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The MASTER imaging spectrometer for the JAXA/Okeanos mission

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Abstract

We present an overview of MASTER (MApping Spectrometer for Trojans Exploration and Reconnaissance), an high resolution imaging spectrometer proposed for the JAXA/OKEANOS mission.

1. Introduction

The target of the JAXA Okeanos mission is a Trojan asteroid. These asteroids are located in the L4 and L5 Lagrangian points of the Sun-Jupiter system. Most of them are primitive bodies, belonging to the C- and mainly D-type taxonomic classes. The Okeanos science goals are directed at improving our understanding of the origin, evolution, composition and physical properties of the Trojans.

Their origin is still debated. One scenario suggests that the Jupiter Trojans formed in the same part of the Solar System as Jupiter and successively entered into its orbit [1]. In another scenario, the Jovian planets are assumed to have formed between 5-15 AU and were captured into their current orbits during the planetary migration triggered by the 1:2 Jupiter-Saturn resonance [2]. Whatever the origin, an in-depth exploration enables us to obtain information about planetary bodies in the snowline or the Kuiper Belt and their role in the delivery of building blocks of life to Earth.

There are several strategic knowledge gaps (SKGs) in understanding the primitive nature of the Trojans and their origin and evolution. The Trojan SKGs include: 1) What is their surface composition? 2) Do they include materials of astrobiological interest (e.g., CHONS? 3) Are they compositionally homogeneous both as a group and individual objects? 4) Do they experience cometary activity? 5) What is their link with comets and main belt asteroids?

2. Science objectives

The MASTER (MApping Spectrometer for Trojan Exploration and Reconnaissance) imaging spectrometer will perform science investigations aimed at addressing the SKGs. Specifically, the MASTER objective will be to detect, quantify and study the spatial distribution of spectral parameters related to surface materials (the following list is not exhaustive and can be expanded on the basis of future results from ground-based observation and the early phases of the SPS mission):

a) depth of absorption features in reflectance spectra associated with organics (3.1-3.3 μm), tholins (2.7 μm), hydrated materials (2.7 μm), ices (2.0-3.0 μm), and hydrous silicates (2.2-2.3 μm). The occurrence of some of these bands (2.3, 3.0, 3.2 and 3.4 μm) has been suggested, but never confirmed, by ground-based observations.
b) spectral infrared slope (e.g., between 2 and 3 μm).

In order to be sensitive to potentially low abundances of these materials, measurements should be able to identify a 1% band depth and this imposes a minimum required reflectance accuracy of 0.5%.

3. Specifications

MASTER acquires hyperspectral images, i.e. two-dimensional spatial images obtained simultaneously at different wavelengths, operating in pushbroom mode acquiring one line at a time through a slit of the spectrometer. The along-track spatial dimension is obtained by exploiting the spacecraft relative motion and velocity. Specification and performance of the MASTER instrument are summarized in Table 1.

Name	MASTER
Components	Optics, detectors, proximity electronics, radiator
Size	450Wx150Hx75D mm^3
Mass	5.5 kg
Power	0.5 W (detector) 5 W (proximity electronics)
Heat consumption	0.5 W (transmitted to IS)
Temp. range	120 K (detector), 160K (optics)
Amount of data	< 10 Gb
Telemetry rate	~300 kbit/s (average)
Detector	HgCdTe array
Wavelength range	1.8-3.6 μm
Resolution	20 nm
FOV	6°
IFOV	1mrad
SNR	>100
Quantum efficiency	>0.5
Spectral sampling	20 nm
Band depth accuracy	1%

Table 1. MASTER specifications.

Currently, a different MASTER configuration to expand the wavelength range up to 5 μm is under study.

References

[1] Peale, S.J. (1993), Icarus 106, 308;

[2] Morbidelli, A. et al., (2005), Nature 435, 7041, 462-465