MAPPING THE GALACTIC CENTER REGION WITH GRASP

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ABSTRACT

The GRASP mission (*Gamma-ray Astronomy with Spectroscopy and Positioning*) is currently under study as an ESA space astronomy mission to be launched in the mid 90's. GRASP is designed as a high quality spectral imager ($E/\Delta E \approx 500$ at 1 Mev) with positioning to the arc minute level within a large field of view ($\approx 7°$) which operates over a wide spectral range (30 Kev-100 Mev) with a 3σ sensitivity of typically 10 mcrab or better over the entire operational range within an observational period of $\approx 10^5$seconds. In this paper, we will mainly discuss the capability of the instrument with respect to the study of both point source and diffuse source measurements of the galactic center region.

I.INTRODUCTION

The GRASP telescope, which may be the first high resolution spectral imager to operate in the gamma-ray region in space will have the following features:

- a wide operational bandwidth (4 Kev to 100 Mev) which for the first time, links X-ray and γ ray astronomy.

M. Morris (ed.), The Center of the Galaxy, 633–637.

- high resolution spectrometry over the range 30 Kev to 10 Mev ($E/\Delta E \approx 500$ at 1 Mev)

- accurate source positioning (typically ≈ 1 arc min) within a field of view of ≈ 50 square degrees.

- high sensitivity for both extended and point sources (typically 10 mcrab at 3 σ in 10^5 s)

These wide ranging goals are achieved by the use of combination of a coded aperture mask and a position sensitive detector plane associated with a mosaic of high energy resolution detectors. The gamma-ray detector plane consists of an assembly of CsI(Tl) scintallators and germanium solid state detectors arranged into an overall position sensitive array.

II DESCRIPTION OF THE GRASP TELESCOPE

The principal characteristics of the GRASP instrument (fig 1) are:

- a mosaic of 19 stacks of hyperpure Ge detectors for low energy photon detection (20Kev-10 Mev). Each stack consists of 4 planar type detectors (each 5.4 cm diameter, 1.5 cm thick).
The overall spectral resolution is of the order of 2 Kev at 1 Mev and the geometric area ≈ 400 cm^2. This configuration, advantageous in terms of the rejection of $\beta^{\pm}$ decay background, has a low total background level and is resistant to radiation damage.

- an array of 3 D position sensitive CsI(Tl) scintillators capable of both locating and measuring the energy deposited by particle interactions throughout the detector volume, corresponding to a sensitive area of ≈ 2400 cm^2.

- a Stirling cycle cooler system associated with a passive radiator for the solid state spectrometer make a long mission possible (> 3 years)

- an active shield for the solid state spectrometer consisting of an array of CsI scintillators (mean thickness:12 cm).

- an hexagonal URA mask located about 4 meters "above" the detector plane gives a point source location capability of the order of the one arc minute.

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The narrow line and broad line sensitivities of the germanium and CsI detectors for 10^5 s. and 10^6 s. observation periods are shown in fig 2. and 3.

Typically these 3 σ sensitivities are of the order of a few times 10^{-6} photons. $cm^{-2}.s^{-1}$ at 1 Mev for narrow lines and a few times 10^{-7} photons.$cm^{-2}.s^{-1}$ at 10 Mev for broad lines.

