EPSC Abstracts
Vol. 12, EPSC2018-1105, 2018
European Planetary Science Congress 2018

FRIPON and IMPACT projects to pinpoint interplanetary matter in the centimetre - hundred meter range

François Colas (1), Kévin Baillié (1), Sylvain Bouley (3,1), Brigitte Zanda (2,1), Jérémie Vaubaillon (1), Simon Jeanne (1), Auriane Egal (9, 1), Pierre Vernazza (4), Jérôme Gattacceca (5), Mirel Birlan (1), David Baratoux (10), Salma Sylla (11), Laurent Jorda (4), Jean-Louis Rault (7), Stéphane Caminade (6), Marc Delcroix (12), Lucie Maquet (1), Cyrille Blanpain (8), Asma Steinhausser (2), Julien Lecubin (8), Adrien Malgoyre (8)
(1) IMCCE, Observatoire de Paris, Paris, France (colas@imcce.fr), (2) IMPMC, Muséum National d'Histoire Naturelle, Paris, France, (3) GEOPS, Université Paris Sud, Orsay, France, (4) LAM, OSU Pytheas, Marseille, France, (5) CNRS, Aix Marseille Université, IRD, Coll France, INRA, CEREGE, Aix en Provence, France, (6) IAS, Université Paris Sud, Orsay, France, (7) International Meteor Organization, (8) OSU Pytheas, Marseille, France, (9) Department of Physics and Astronomy, University of Western Ontario, London, ON, N6A 3K7, Canada, (10), Géosciences Environnement Toulouse, IRD, Université de Toulouse, & CNRS UMR 5563, 14 Av. Edouard Belin, 31400, Toulouse, France, (11) Institut de technologie Nucléaire Appliquée, Laboratoire Atomes Laser, Université Cheikh Anta Diop, Dakar, Sénégal. (12) Société Astronomique de France, France.

Abstract

Improving our knowledge of the interplanetary matter is important to better understand the evolution of the solar system. However, it is mostly undetectable except when it enters the terrestrial atmosphere or when it is large enough to be detected by optical telescopes [1] (Harris et al, 2015). There is in particular a lack of knowledge for particles between 100 m (exhaustive limit of large telescopic surveys) and a few centimeters (typical maximum size for meteor surveys) (fig 2). Fireball observation networks like FRIPON (Fireball Recovery and Interplanetary Observation Network) [2] (Colas et al, 2014) can fill this gap for objects between a few centimeters and a few meters. For larger objects, fall statistics on Earth are too low to determine a precise impact flow. The idea of the IMPACT project is to detect the similar falls of objects from several meters to a hundred meters on Jupiter and Saturn: such events should be more frequent on these more massive planets than on the Earth [3] (Delcroix et al 2015).

1. FRIPON project

The aim of the FRIPON project is to better constrain the connections between meteorites and asteroids. It is easy to study a meteorite in the laboratory but we cannot tell where it came from, because its orbit is most of the time unknown. On the other hand, we currently have more than 750,000 asteroid orbits with almost no physical information. However, these parameters are crucial for understanding the origin and evolution of the solar system.

The goal of the FRIPON network is to detect large objects that are possible sources of meteorites. We decided to use fisheye cameras to detect fireballs of negative magnitude, allowing us to detect particles larger than a few millimeters. To reach a sufficient statistic we decided to cover the entire French territory (fig 1). We measure an average of 2000 orbits a year and expect to get one meteorite a year.

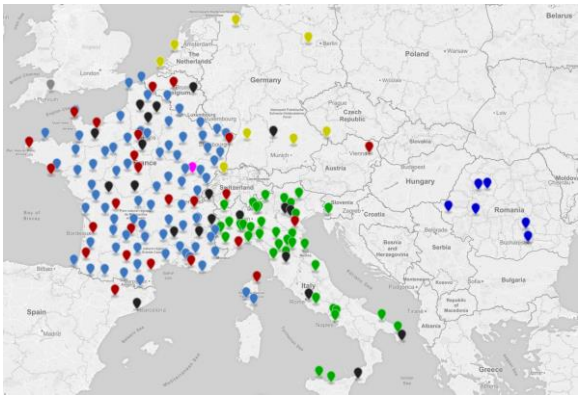

Figure 1*: State of the FRIPON network (95 cameras installed, light blue) and extensions in Europe, PRISMA (Italy, green), MOROI (Romania, dark blue). Red dots are for radio stations using GRAVES radar*, black for station in installation, yellow for new European networks.

