OVERVIEW OF EUROPEAN ACTIVITIES

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ABSTRACT

Technology developments in the field of spacecraft charging and spacecraft plasma interactions continue to be made in ESA-sponsored activities and elsewhere in Europe. This presentation attempts to show the diversity of European efforts in this area. It outlines some of the missions that are driving these activities and briefly mention some of the solutions that have been developed.

1. UPCOMING AND PROSPECTIVE MISSIONS

Science missions are often challenging for spacecraft charging assessment because they may travel to poorly explored regions or have demanding electrostatic requirements. Within the ESA science project programme, there are several missions currently being developed in a variety of orbits

- JUICE (Jupiter) and Athena (L1 or L2) – L-class missions
- Solar Orbiter (>0.28AU), Euclid (L2), Plato (L2) – M-class missions
- CHEOPS (SSO), SMILE (Molniya) – S-class missions

In addition, three M-class candidate science missions are being assessed for a possible 2025 launch

- THOR (HEO), XIPE (LEO), ARIEL (L2)

However, there are some other notable missions and programmes that are also influencing European activities in the field of spacecraft charging:

- Galileo 2nd Generation (MEO)
- Proba-3 (GTO-like)
- Many Earth observation missions in SSO
- Manned missions to Moon/Asteroid
- Space Situational Awareness
- Electra (Electric orbit raising)

JUICE especially will experience an environment that is both hazardous due to surface and internal charging and is poorly characterised. Solar Orbiter is also in a quite unfamiliar environment. Many new missions are planned for L1 or L2 and SSO, indicating the importance of a good definition of these environments. THOR is a mission where electrostatic requirements will be very stringent if it is to achieve its goals.
In the longer term, manned missions to the Moon and asteroids are being considered and these have dusty plasma environments that present a significant hazard and need understanding. Electric orbit raising missions are electrostatically challenging because of long-term use of electric thrusters and because they slowly cross a spatially varying environment. Proba-3 is interesting as a possible vehicle for making measurements throughout the magnetosphere. Similarly, SSA has a need to monitor charging environments and may provide the platforms to perform this task.

2. WHO IS ACTIVE?

Activities is the field are often driven by ESA and National Agencies such as CNES. The EU, which is becoming more involved in space research generally, is not yet heavily involved, although this may change. Universities and research organisations are active performers of research under agency contracts and under their own internal programmes. Technology companies, often SMEs are frequently involved in making developments and providing services to end users. Finally, industry (particularly Airbus D&S, TAS and OHB in Europe) is involved in many ways: as the end user, as a partner in development activities and in influencing the agencies' requirements for new work

3. SOME ACTIVITIES

Some activities in different areas of spacecraft plasma interactions are mentioned below. This is obviously not a comprehensive list and is based mainly on ESA activities.

Performance of Simulations

Simulations of surface and internal charging are a normal aspect of the spacecraft development programme and are too numerous to describe here. Within Europe, the use of SPIS for surface charging analysis has become common and there is considerable expertise in its use within industry. Similarly, within ESA, SPIS simulations, for hazard analysis and to maximise the scientific return of science missions, are regularly performed. Instrument teams are also able to use SPIS to simulate the effects of spacecraft potentials on their instruments.

Simulation tools

- 3-d internal charging. The earlier ELSHIELD development has been extended under ESA contracts in the 3DMICS and CIRSOS activities
- As part of the JCAT project a 1-d Monte Carlo internal charging tool MCICT was developed.
- SPIS capabilities have been extended to include dusty plasmas.
- SPIS is being further developed to model electric propulsion plume physics.

Instrument Developments

- The HOPE-M plasma instrument has been prototyped and tested in the laboratory.
- 3DEES is a 3-d instrument for radiation belt electrons. It is currently in phase C1 development.
- A multi-needle Langmuir probe has been developed for LEO plasma measurements.
- Under a CNES programme, the AMBER electrostatic analyser has been developed and is now flying on Jason-3.

Charging Environment Definition

- As part of an analysis of the Galileo radiation environment, the MOBE-DIC model for internal charging worst case assessment was created.
- As part of the JCAT project a statistical model of radiation belt electrons called HPEM has been developed.
- In the same study a plasma environment model for charging effects CPEM was created.
- Under a CNES study by ONERA, a detailed statistical analysis was made of severe charging environments in GEO to be used for the definition of worst case charging environments.

4. SUMMARY

Technology developments and analyses in the field of spacecraft charging and spacecraft plasma interactions continue to be made in ESA and CNES sponsored activities and elsewhere in Europe.

Drivers include scientific missions in poorly characterised locations, possible future manned lunar and asteroid missions, the increasing use of L1 and L2, SSO and Galileo orbits, and electric orbit raising.

This week you will hear and read about some of these developments.