has been found so far from the study of the images. In the imagery taken during mid-Nov. 2012 we noticed an elongated comma at anti-solar-direction. Such observation was confirmed by K. Meech and T.E. Riessen using the Perkins 1.8 m telescope (Lowell Observatory) so we conclude that it was just a foreshortened view of the dust tail due to the observing geometry of the comet from Earth at that time. During early January 2013 the comma had a small width of 15 arcsec that, taking into account the distance to Earth, are equivalent to a C/2012 S1 coma diameter of about 50,000 km for a heliocentric distance of 5.22 AU. In early January the coma is spherical with not features (Fig. 3). At the observed resolution, no small features nearby the nucleus have been found to rotate, but more studies comparing the successive images will follow.

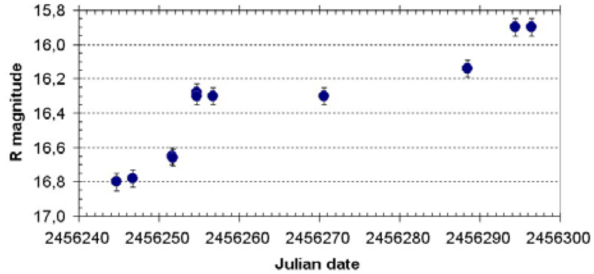

Figure 3. C/2012 S1 ISON photometry in the R band obtained for a 10 arcsec standardized aperture.

Conclusions: We have started a photometric monitoring program of sungrazing comet C/2012 S1 ISON with medium-sized telescopes. So far we have found that the comet exhibits cometary activity, but it has been very limited below 5.7 AU. The arrival to the right heliocentric distance to allow water ice sublimation has shown a progressive increase in the comet activity. The progressive increase observed in early January observations let us keep hope in that this comet still can keep increasing in magnitude to become one of the brightest comets in this century.

References: [1] Bailey M.E. et al. (1992) *A&A*, 257, 315-322. [2] Jewitt, J. (2008) in *Trans-Neptunian Objects and Comets*, SAAS-FEE 35, Springer, pp. 1-78 [3] Bortle J. (2012) comets mailing list, Sept. 24th [4] Sekanina. Z. (1982) In Comets (L.L. Wilkening, ed.), Univ. Arizona Press, pp. 251-287 [4] Trigo-Rodríguez J.M. et al. (2009) *A&A*, 485, 599-606. [5] Trigo-Rodríguez J.M. et al. (2010) *MNRAS*, 409, 1682-1690. [6] Trigo-Rodríguez J.M. et al. (2010) *LPS XLI*, Abstract # 1533. [7] Trigo-Rodríguez J.M. and Blum J. (2009) *PSS*, 57, 243-249. [8] Jewitt D. et al. (2008) Astron. J., 135, 400-407.