Observations of Leonids, Draconids, α-Monocerotids, ε-Perseids and meteors of comet C/2012 (ISON)

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Our group presents new results of the "All-Sky Beobachter" astronomical project which is based on previous experience with different wide-field cameras (All-Sky). In this project we search for meteor phenomena in images obtained with All-Sky cameras. As a result coordinates of radiants of active meteor showers are calculated. In this paper we provide the final result for meteors of comet C/2012 S1 (ISON) found in the period from 05 to 27 January, 2014. Also, we present three possible candidates for the radiant of meteors of comet C/2012 S1 (ISON).

1 Introduction

Our group presents new results of the "All-Sky Beobachter" astronomical project which is based on previous experience of working with different wide-field cameras (All-Sky). In this project we search for meteor phenomena in images obtained with All-Sky cameras. As a result coordinates of radiants of active meteor showers are calculated.

2 Observations of Leonids, Draconids, α-Monocerotids and ε-Perseids

All-Sky cam images were collected in the period 2010 – 2013 and a search for Leonids meteors was conducted on these images. The calculated coordinates of the radiant of the Leonids meteor shower for the mentioned four years are presented in the Figures 1 – 4. Although the Moon was in the constellation of Leo in 2011, it was possible to detect Leonids activity. Nevertheless only two stationary meteors were found.

In 2012 we detected that the α-Monocerotids meteor shower displayed activity simultaneously with the Leonids, during its maximum activity (Figure 3).

In 2011 observing conditions for the Draconids meteor shower were unfavorable due to strong intereference of the moonlight. Nonetheless meteors and their coordinates were detected in All-Sky images (Figures 5 – 6).

In September 2013 many observers noticed an unexpected increase in activity of the ε-Perseids, a minor meteor shower. Using images of the All-Sky camera at the Liverpool Telescopes we were able to calculate the radiant coordinates of this meteor shower. (Figure 7).

An analysis of the results of the search for meteor activity in the All-Sky images shows that it is impossible to detect meteor shower activity during one day if its activity is less than 20 meteors per hour, and when meteors are fainter than +2 – +3 magnitude (for the fast meteors). To detect any activity of a meteor shower with meteors fainter than magnitude +3 and with an average or low angular velocity the meteor activity must be at least 15 meteors per hour. When combining all archived observations for some days from all accessible All-Sky cameras then it's possible to detect the activity of meteor showers with a ZHR value of 10 or more meteors per hour. We got the same results during our work on the data for the Geminids meteor shower for the period 2009 – 2010 (Bryukhanov, et. al., 2012, 2013).

3 Investigation of the possibilities of All-Sky cameras to search for meteors of C/2012 (ISON) comet

In this paper we provide the final results for meteors of comet C/2012 S1 (ISON) found in the period 5 to 27 January, 2014. Also, we present three possible candidates for the radiant position of meteors of comet C/2012 S1 (ISON) (Figures 8, 9 and 11).

While analyzing the All-Sky images some fireballs indicated a very uncertain radiant being close to theoretical one. A photo of one of the most bright fireballs is presented in figure10.

Special research to detect some possible meteoric activity connected to the remains of comet C/2012 S1 (ISON) was conducted in January 2014. This work was based on the observing data obtained at various sites on Earth, by means of 10 CCD cameras, equipped with a "fish-eye" lens (like all-sky cameras) and by means of FM radio observations. Exposure times vary from 60 to 180 seconds for different CCD cameras. The interval between the images obtained varies from 10 to 120 seconds under Full Moon.

The theoretical research on the possible occurrence of some meteoric activity associated with the close approach of the central point of the orbit of comet C/2012 S1 (ISON) to the Earth has been published (Sekhar and Asher, 2014). The authors drew the conclusion that such meteoric activity is unlikely. However we decided to check the existence or lack of the meteoric activity connected with comet C/2012 S1 (ISON), using the observational data which was at our disposal.

A special technique and the computer program described in (Neslušan et al., 1998) were applied to calculate a theoretical radiant of the meteor shower. Calculations are based on known elements of the heliocentric orbit of comet C/2012 S1 (ISON) published in the Minor Planet Electronic Circular (M.P.E.C. 2012-S63). We present the observing conditions of the possible meteoric activity: $\alpha=153°$, $\delta=+16.8°$. The maximum of activity was expected on January 16.2, 2014 at $\lambda_{\Theta(2000.0)}=295.7°$. On the day of the estimated maximum the Earth passed at a distance of 0.02 a.u. to the closest point of the orbit of the comet where it was 74.7 days prior to its perihelion passage. On 16 January the closest point of the comet's post-perihelion orbit was located at 0.4 a.u. from the Earth. Therefore any meteoric activity connected to the remains of the comet is unlikely after the perihelion passage.

