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Introduction

Following the pioneering collection of Interplanetary Dust Particles (IDPs) in deep sea sediments and in the stratosphere [1], space collections started in the early 80s. They consisted in the return to the Earth of surfaces exposed during long durations to space, at altitude 300 to 500 km (e.g. : LDEF [2], ARAGATZ-MIR [3], TICCE-EURECA-1 [4]). In this context, the KMP/COMET experiment, proposed in 1982 by the French team has been accepted in the framework of the Soviet-French space cooperation program [5]. The idea was to install collectors inside hermetic boxes, maintained in vacuum from the lab to space and then back from space to the lab; to have these boxes mounted outside a space station, orbiting the Earth; to have the capability of chosing the date and duration of the collection, that is to open and close each box at selected periods [6]. In February 94, it has been proposed to fly an improved version of this instrument, slightly modified to accomodate a variety of instruments, as part of the payload of the Euromir 95 mission, negociated between ESA and NPO Energya. Renamed as the European Space Exposure Facility (ESEF), it carries several PI experiments designed to analyse in real time some parameters of the encountered particles (number density, trajectory, velocity and distribution), to expose surfaces to the space environment, and to collect material, both of terrestrial and extraterrestrial origin, to be brought back to the Earth at the end of the mission (29 February 1996). The relevant goal of the mission is the characteriszation of the collected grains: flux distributions, elemental, isotopic, molecular and mineralogic compositions. Are described the instrument, the passive and active experiments ; first results are given.

Description of the instrument

ESEF consists of a platform, that has been mechanically mounted and electrically connected to the Spektr space module on the ground, prior to its launch in May 1995, followed by its docking to the MIR station. This platform can receive the electronic unit, up to five mechanical units, only two of which were used during EUROMIR-95 and one instrument with active sensors (ICA). The mechanical units, appropriately labeled, contain the boxes called cassettas used for the passive collection of the ESEF experiments. Each mechanical unit has the capability of opening a selected cassetta to free space, to initiate the collection of impacting grains and then to close the cassetta, until a cosmonaut retrieves it and takes it back into the Station, from thence to the ground. Inside the station are the command units for commanding the different operations and receiving the data from the active experiment for downlink transmission ; data transfer is through the on board TM/TC system.

The passive experiments

The main goal of the passive experiments is to collect grains in space and to return them to Earth for further analyses. Three types of collecting material are used : high purity metals either as thick surfaces or multilayers, foams and silica aerogels. All grains down to submicron sizes can be possibly identified by such a variety of collectors ; the presence of very low density collectors, like the foams and silica aerogels, should permit the collection of grains either intact or least modified, one of the primary goals of this investigation.

Three PIs have flown their passive experiment on ESEF during the EUROMIR-95 campaign : J. Borg is responsible for the COMRADE passive experiment, J.A.M. McDonnell for DUSTWATCH-P and J. C Mandeville for MULTILAYER.

On Low Earth Orbits, are found particles of both terrestrial and extraterrestrial origins : respectively the orbital debris and the IDPs, easily identifiable by their chemical signature. Their flux distributions are such that the most abundant population is in the micron size range, orbital debris being predominant for all particle size ranges, except in the 10 µm - 1 mm range. Their velocity relative to the target is high (> 5 km/s). The impact of a hypervelocity projectile

(> ~ 3 km/s) is a process which can cause an extensive degree of fragmentation, melting and vaporization of the incident particle, in direct relation to the density relationship between the projectile and the target materials. For metallic targets, the result of the impact is either a crater or a perforation, depending on the size of the particle relative to the thickness of the target ; size and density of the particle are known through calibrations [7]. The chemical analysis of the impacting particle melted residues is possible in the rims of the crater, for thick targets, or on appropriate metallic plates under the thin foil stacks. Carbon compounds can be analysed in high purity metals. A very exciting goal of the ESEF experiments is the return of practically intact particles to the laboratory. This can only eventually be achieved by using as a target a very low density material. Three approaches are used in the ESEF experiments, towards achieving the lowest possible target density : i) a succession of thin metallic films, spaced to allow nondestructive energy dissipation between impacts (DUSTWATCH-P, MULTILAYER) ; ii) aerogel material in its silicon form (DUSTWATCH-P, COMRADE) ; iii) polymer foams of extremely low bulk density (COMRADE).

The Active experiment

The ICA module, together with the cassettas for collection, has been installed during the Extra Vehicular Activity (EVA), and will remain on the platform. There is a dedicated command unit that sends telecommands and receives telemetry to control the surface temperatures and relay data back to Earth. The different sensors included in ICA allow to actively measure, in-situ, micrometeroid and orbital debris fluxes and trajectories, the atomic oxygen flux, the contaminants deposited during quiescent and rendezvous periods and any subsequent thermo-optical effects. The reliable determination of the trajectory of each individual dust particle is a high priority of the proposed investigation.

The schedule, first results and conclusion

The EUROMIR-95 mission started September 3, 1995, with the launch of SOYOUZ TM-22, with, aboard, Thomas Reiter (the ESA astronaut), Yury Gidzenko and Sergei Avdeev. The EVA during which the mechanical units, ICA and the electronic unit were installed on the ESEF platform took place on the 20th of October. The two cassettas were opened to space collection the next day ; one of them was closed just after the Orionides encounter (18 - 26 October), and the second one remained open until the second programmed EVA of the European cosmonaut in February 1996, after which the two cassettas will be brought back inside the MIR station and then to Earth. During this EVA, a third cassetta will be installed for future collection. ICA started delivering data at the end of November ; 50 impacts have been registered during the first operational month ; their analysis is under progress.

Such a platform might be considered as an opportunity for future space collections aboard MIR. Inside the cassettas, installed by the cosmonauts during future EVAs, different passive collectors can be installed. The possibility of opening and closing the cassettas at given dates favours the exposure of the collectors to selected particles, most important for studying identified parent comets.

References

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