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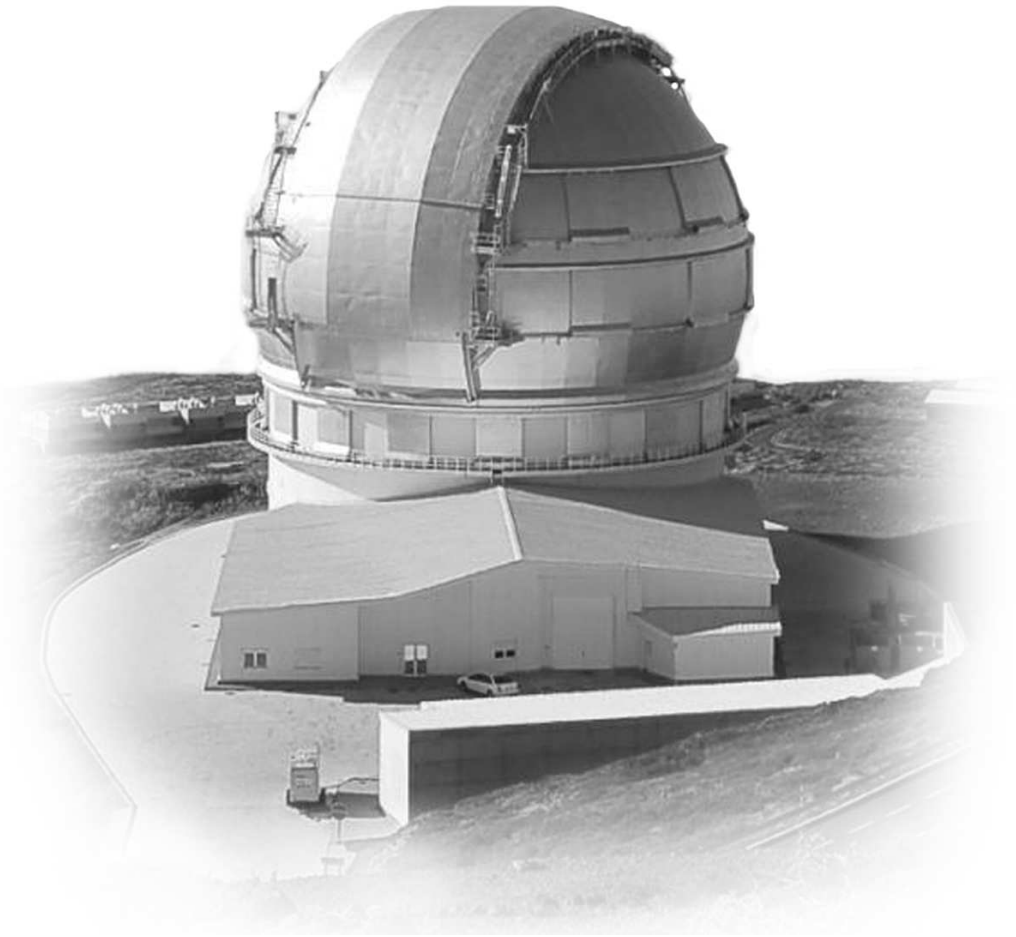

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First scientific results of the Fireball Detection Station at UCM Observatory

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Observatorio UCM is one of the nodes of the Spanish Meteor Network (SPMN), an inter-disciplinary research project on interplanetary matter. Since 2008, we are operating a high-sensitivity camera in double-station with UCLM in Toledo, and, since 2010, we are operating the full station with 6 additional cameras. We present the scientific results of the UCM Fireball Detection Station during its first two years of operation. The main event was the observational campaign for the Draconids 2011 outburst with the addition of a mobile station and a stratospheric balloon. This campaign joins the general exploitation of the data generated continuously by the station in collaboration with SPMN. In addition to our outreach efforts in this field and the results obtained, the project has opened up itself even more to the society and students of the Bachelor Degree in Physics at UCM, who have participated in the reduction and analysis of the data as well as in some graduation projects and collaborations.

1 Introduction

The Fireball Detection Station of the Universidad Complutense de Madrid is located at the roof terrace of the Faculty of Physics, and is part of the Observatorio UCM ($\varphi = 40°27'04''$ N and $\lambda = 3°43'34''$ W).

The station has 6 high-sensitivity cameras covering the whole sky at night with a plate scale better than 10 arcmin/pixel. The project was funded by the Spanish Science Ministry to monitor continuously the sky over the center of the Iberian Peninsula. It is part of the SPMN Network.