4 Results of CCD and FM radio detection of meteors

43 meteor events were revealed after viewing 54.000 images from the period 10 to 17 January 2014. The radiant of the meteors was located in the constellations of UMa, LMi, Leo and Lyn. The position measurements of the images and calculations by means of the program 'RADIANT[1] (1.43) gave the following radiant position: $\alpha=156°$, $\delta=+38°$ (Figure 11).

The greatest number of meteors was observed during the period from January 10 to 15, 2014 as a result of the two supervision cameras located at the SAO of the Russian Academy of Sciences (in the Northern Caucasus). The maximum number of meteors was registered on 12 January in observations obtained by means of a camera located at La Palma. Unfortunately, as the sky was strongly lit by the Moon (a Full Moon on 16 January 2014), it wasn't succesful to get complete observing material for the dates close to the expected maximum of meteoric activity.

Patrol observations of a meteor background with FM broadcast radio on 88.6 MHz by Ivan M. Sergey were carried out in Belarus (Figure 12a). An increase in the meteor activity level of the sporadic background was recorded during the period from 8 to 24 January 2014. During this period an increase of the meteor activity above the level of the sporadic background was confirmed by radio observations at 143.05 MHz by Morillas Sanchez (EA7GA)[2] in Spain (Figure 12b).

5 Conclusions

All the supervision photographs used in the research weren't suitable. Therefore the orbital elements of the recorded meteoric bodies weren't calculated. The good agreement between the temporary period and the region of the meteor activity with the theoretical prediction gives reasons to assume that the meteors were genetically related to the comet C/2012 S1 (ISON). The meteor activity was very low and was confirmed by the lack of a pronounced active radiant of the meteor shower. Thus, the meteor shower was observed as surge in activity of the sporadic meteors concerning a usual level of the sporadic background. The coordinates of the radiant were found only thanks to the big amount of statistical material collected in various observing posts on the Earth. Possibly some weak meteor activity can be explained by the passage of the Earth through the peripheral part of a swarm of dust particles which have been ejected by comet C/2012 S1 (ISON). The results of the observations are being carefully checked now.

Acknowledgment

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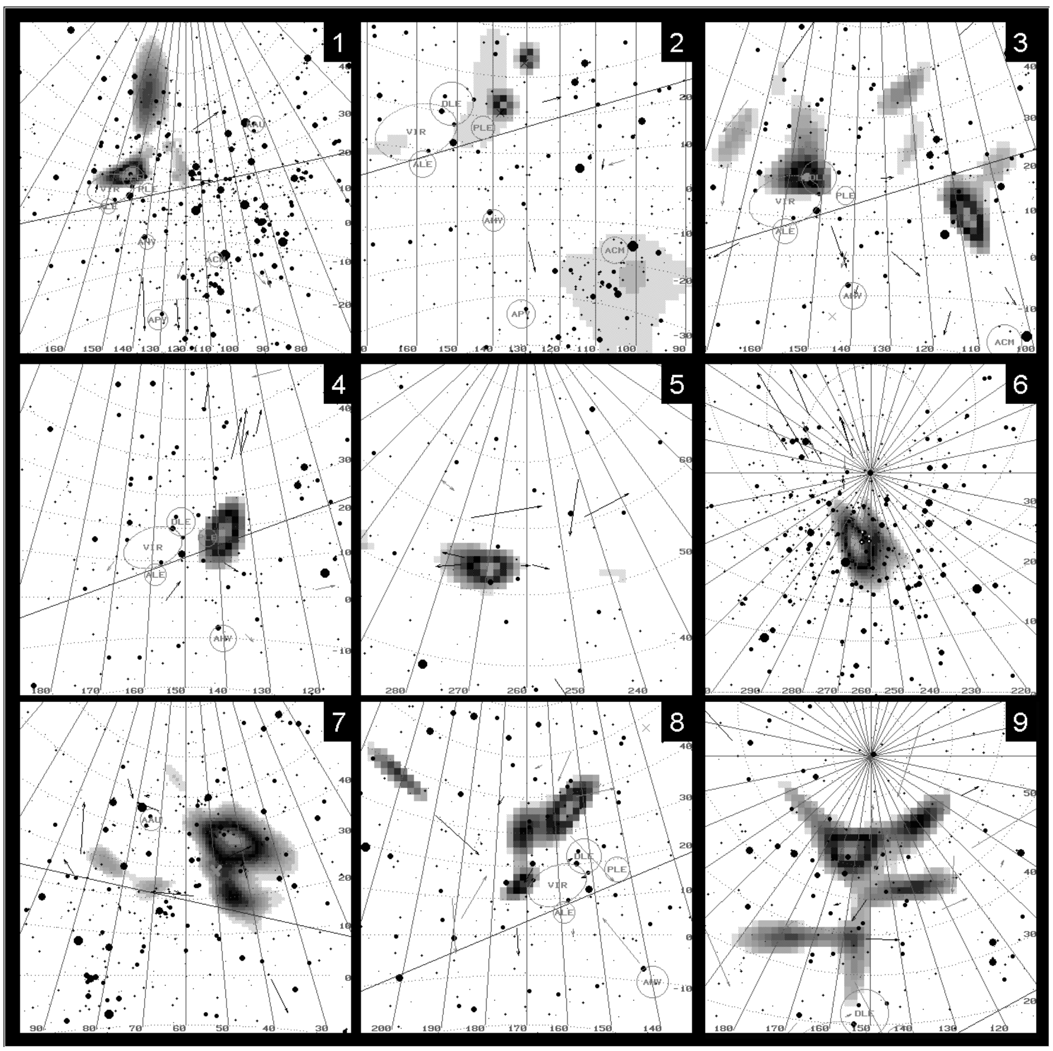


