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ORISON, A Stratospheric Project

P. Maier (1), J.L. Ortiz (2), A. Sanchez de Miguel (2), J.J. Lopez-Moreno (2), K. Schindler (3), F. Graf (3), J. Wolf (3), T. Müller (1), R. Duffard (2), L. Berenguer Poblet (4) and L. Alvarez Cuevas (4)
(1) Max Planck Institute for Extraterrestrial Physics, Germany, (2) IAA-CSIC, Spain (ortiz@iaa.es), (3) Institute of Space Systems, University of Stuttgart, Germany, (4) Ernst & Young, Spain

Abstract

This paper reports the concept and preliminary outcomes of the ORISON study, addressing an observatory-type, regularly flying high stratospheric research infrastructure. Implemented with a focus on comparably low costs and flexible operations, balloon-based systems such as the one presented have the potential to complement ground and space based observations and, in addition, to provide a test platform for future space-based instrumentation. The stratospheric observation conditions make such systems particularly suitable for planetary observations. They not only provide access to spectral regimes inaccessible from the ground and photometric stabilities not obtainable from the ground, but also observational opportunities at additional times of the daily cycle and throughout the year. In this paper, we present the overall ORISON concept, exemplary applications for planetary science, and propose first-light instrumentation for a balloon-based observatory to serve these applications.

1. Introduction

The objective of ORISON (http://www.orison.eu) is to investigate an infrastructure providing a flexible platform, tailored for astronomical use and designed to carry light-weight medium-sized telescopes and other exchangeable instruments. The focus thereby lays on a reusable platform performing regular flights from accessible locations and an operations concept that provides researchers with a similar access to observations as practiced on ground-based observatories. As such, the ORISON concept aims at complementing the current landscape of scientific ballooning activities by providing a service-centered infrastructure tailored towards broad astronomical use**.** Beyond the technical feasibility, ORISON also includes a study on different procurement options for the designed infrastructure, including instruments of innovative procurement.

2. Technical Concept

The goal of ORISON is not to provide a fixed observation system, but to provide a modular flight platform that can accommodate exchangeable instruments. In order to exemplify its application, however, both the flight platform as well as potential instruments with a wide applicability are presented.

2.1 Flight Platform

The ORISON flight platform will be designed to accommodate two classes of instruments: (1) telescope instruments, to be installed at the telescope, and (2) platform add-on instruments, to be installed on the platform, not using the telescope. For all these instruments, the platform will provide the conditions and services necessary for operation, including power, data and command handling, and thermal environment. For the telescope, the platform aims to provide coarse pointing with an accuracy on the order of 10 arcsec rms. Maybe most importantly, the flight system will be designed to be readily reusable which prominently requires undamaged return and landing of the instruments and the platform itself.

An assessment of scientific needs and the technical challenges of the balloon system showed that a platform capable of carrying a 0.5 m aperture diameter telescope for the UV to the NIR would constitute a good compromise between performance and size/mass.

2.2 Telescope and Instrumentation

The baseline telescope chosen for the ORISON feasibility study is a Ritchey-Chretien design with achievable system focal ratios between f/4 and f/16, allowing both wide field observations and high angular resolution. To enable high-resolution imaging, the optical system will include a tip/tilt mirror system aiming to provide image stabilization at the order of 0.1 arcsec rms.

To maintain the goal of a comparably light-weight and low-cost system, the ORISON baseline system will be optimised for the wavelength range from 0.2 to 2 µm, complementing the GHAPS balloon telescope concept that focuses on infrared wavelengths up to 5 µm [1].

Two potential first-light instruments with industry-standard detectors are considered, covering a broad initial range of applications. The first one being a simple direct wide field imager with exchangeable filters, which by itself can be used to address a wide range of science cases. The second potential baseline instrument is a multichannel fast imager with spectroscopic capabilities, based on the HiperCam [2] or reduced Octocam [3] and GROND [4] designs, offering simultaneous, photometrically accurate imaging capabilities in the u/g, r, i/z, J, and H bands.

Attractive "second generation" instruments would be dedicated spectrographs for the near UV and near IR spectral ranges.

3. Planetary Science Applications

The stratospheric observation conditions will provide a beneficial environment for a large range of planetary science applications. To illustrate the applicability, we present a selection of planetary science cases that could be pursued with the baseline instrumentation described above in table 1.

Table 1: Planetary Science Cases for ORISON

Science Case	Stratospheric Advantage
Multichannel exoplanet follow-up/confirmation	Photometric stability, no scintillation noise
Extended asteroid topology including near UV	Accessibility to UV spectral regions
Study of the 1.4 and 1.9 µm OH/H_2O bands on asteroids	Absence of telluric bands limiting NIR spectroscopy from the ground
Study of Mercury's exosphere	Observations close to the Sun possible
Small body light curves and absolute photometry	Increased photometric stability

4. Summary and Conclusions

An observatory-type balloon telescope, designed for regular flights and flexible instrument deployment, will provide a beneficial tool for planetary scientists. It will particularly make stratospheric observations accessible for scientists and groups without the capacity or aspiration to design and organize their own ballooning missions. The ORISON study, once completed at the end of July 2017, will provide a technical concept and a potential funding approach for such an observatory. A follow-on project is planned to build upon these results towards an implementation.

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