

The re-entry of artificial meteoroid WT1190F

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Introduction

In the near future, it is likely that a 3-m to 7-m sized asteroid will be detected in space with sufficient warning time for observers to be able to travel to the area of atmospheric entry and study the manner in which the asteroid breaks apart. With good characterization of the asteroid before impact, this could provide valuable ground truth for high-fidelity models of asteroid impacts.

Observations

A great opportunity to practice such an observing campaign arose on October 23, 2015, when a space debris object was detected on an eccentric orbit and predicted to impact Earth over the Indian ocean near the coast of Sri Lanka six weeks later. Now named WT1190F, this space debris object entered Earth's atmosphere near local noon on Friday November 13, with an entry speed of 10.61 km/s, relative to the atmosphere at 100 km altitude, and an entry angle of 20.6°. These circumstances are more similar to those of asteroid impacts than to most other space debris re-entries.

The International Astronomical Center in Abu Dhabi and the United Arab Emirates (UAE) Space Agency chartered a commercial G450 aircraft to observe this daytime re-entry. The aircraft was instrumented by an observing team from Dexter-Southfield School and Embry-Riddle Aeronautical University, a team from the Institute for Space Systems of the University of Stuttgart, and by teams from the SETI Institute, the UAE Space Agency and the International Astronomical Center.

Cameras deployed included a Red EPIC movie camera equipped with a 200-mm focal length lens for high spatial resolution imaging, a second movie camera slightly out of focus for photometry, two Prosilica monochrome spectrographic cameras for measuring emission signatures, a series of wide angle filtered Watec WAT902 H2 Ultimate cameras for photometry, a wide angle Sony 7αS digital still camera for early detection, a Lumenera monochrome camera with small field of view for fragment tracking, and a miniature Echelle spectrograph with fibered collection optics for high resolution spectroscopy.

Results

Results were presented in [1]. In the days leading up to the entry, the trajectory was refined and updates for the impact location and time were provided to the observing team. Observations in the hours before impact showed

that the object was rapidly tumbling with a period of about 1.5-s. Weather updates showed high clouds in the area of impact, with areas of low cloud ceiling drifted through. The aircraft path was timed to enter one of these areas at the time of re-entry. The sky cleared and the re-entry was well observed.



Figure 1. Re-entry of WT1190F in a wide-angle view. The object moved from upper left to lower right.

The artificial meteor was first detected at 73-km altitude. It fluctuated in brightness with a period of 1.5-s. WT1190F first lost several fragments starting at 60.0 (± 2.5) km. Two of those had nearly identical ballistic coefficients and travelled down side-by-side. The object broke in two at 55.8 km. The lower fragment disrupted further at 47.2-km altitude, at which time an emission spectrum was measured showing TiO bands and an intermittent hydrogen line. Two surviving pieces of the upper fragment were tracked down to 33 km altitude where they left the field of view.

In part based on these observations, the leading candidate for the identity of WT1190F is the Trans-lunar Injection Stage of the Lunar Prospector, a past NASA mission that was directed from Ames Research Center. Much information about this vehicle is in the public domain and efforts are underway to use the WT1190F reentry observations to calibrate satellite re-entry breakup models. In the future, similar work is envisioned in the context of asteroid impact fragmentation.

References

[1] Jenniskens, P., Albers, J., Koop, M., Odeh, M. S., Al-Noimy, K., Al-Remeithi, K., Al Hasmi, K., Dantowitz, R. F., Gasdia, F., Löhle, S., Zander, F., Hermann, T., Farnocchia, D., Chesley, S. R., Chodas, P. W., Park, R. S., Giorgini, J. D., Gray, W. J., Roberston, D. K., Lips, T., AIAA Science and Technology Forum and Exposition (SciTech 2016), 4-8 Jan. 2016, San Diego, CA. Paper AIAA-2016-0999. (See also: <http://impact.seti.org>)