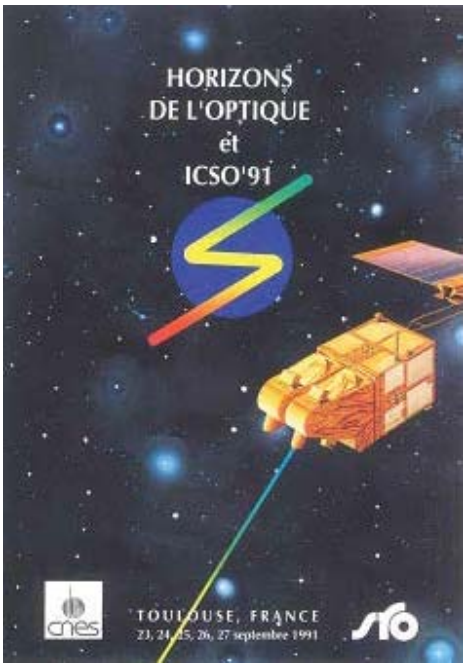
International Conference on Space Optics—ICSO 1991

Toulouse, France

25–27 September 1991

Edited by Guy Cerutti-Maori



Session 2: Astronomy

International Conference on Space Optics — ICSO 1991, edited by Guy Cerutti-Maori, Proc. of SPIE Vol. 10571, 1057102 · © 2018 SPIE · CCC code: 0277-786X/18/$18 · doi: 10.1117/12.2326751

A SEMI ACTIVE TELESCOPE FOR THE FRENCH PRONAOS SUBMILLIMETRIC MISSION

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ABSTRACT

The PRONAOS balloon borne gondola to be flown in 1992 will be dedicated to astronomical observation in the submillimetric wavelength domain (100 microns, 1 millimetre).
On behalf of the french Space Agency (CNES) responsible of the overall programme, Matra Espace is prime contractor of the 2 meter telescope, responsibility includes design development and acceptance testing of the flight hardware. Mass and thermal stability stringent requirements have imposed to build a full CFRP telescope including its primary mirror. A surface accuracy better than 10 microns (RMS) associated to an areal mass lower than 20kg per sqmeter have led to select for its 2 meter primary mirror a 6 actively controlled petals configuration. Each of them is supported by 3 linear actuators providing 3 degrees of freedom : the piston and the two tilts. A set of displacement sensors allows to derive through a control algorithm the actuators commands required to maintain the mirror geometry within its optimal configuration whatever the environmental conditions are. After a description of the basic design of the different units constituting the telescope, emphasis will be given to the alignment technique and to the results of the optical performance measurements.

FAR UV SOLAR SPECTROMETER: STUDY AND DEVELOPMENT

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A high resolution far ultraviolet spectrometer has been proposed to study the high temperature range of the solar atmosphere, between 10**4 K and 1.5 *10**6 K, called SUMER (Solar Ultraviolet Measurement of Emitted Radiation). The SUMER instrumentation is part of the SOHO (SOlar and Heliospheric Observatory) payload, a joint ESA/NASA mission to be launched in 1995.

The instrument combines the good image quality given by a single optical surface telescope with a stigmatic Wadsworth spectrometer to provide high resolution spectra in the 50-160 nm wavelength range on a bi-dimensional detector. To fulfill the scientific objectives the telescope must provide near one arsecond angular resolution of the solar disk image with very low scattering in order to make good observations of low intensity lines emitted above the solar limb. The spectrometer must keep the high quality angular resolution figure given by the telescope along the entrance slit and must furnish the high spectral resolution needed to analyse the spectral profile of solar ultraviolet lines.

We describe the main features of the optical design, the performances expected, the quality requested for each optical element, the preliminary results of some tests and the status of development.

One of the new main features of the optical design is the use of CVD-SiC surface on SiC blanks for all the optical elements, including the grating. Within the wavelength range of the spectrometer the performance expected with this design is discussed. The near one arcsecond angular resolution and 4 pm spectral resolution goals can be achieved with a careful implementation of the optics inside the support structure. and its mechanisms.

DESCRIPTION ET PERFORMANCES DES MIROIRS ET MULTICOUCHES POUR LE TELESCOPE EN EXTREME ULTRA-VIOLET (EIT) DE LA MISSION SOHO.

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Le téléscope en Extrême Ultra-Violet (EIT) prévu dans la mission SOHO (Solar and Heliospheric Observatory) de l'ESA doit fournir des images de la totalité de la couronne solaire dans quatre bandes de longueurs d'onde centrées respectivement autour de 17,1 nm, 19,5 nm, 28,4 nm et 30,4 nm. A cet effet, les deux miroirs de ce téléscope de Ritchey-Chrétien sont divisés en quatre quadrants recouverts de multicouches différentes et qui seront utilisés successivement pour former les images sur un détecteur unique.

Fabrication et contrôle des miroirs.

Afin d'obtenir la résolution demandée de 1 seconde d'arc pour l'instrument assemblé, on prépare tout d'abord des miroirs sphériques en zérodur polis à mieux que lambda/20 (pic à vallée, lambda = 546 nm) pour la forme et 0,3 nm rms pour la rugosité mesurée par des palpeurs mécaniques et optiques. La forme définitive est obtenue par dépôt sous vide d'une couche à gradient d'épaisseur radial. Le profil d'épaisseur mesuré par interférométrie sur un témoin plan est conforme au profil théorique à ± 10 nm prés.

