THE URSID METEOR OUTBURST IN 2020: PRELIMINARY RESULTS. J.M. Madiedo[1], J.L. Ortiz[1], J. Aceituno[2], E. de Guindos[2]. [1]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada (Spain). [3]Centro Astronómico Hispano-Alemán, Calar Alto (CSIC-MPG), E-04004 Almería, Spain.

Introduction: The Ursid meteor shower gives rise to an annual display of meteors from about December 17 to December 26, peaking on around December 23. Its activity is low, with a normal peak ZHR of about 10 meteors/hour. However, this shower exhibits activity outbursts that significantly increase this maximum zenithal hourly rate. These outbursts take place when the parent body of Ursid meteoroids, Comet 8P/Tuttle, is located at its perihelion or at its aphelion. One of these burst was predicted to take place in 2020.

The Ursids have been monitored in the framework of the SMART project (Spectroscopy of Meteoroids in the Atmosphere by means of Robotic Technologies) since 2006. This survey, which is being conducted by the Southwestern Europe Meteor Network (SWEMN), employs an array of automated spectrographs deployed at 10 meteor-observing stations in Spain [1, 2]. SMART also provides valuable information for our MIDAS project, which we conduct to study lunar impact flashes [3-7]. With SMART we can determine the atmospheric trajectory of meteors and the orbit of their parent meteoroids, but also the evolution of the conditions in meteor plasmas from the emission spectrum produced by these events [8-15]. In this work we present a preliminary analysis of the Ursid outburst observed in December 2020, where several Ursid emission spectra were also recorded.

Instrumentation and methods: The activity of the Ursids has been monitored by means of different instruments. To record meteor events and their emission spectra during the 2020 Ursid outburst we have employed an array of low-lux CCD video cameras manufactured by Watec Co. (models 902H and 902H2 Ultimate), some of which are configured as spectrographs by means of 1000 lines/mm diffraction gratings. CMOS color cameras were also employed [8]. These cameras monitor the night sky and operate in a fully autonomous way by means of software developed by J.M. Madiedo [1, 2]. The atmospheric trajectory and orbital data of the event were obtained with the Amalthea software, which was also written by the same researcher [9]. Besides, two forward scatter systems operating at two of our meteor-observing stations (Sevilla and La Hita) have been used to monitor the activity of radio meteors.

The Ursid 2020 outburst: The activity of Ursid meteors was monitored in 2020 during the activity period of this meteor shower. Between 21 and 22 December, our forward-scatter systems located at La Hita and Sevilla recorded an enhanced activity. Our video devices observed this phenomenon on the night of 21-22 December peaking around 22 December at about 5 UT, and revealed that this enhanced meteor activity was produced by Ursid meteors, and confirmed that the predicted Ursid outburst took place.

Figure 1. Sum-pixel image of a mag. -5 Ursid recorded on 2020 Dec. 23 at 0h37m37s UT from the SMART meteor-observing station located at Sevilla.

Figure 2. Sum-pixel image of a mag. -8 Ursid fireball recorded on 2020 Dec. 22, at 2h26m28s UT, from the meteor-observing station located at Calar Alto.

Preliminary results: The analysis of meteor events recorded during the Ursid outburst is still in progress. For most of the events identified so far during the activity period of this shower in 2020, the peak luminosity is below the corresponding to an stellar magnitude of -5. Figure 1 shows an example of one of these multi-station events, recorded from Sevilla. But, brighter events have been also identified among our recordings. One example is the mag. -8 Ursid fireball recorded from two of our meteor-observing stations (Sierra Nevada and Calar Alto) on 2020 Dec. 22 at 2h26m28s UT (Figure 2). The heliocentric orbit of multi station Ursids is currently in progress. The average geocentric velocity obtained for events analyzed so far is of around 32 km/s.

Several emission spectra of Ursid fireballs were recorded by means of the spectrographs operating in the framework of the SMART project. These spectra are being analyzed by means of the CHIMET software, developed by J.M. Madiedo [1, 2]. Most lines identified in the spectra analyzed so far correspond to neutral Fe, as usual in meteor spectra [16-20]. However, these signals are dominated by the contributions from the Na I-1 doublet at 588.9 nm and the Mg I-2 triplet at 516.7 nm. As in previous works, to obtain information about the chemical nature of the progenitor meteoroids the relative intensity of the contributions from Na I-1, Mg I-2 and Fe I-15 are being compared [21-25]. The preliminary result for one of the spectra processed so far is shown in the triangular diagram in Figure 3. The solid curve indicates the expected relative intensity as a function of meteor velocity for chondritic meteoroids. The value corresponding to this spectrum fits fairly well the expected relative intensity for a meteor velocity of about 30 km/s, which suggests a chondritic nature for Ursid meteoroids.

