スウェーデンにおける高速中性粒子撮像の研究

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Research on ENA imaging at the Swedish Institute of Space Physics

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We have an comprehensive program of ENA (Energetic Neutral Atoms) imaging for all of (1) experimental worktargetting 0.1-500 keV range, (2) data analysis, and (3) theoretical activities. The application of ENA imaging is not limited to the study of magnetospheres of the terrestrial planets (Mercury, Venus, Earth, Mars), but also the astrophysics.

1. We developed and built ENA instruments for the Swedish microsatellite Astrid, Russian Martian mission Mars-96, and the newly developed Swedish nanosatellite Munin (to be launched December 1999). We are currently developing an ENA package for Mars Express, the ESA mission to Mars. The ENA measurements on board Mars Express will cover 0.1 - 10 keV range and is planned to perform first ever observations of low energy ENAs at another planet.

2. Our instrument on board Astrid-1 was the first dedicated ENA imager flown in the earth's magnetosphere, and obtained ENA images at low altitudes. It demonstrated that ENA emissions from mirroring ring current ions as well as from low altitudes near the Pole concentrated within a thin layer, ENA wall. Thus with ENA omage we can obtain an instantaneous image of the MLT distribution of the ring current ions. The experiment also established the existence of ENA emissions from the upper atmosphere/ionosphere, and the emissions are probably related to the ion outflow flux.

3. We performed numerical simulations of ENA emissions from the Mercury magnetosphere and near-Mars space. We first developed exosphere models and magnetosphere plasma dynamics models, then used these models to simulate ENA production in the Mercury magnetosphere. In collaboration with the Finnish Meteorological Institute we also modeled the ENA production in the near-Mars space. The result shows that ENA can be used to study both the solar wind plasma population and the oxygen pick-up ions. We have also discovered a new effect, ENA precipitation, which seems to be important for the energetics and sputtering of the Martian upper atmosphere. The global ENA production rate in the earth's ring current is also studied: while the ring current correlates with the corrected Dst index, it experiences oscillations and beatings which reflect the dynamics of the trapped particles in the inner magnetosphere.

For the astronomical application, we considered possible generation mechanisms of the extra-heliospheric relativistic ENAs (1 -10 GeV) from, e.g., the supernova explosions. Our evaluation of the propagation loss suggests that the extra-heliospheric ENAs from the astronomical object at distances 150 Pc could even be detected, and hence ENA imaging would certainly open up a new clue to study our local galactic environment.