The following sections summarize some scientific results obtained at this station during these first two years.

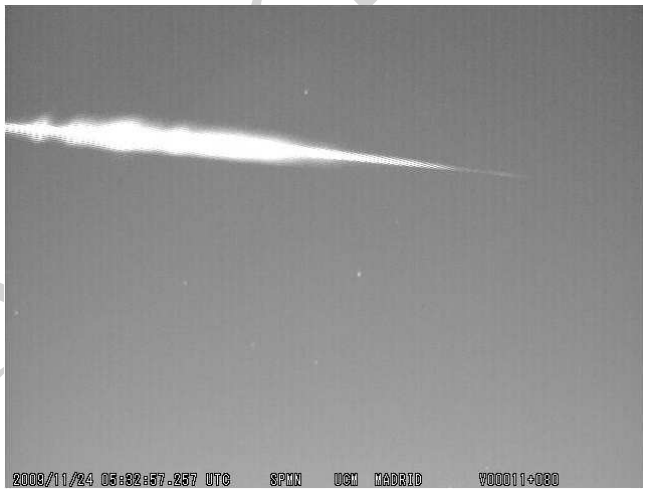

Figure 1 – The Valhermoso bolide (SPMN 241109) was an Earth-grazing event imaged by high-resolution video cameras in the UCM station in Madrid and the UCLM station in Toledo. The estimated absolute magnitude was −10 (Moreno-Ventas et al., 2010).

2 Large meteoroids in minor cometary streams

Meteoroid streams are mainly associated with comets. The classic mechanism is ejection from the comet surface by the drag of the sublimated gas. However, it imposes certain restrictions to the lift-off for massive particles. Other streams are formed via catastrophic disruption (Trigo-Rodríguez et al., 2009), and this process leads to some amount of large meteoroids. These big fragments are observed by the SPMN as large fireballs when they enter the atmosphere, and the recording of these events allow us to calculate the orbit and parent body. (See Figures 1 and 2.)

3 Outburst of the 2011 Draconids

A Draconid outburst took place on October 8, 2011, with the maximum around 20^h UT, as forecast. The GUAIX (UCM group of Extragalactic Astrophysics and Astronomical Instrumentation) prepared an observing campaign dedicated to complement the continuous monitoring at the Observatorio UCM. (See also Figure 3.)

The highlight was the launch of a high-altitude helium balloon with a scientific payload to record the Dra-

Figure 2 – The SPMN 310711 α-Capricornid fireball imaged from Madrid (Observatorio UCM). Our data are consistent with the recently established idea that Minor Planet 2002 EX12 is the parent body of the α-Capricornid meteoroid stream, rich in large meteoroids (Zamorano et al., 2012).

conids. This was done in collaboration with Proyecto Daedalus that had successfully launched other balloons. The payload consisted of a netbook recording the signal coming from a Watec high-sensitivity video camera. The balloon was launched in Daimiel, Spain, and it landed 200 km further, after a 4-hour flight. It reached an altitude of 29 km, and descended slowly to a place close to Jaén. The probe was recovered just before the astronomical twilight. Unfortunately, the computer stopped working after 35 minutes, when it was still too low to be stable, around 11 000 m high.

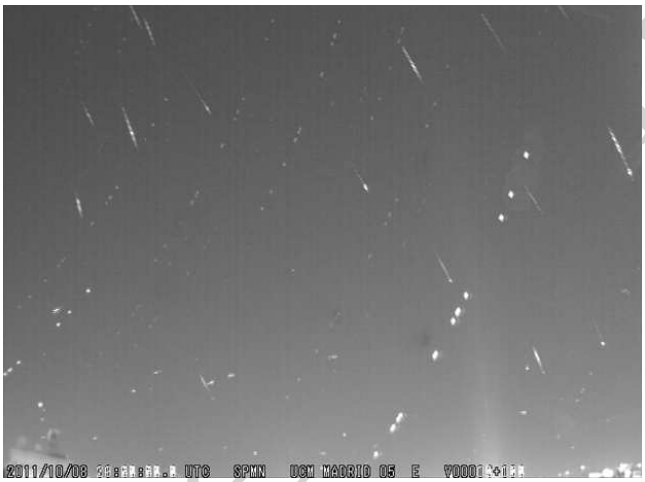

Figure 3 – Composed image with all the Draconids detected in 1.5 hours by one of the cameras of the Fireball Video-Detection Station at the Observatorio UCM. The "jet of light is caused by the illumination of the Torre Picasso.