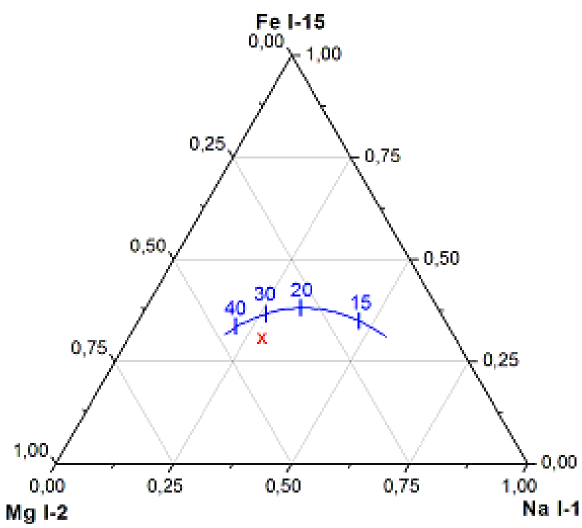

Figure 3. Expected relative intensity (solid line), as a function of meteor velocity (in km/s), of the Na I-1, Mg I-2, and Fe I-15 multiplets for chondritic meteoroids. The crosses show the experimental relative intensity obtained for one Ursid fireball.

Conclusions: In the framework of the SMART survey, we have performed a monitoring of the Ursid meteor shower during its activity period in 2020. The predicted outburst of this shower was observed by means of forward-scatter and video systems between December 21 and 22. The peak was observed around 5 UT on December 22. The brightest Ursid event found so far in our recordings has a magnitude of about -8, and the average geocentric velocity of Ursid meteors analyzed up to now is of around 32 km/s. We have also recorded several Ursid emission spectra. The preliminary analysis of these signals shows that meteoroids in the Ursid stream have a chondritic nature.

Acknowledgements: JM Madiedo acknowledges support from the Spanish Ministry of Science and Innovation (project PID2019-105797GB-I00).

References: [1] Madiedo J. M. (2017) Planetary and Space Science, 143, 238-244. [2] Madiedo J. M. (2014) Earth, Planets & Space, 66, 70. [3] Madiedo J. M. et al. (2015) Planetary and Space Science, 111, 105, 115. [4] Madiedo J. M. et al. (2019) MNRAS, 486, 3380-3387. [5] Madiedo J. M. et al. (2018) MNRAS, 480, 5010-5016. [6] Madiedo J. M. et al. (2015) A&A, 577, A118. [7] Ortiz J. L. et al. (2015) MNRAS, 454, 344-352. [8] Madiedo J. M. et al., in preparation. [9] Madiedo J. M. et al. (2011) NASA/CP-2011-216469, 330. [10] Madiedo J. M. et al. (2013) MNRAS, 431, 1678-1685. [11] Madiedo J. M. et al. (2014) Icarus, 231, 356-364. [12] Madiedo J. M. et al. (2014) MNRAS, 445, 3309-3314. [13] Madiedo J. M. et al. (2014) Icarus, 233, 27-35. [14] Madiedo J. M. (2015) MNRAS, 448, 2135-2140. [15] Madiedo J. M. et al. (2014) Icarus, 239, 273-280. [16] Madiedo J. M. et al. (2016) Icarus, 275, 193-202. [17] Madiedo J. M. et al. (2013) MNRAS, 433, 571-580. [18] Madiedo J. M. et al. (2013) MNRAS, 436, 2818-2823. [19] Madiedo J. M. et al. (2016) MNRAS, 460, 917-922. [20] Madiedo J. M. et al. (2014) MNRAS, 443, 1643-1650. [21] Madiedo J. M. et al. (2014) A&A, 569, A104. [22] Madiedo J. M. et al. (2013) MNRAS, 436, 3656-3662. [23] Madiedo J. M. et al. (2013) MNRAS, 435, 2023-2032. [24] Madiedo J. M. et al. (2014) MNRAS, 439, 3704-3711. [25] Madiedo J. M. (2015) Planetary and Space Science, 118, 90-94.