Training Opportunity for Swiss Trainees

Reference | Title | Duty Station
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CH-2017-SCI-OOG | A radiation belt model for INTEGRAL | ESAC

Overview of the unit's mission:
The INTEGRAL Science Operations Centre (ISOC) at ESAC is responsible for:
- Handling of Announcements of Opportunity and proposals for observations of the INTEGRAL gamma-ray mission, including technical evaluation and support to the Time Allocation Committee.
- Long- and Short-Term planning of observations, including instrument handling, calibration observations and Targets of Opportunity.
- Support to the scientific community.

Overview of the field of activity proposed:
The INTEGRAL satellite is flying on a highly eccentric orbit, with the apogee at >140,000 km and the perigee at less than 10% of this. This orbit is evolving continuously, due to natural forces, much more than in most satellites – the plane of the orbit, e.g., has rotated by almost 300 degrees, the inclination varies between ~50 and almost 90 degrees and the perigee height is slowly oscillating between more than 10,000 and a few 1000 km. Around perigee, operations are affected by the Earths radiation belts, which require switching off the instruments, before they are entered and only reactivating them, once they have been left behind. Planning data is routinely adapted to make sure the critical parts of the orbit are avoided; on the other hand, leaving too large margins would waste precious observing time. The actual times and altitudes at which the radiation belts are encountered are tracked via radiation monitors, which remain active always.

The observed entry and exit heights show a complex evolution. While a ‘seasonal’ (note quite yearly, due to the rotation of the orbital plane) variation is easily understood by the shape of the belts around Earth along the Sun-Earth line, larger long-term trends have so far resisted an easy explanation (solar cycle, correlation with orbital parameters, ...) which would allow to predict the times well enough for safe long-term planning. For XMM-Newton, another satellite on a highly eccentric orbit – with very different orientation – in the past a model was successfully developed based on a simplified description of the radiation belt geometry, but the direct application of this model to the INTEGRAL orbit does not yield predictions in line with observations.

The activity foreseen for the Trainee is to attempt to build a predictive model of radiation belt passages for INTEGRAL, which then would feed into the Long-Term Planning and the generation of planning files at ESOC. The approach foreseen is to convert the orbital trace of historical belt passages into Geocentric solar magnetospheric coordinates and then compare with current data of the Earths magnetosphere and expected belt regions as provided, e.g., by the Cluster mission and others accounting for geometry and solar activity operation. The created model could then also be cross-checked against the existing XMM-Newton model for verification with different orbital parameters. A deeper understanding of the ~15 years of belt passage from INTEGRAL could also be useful additional data for studies of the variations of the Earths magnetosphere.

In the course of this project, the Trainee would gain a deep insight into the procedures and challenges of operating a space mission, on the radiation belt environment around Earth and its variability and also train analysis and modelling skills.

Required education:
A university education in a scientific degree – preferably, physics, astronomy or space engineering is required, including some proven skills in data analysis and modelling. Programming experience for scientific analysis or technical modelling would be a strong bonus.