Part of the group went to the Observatorio de Sierra Nevada (OSN) of the Instituto de Astrofísica de Andalucía (IAA) at 2900 m high. More than a hundred Draconids were recorded. Some fireballs were observed in multiple stations by several nodes of the Spanish Meteor Network. The results of the UCM group are published by Ocaña et al. (2013) and the result of SPMN collaboration by Trigo-Rodríguez et al. (2012, 2013) and Madiedo et al. (2012, 2013).

4 Photometry for fireball observing

We have designed a photometric system to measure several meteor properties more efficiently than other spectroscopic methods using prisms or gratings. Using photometric filters improves the detection of fireballs and meteors, especially under skies with heavy light pollution like at the Observatorio UCM (Ocaña et al., 2011). This work was awarded by the Spanish Ministry of Education and Science. The prize ensures continuation of the station and the possibility to acquire more equipment.

We have developed simulation and pipeline software, and tested the feasibility of this technique. We are currently using the Spanish VO service to analyze a small spectra dataset in the literature.

5 Undergraduate research projects

The project has opened up itself to students of the Bachelor Degree in Physics at UCM, who have participated in the reduction and analysis of the data.

Dungeons and Draconids (& Fellows!). The GUAIX group conducted an observing campaign of the Draconids 2011 meteor shower, motivated by the predictions of a high activity. More than 50 GB of data were collected and taken to the dungeons of the Faculty of Physics of the UCM, where they are being analyzed by students in an undergraduate collaboration project. Some results are published by Ocaña et al. (2013).

Spectracolour. This project studies light emission from fireballs and meteors. Our goal is to test a narrow-band photometric system as an alternative to spectroscopy. The system is described by Ocaña et al. (2012).

MetCoDe. This is an automatic system to delete false positives in meteor detection. It improves the quality of the detection efforts without diminishing the sensitivity of the software.

Radiantes UCM. This is an undergraduate student project of the Fireball Research Group. The main goal of the project is to introduce young students into research and to help the group to exploit the meteor database. Since the installation of the station in 2010, over 10 000 events have been detected.

6 Space surveillance educational outreach—video monitoring

Satellites orbiting the Earth can be monitored using different techniques. Video monitoring has been proven

to be successful for optical ground tracking allowing high temporal resolution (equivalent to good astrometric precision for these moving objects). It is feasible to use this technique at secondary school and university levels to increase the educational outreach of space-related activities. Ground optical and radar tracking suffer from some difficulties that can be overcome by a network of low cost cameras spread throughout Europe. From continuous monitoring at UCM Observatory, we have recorded satellite re-entries, fuel dumps, and several satellite flashes (Ocaña and Zamorano, 2011). Some examples of the recordings are shown in Figures 4 and 5.

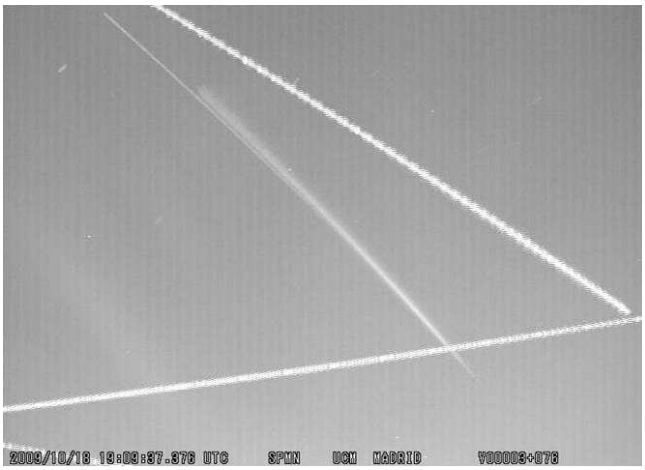

Figure 4 – On October 18, 2009, the detection station recorded an object surrounded by a relatively bright halo. Several other stations and amateur observers around the world observed this phenomenon. The object was lately identified by several sources as a Centaur stage dumping the remaining fuel after inserting into orbit the F18 US Military Weather Satellite.

Figure 5 – Observatorio UCM has collaborated with Simone Corbellini (Politecnico di Torino) in satellite surface modeling. This omposite image shows our first successful observation. It was done for the pair NOSS 3 4(A) and NOSS 3 4(C) on February 17, 2007.

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