2. IMPACT project

The size distribution of dust and asteroids are known with relative accuracy only in the immediate vicinity of the Earth (fig 2). It is essential to model this flow

precisely to understand the formation of the Solar System, in particular to measure the age of planetary surfaces determined by crater counting. The IMPACT project aims to monitoring the surfaces of giant planets with the best temporal continuity to obtain a good statistic of these impacts. It proposes to coordinate observation campaigns with the 1 meter telescope of the Pic du Midi Observatory by associating amateur and professional astronomers in order to maximize the temporal coverage of the observations.

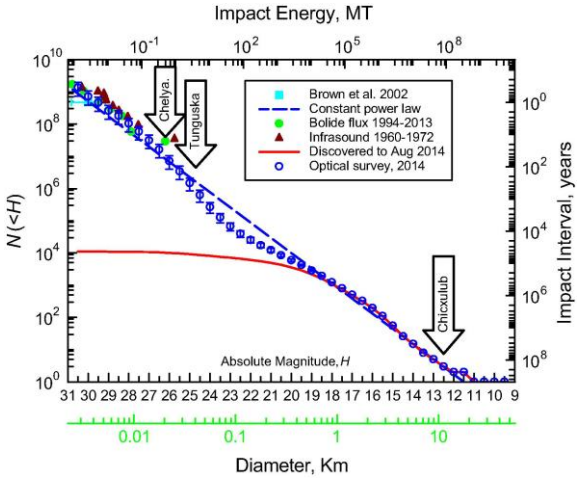

Figure 2 : *Cumulative distribution of Near Earth Asteroids [1](Harris and D'Abramo, 2015)*

The IMPACT program is complementary to the one carried out by the University of Bilbao, in particular with the development of the DeTeCt program [3] (Delcroix et al, 2013), aiming to automatically detect possible impact flashes in the observations of Jupiter routinely performed by amateur astronomers.

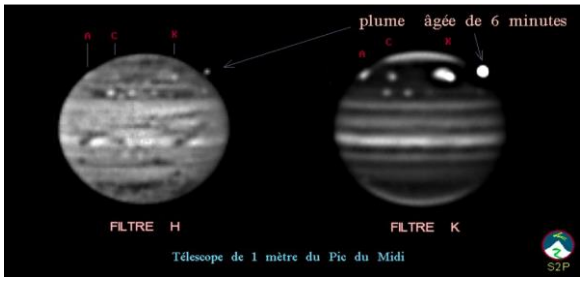

Figure 3 : *Impacts of SL9 comet on Jupiter. On the right image, made with CH4 narrow band filter, it is possible to see (top) the flash and traces of older impacts at the same latitude [4] (Colas et al, 1995).*

IMPACT will not only detect live flashes, it will be especially focused on the detection of impact traces with lifetimes of a few days to several months, such as the impact of comet SL9 in 1994 (fig 3). Our goal is to observe Jupiter twice a month, and thus exhaustively detect all traces that last a few weeks or more. With the image quality of the 1m Pic du Midi telescope, we can detect objects from ten meters to a hundred meters. Beyond this size, Jupiter events will be too rare to measure an impact flux with a good precision.

3. Conclusion

With the combination of the FRIPON and IMPACT programs, we hope to be able to measure the flow of inter-planetary material at the Earth's orbit as well as for Jupiter and Saturn, and obtain a new a global model for the whole Solar System. With the addition of meteor observations and the discovery of near-Earth asteroids, we will thus have a global assessment of the matter falling on Earth from a few 1/100 mm to 1000 km. The knowledge of this flow will also yield better estimates of the age of cratered surfaces outside those of the Moon that have been calibrated with sample returns.

Acknowledgements

The FRIPON project is funded by the French ANR (Agence Nationale de la Recherche: www.anr.fr).

References

[1] Harris, A. W. and D'Abramo, G. (2015). The population of near-earth asteroids. Icarus, 257, 302 – 312

[2] Colas, F., Zanda, B., Bouley, S., Vernazza, P., Gattacceca, J., Vaubaillon, J., Marmo, C., Kwon, M.K., Audureau, Y., and Rotaru, M.: FRIPON, a French fireball network for the recovery of both fresh and rare meteorite types, Asteroids, Comets, Meteors 2014

[3] Delcroix, M. and Hueso, R. (2013). Jovian impact flashes detection with DeTeCt software project. European Planetary Science Congress, 8, EPSC2013–812.

[4] Colas, F., Tiphène, D., Lecacheux, J., Drossart, P., de Batz, B., Pau, S., Rouan, D., and Sèvre, F. (1995). Near-infrared imaging of SL9 impacts on Jupiter from Pic-du-Midi Observatory. Geophysics Research Letters, 22.