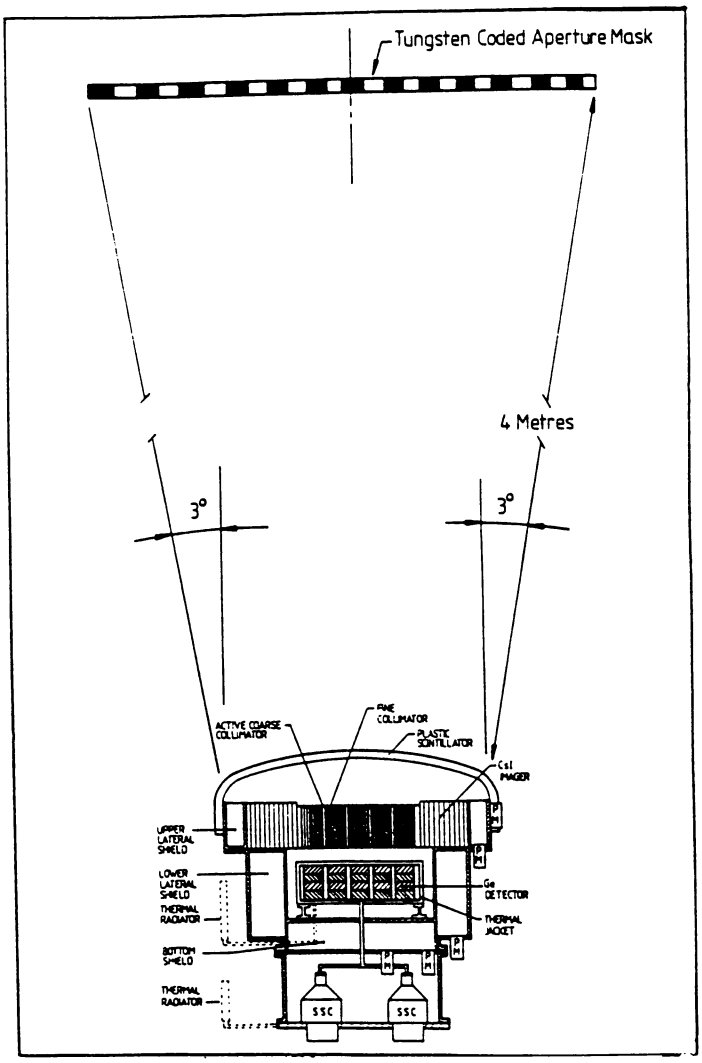

Fig 1 Schematic diagram of the GRASP telescope.

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The continuum sensitivity for GRASP is presented in fig 4 (where a 10 mcrab spectrum is shown as reference)

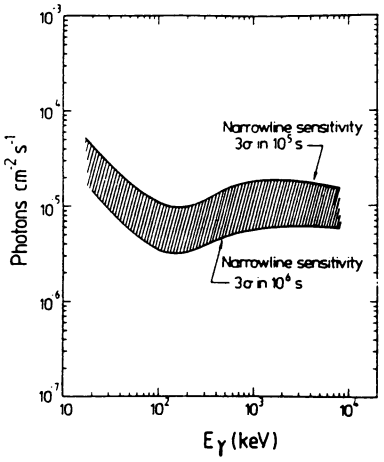

Fig 2: Narrow line sensitivity of the GRASP telescope (Ge detectors)

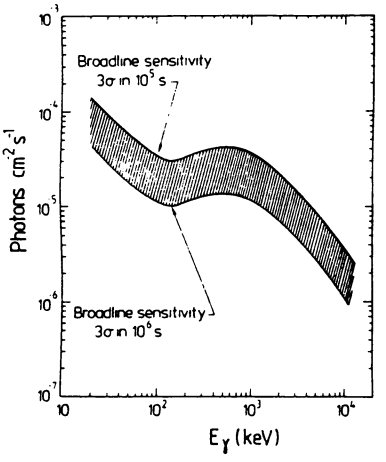

Fig 3: Broadline sensitivity of the GRASP telescope (CsI(Tl) detectors

III ASTROPHYSICAL OBJECTIVES

1- Extragalactic objects

The study of active galaxies is to be one of the major features of the mission.
The unambiguous identification of a large number of actives galaxies will lead directly to the compilation of a gamma-ray luminosity function for these objects in the region of the spectrum where their liminosity is at a maximum.

Futhermore the detailed study of red-shifted electron-positron annihilation lines from these distant sources has fundamental cosmological implications.
Precise measurements of both the line and continuum spectra will provide a revealing probe of the physics in the vicinity of the compact objects associated with extragalactic nuclei.

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The study of explosive nucleosynthesis in local supernovae (<10 Mpc) will be also possible.

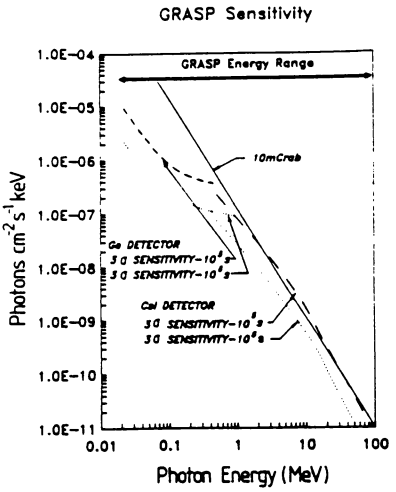

Fig 4: Continuum sensitivity of the GRASP telescope

2- Galactic objects

In the context of our galaxy, GRASP will discover new gamma-ray sources, map extended objects, locate point sources precisely (≈1 arc min) analyse their emission spectra with high resolution and study the variability of a wide variety of spectral objects,with special emphasis on the galactic center.

A picture of the distribution of the recent products nucleosynthesis in the galaxy will be derived by mapping key emission lines Al^{26} and $e^- + e^+$ annihilation .

This has direct bearing on the study of stellar nucleosynthesis e.g. in the Red Giant and Wolf-Rayet phases.

Also galactic novae are exciting targets for high resolution spectroscopy studies, as they are potential explosive nucleosynthesis sites. Finally, γ rays coming from the interaction of cosmic rays with the interstellar medium are interesting goals for observations.

IV MISSION AND SCENARIO

This mission is under phase A study at the European Space Agency for a final selection which will take place in November 1988. This phase A is accompanied by industrial studies for a space platform which might satisfy the GRASP requirements, allowing about 10^3 pointings in the sky , lasting 10^5 to 10^6 s.

This would maximise the scientific output of the mission, and offer a significant opportunity of a benificial fallout on the wider astronomical community through an Associate Observer Program which was investigate during the GRASP Workshop held at the Observatoire de PARIS-MEUDON on May 31st-June 1st & 2nd 1988.

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