Conception, fabrication et test des multicouches.

On utilise des multicouches Mo/Si de différentes périodes pour réfléchir sélectivement la lumière dans les quatre bandes prévues. Elles sont préparées par évaporation sous vide, l'épaisseur de chaque couche élémentaire étant contrôlée par réflectométrie de rayons X mous pendant le dépôt. Aprés fabrication, la période finale est mesurée sur un témoin plan par interférométrie de rayons X rasants. Leur réflectivité en Extrême UV est mesurée en fonction de la longueur d'onde en utilisant le rayonnement synchrotron monochromatisé. Pour les multicouches faites par évaporation thermique, la réflectivité maximum en incidence normale va de 30% pour 17,1 nm à 20% pour 30,4 nm et la résolution correspondante ($\lambda/\Delta\lambda$) décroît de 15 à 10.

Des réflectivités légèrement plus élevées sont obtenues en préparant les multicouches par dépôt assisté par bombardement ionique, ou par pulvérisation ionique; ces méthodes permettent de réduire la rugosité d'interface dans les empilements; cependant nous avons conservé le procédé d'évaporation thermique qui permet seul d'obtenir l'uniformité d'épaisseur requise sur les miroirs traités.

Un probléme particulier est posé par le traitement réfléchissant pour 28,4 nm qui doit simultanément atténuer la raie voisine très intense de l'hélium II à 30,4 nm. La résolution d'une multicouche classique Mo/Si étant insuffisante, nous avons conçu et préparé des multicouches à bande passante plus étroite en alternant deux matériaux relativement "transparents" tels que Al et SiO_2. En superposant les deux types de multicouches on peut obtenir une courbe de réflectivité présentant un maximum de 10% à 28,4 nm et un minimum de l'ordre de 0,05% à 30,4 nm.

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THE OPTICAL DESIGN OF THE CORONAL DIAGNOSTIC SPECTROMETER (AN INSTRUMENT FOR SOHO)

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The Coronal Diagnostic Spectrometer (CDS) is one of thirteen instruments which will form the payload of the joint ESA/NASA Solar and Heliospheric Observatory (SOHO) due for launch in 1995. CDS is currently under construction by an international consortium led by the Rutherford Appleton Laboratory, UK. It is a high resolution, extreme ultra-violet telescope and spectrometer system which will be used to derive temperature and density information on scales appropriate to the fine-scale structures in the solar corona. The ultimate goal is that this information will lead to a greater understanding of the heating of the solar corona and the acceleration of the solar wind. The wavelength region utilised has not been fully investigated by earlier satellite missions (Skylab, OSO-8, SMM), so CDS will provide important new results.

The paper describes the general features of the optical system, and then discusses certain aspects of the design in more detail.

In particular:

The choice of aperture stop position in the instrument;

The geometrical aberrations of the grating spectrometers (with some discussion of tolerances);

Overall performance in terms of spatial/spectral resolution.

THE INTERNATIONAL DIFFUSE EUV SPECTROMETER (IDES) EXPERIMENT FOR EURECA

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The EUV diffuse background (100 to 912 Å) is the most poorly known of any of the diffus astronomical backgrounds. Only upper limits to this flux exist. A variety of source mechani smshav been postulated which will radiate in this bandpass. One source which is certainly producing flux in th band is the *hot phase of the interstellar medium*. The detection of just a few lines from this source wi add tremendously to our knowledge about this poorly understood material. A second mechanism whic is known to emit radiation in this band is the *inflowing interstellar medium* which is resonantly excite by solar radiation. A third source of EUV line emission will be *atmospheric airglow emission*, the stud of this emission will elucidate processes occuring in the upper atmosphere. Finally, a variety of othe processes have been suggested which may be producing emission in this band; a speculative but highly exciting possibility is that *dark matter associated with our galaxy* is producing radiation in this band.

IDES is a *small mass and small size* EUV background spectrometer optimized in both sensitivity and spectral resolution over the whole bandpass: 350 – 900 Å. The instrument will have two orders o magnitude more sensitivity than previous instruments operating in the EUV band and more than an order of magnitude higher spectral resolution. Despite the vastly increased sensitivity of this improvec instrumentation, long integration times will be needed which dictates that the instrument must be deployed on a orbiting platform like EURECA.

IDES optical system consists of two 15 cm diameter Rowland circle spectrographs with holographically ruled 3600 line mm^{-1} diffraction gratings. Each grating views approximately 10 x 10 degrees of sky through a 100 micron wide slit: one slit is for the 350 – 600 Å channel and one for the 550 – 900 Å channel. The slit is periodically shuttered for accurate calibration of internal background. Light then strikes the 30 mm diameter imaging microchannel-plate intensified photon counting detectors. We use optimum photocathode and grating overcoating. *IDES* mechanical system consists of an optical bench and a separate box for the electronics.

IDES does not need pointing capabilities and is mounted on a fixed plate on the spacecraft viewing the anti-sun direction. The intended observing program is to survey that fraction of the sky which will be accessible during one EURECA mission. In 8 months *IDES* will observe a 10 x 180 degree strip of sky. This is 1/18-th of the fraction of sky accessible from EURECA.

The participating laboratories, CARSO, University of Trieste, INTA – Madrid and Center for EUV Astrophysics, University of California, Berkeley, will be responsible for the detailed design, development, manufactory, assembly, test and delivery of the experiment.