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The roadmap and status of the high-level data archive of ASPERA-3/IMA on Mars Express

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Abstract

A high-level dataset of space plasma near Mars derived from the observations by the ASPERA-3 instrument on Mars Express will be archived at PSA. We are working on processing the raw count data to convert to the physical quantities (differential fluxes and moments). In this presentation, we review the current status of the conversion and the roadmap for the archival.

1. Introduction

The ESA's Mars Express (MEX) spacecraft started its operation at the Martian orbit in 2003. Since then, the ASPERA-3 (Analyser of Space Plasma and EneRgetic Atoms) instrument is providing a unique dataset of space plasma near Mars for more than 15 years, allowing a long-term inverstigation of Mars–solar wind interaction. The effort of the ASPERA-3 development is highly international, involving 15 research groups from Europe, USA and Japan [1], and the users are extended more widely nowadays. More than 200 publcations have been published using ASPERA-3 data.

The ASPERA-3 instrument comprises five sensors: three ENA sensors, an electron spectrometer and an ion mass spectrometer. This project concerns the Ion Mass Analyzer (IMA). IMA provides ion measurements in the energy range 0.01-30 keV/q for the main ion components H^+, H_2^+, He^+, O^+, the group of molecular ions (20-80 amu/q) and up to 106 amu/q. It covers 90˚ elevation angle and 360˚ azimuthal angle, while a part of the field of view is blocked by the spacecraft structure. IMA is a replica of the Ion Composition Analyzer (ICA) for the ESA Rosetta mission. The ASPERA-4/IMA on Venus Express was based on the ASPERA-3 design [2].

2. Current data availability in PSA

From the beginning of the mission, the ASPERA-3 team has made an effort to archive the dataset through the Planetary Science Archive (PSA) [3]. On the other hand, the PSA dataset contains only the raw count rate of IMA. Users have to convert the count rate to the high-level products considering their sciences. This is a flexible approach, because in practice, the data processing depends on the purpose of the data analysis and the data quality of each instance. However, the drawback is that the users should consider details such as instrument characteristics, operations and so on. According to the recent trend of the open data policy in the community, the demand on the high-level data product (the differential flux and the moment values) is increasing. As the first official high-level data product of IMA, we produced and delivered the solar wind moments (the density, speed, and temperature) into the PSA system in 2018.

3. High-level data of IMA

The next step of the high-level data production is to calculate the ion differential flux for each species. The differential flux is the number of particles coming from a specific direction with a specific energy within a unit time. The unit of [particles / cm^2 s sr eV] is usually used.

Theoretically, the relationship between the measured count rate for specific directional and energy bin, C, and the corresponding differential flux, j, is expressed as:

$$j(E, \varphi, \theta) = C / E\, G\, \Delta t$$

where E is the energy, φ and θ are the angles, and G is the (energy) geometric factor, and Δt is the sampling time. Practically, to convert the measured counts to the differential flux more precisely, the following issues shall be solved and evaluated.

- How to subtract background counts
- How to separate the mass of the measured ions
- How to correct the internal noise of IMA

Once the differential flux is derived, the moment values (density, velocity and temperature) can be

derived by intergration over the available energy and direction space.

After deriving the high-level data products, the quality of the dataset shall be evaluated by considering

- accuracies of the processing procedure
- statistical errors
- directions that are blocked

In this presentation, we will report the status of the high-level data production, and the roadmap for delivering the products to PSA.

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[3] https://www.cosmos.esa.int/web/psa/mars-express