Figures 1 to 9 – meteor shower radiant: **(1)** - Leonids - 2010, RA=152°, Dec=+21°; **(2)** - Leonids - 2011, RA~135°, Dec~+25°; **(3)** - Leonids - 2012, RA=155°, Dec=+21° and α-Monoceratides - 2012, RA=108° , Dec=+09°; **(4)** - Leonids - 2013, RA=138°, Dec=+19°; **(5)** - Draconids - 2011, RA=270°, Dec=+52°, all-sky camera IRF; **(6)** - Draconids - 2011, RA=274°, Dec=+45°, all-sky camera SAO; **(7)** - ε-Perseids - 2013, RA=43°, Dec=+38°; **(8)** - Radiants of meteors of comet C/2012 S1 (ISON) RA~155°, Dec~+45°, all-sky camera The Liverpool Telescope's, January 12, 2014; **(9)** - Radiants of meteors of comet C/2012 S1 (ISON) RA~165°, Dec~+65°, all-sky camera SAO, January 13 - 14, 2014.

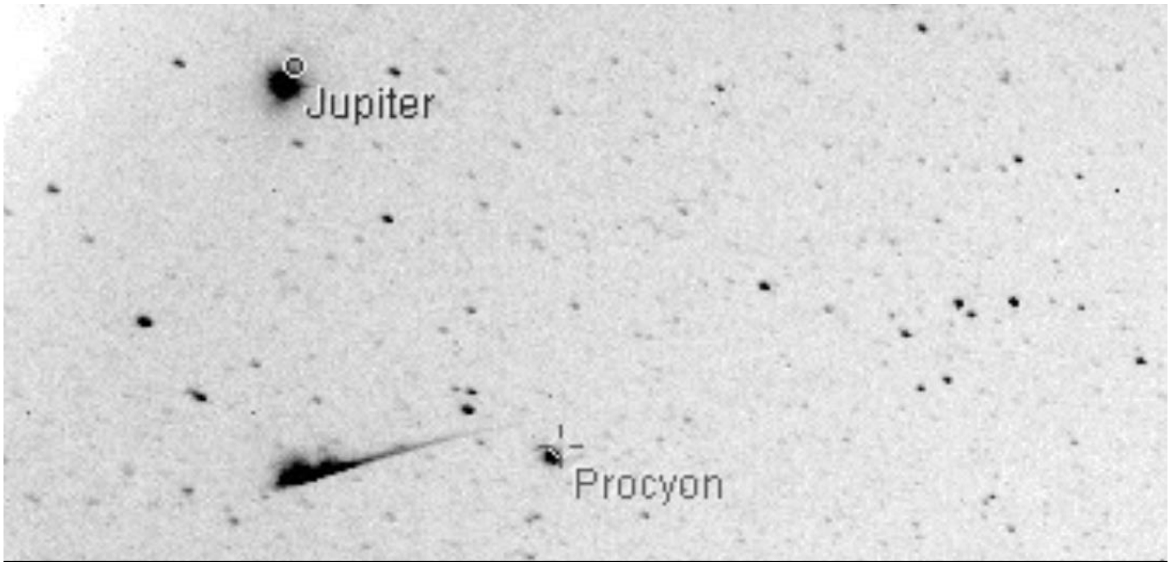
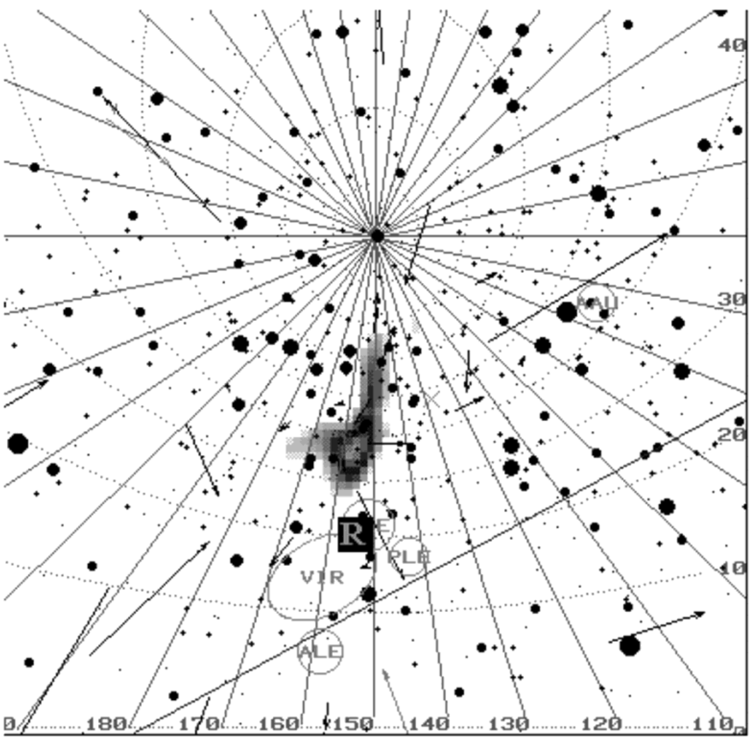


Figure 10 – Fireball (magnitude -3) at the theoretical meteor shower radiant of comet C/2012 S1(ISON): all-sky camera in Australia, January 13, 2014, 18^h03^m UT.



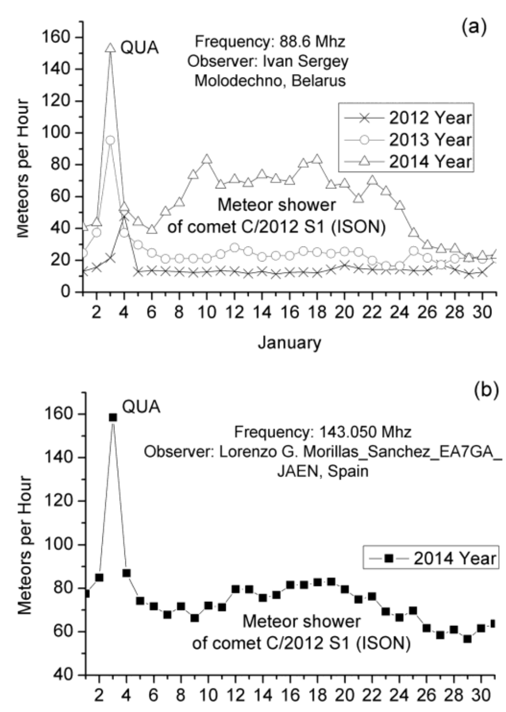


Figure 11 to12 – Results of CCD observations in January 2014 of a meteor shower of comet C/2012 S1 (ISON). R - theoretical radiant. Observations of meteor background in FM radio frequency range: (a) - (January, 2012, 2013 and 2014, at 88.6 MHz) were carried out in Belarus; (b) - (January 2014, at 143.05 MHz) carried out in Spain; QUA - meteor shower Quadrantids.