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ASTRO-F: MISSION OVERVIEW

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ABSTRACT

ASTRO-F is the first Japanese dedicated infrared astronomical satellite which will be launched in 2005FY and is now in the final stage of the development. ASTRO-F is a 70 cm aperture cryogenically cooled telescope and designed for the infrared survey with much higher sensitivity and angular resolution than IRAS. We present the current status of the mission, focal plane instruments, and the observation plan now being discussed.

Key words : infrared — space telescope

I. INTRODUCTION

After the first successful mission of IRAS, space infrared observation has been an inevitable tool for astronomy. After IRAS, COBE, ISO and now Spitzer followed, and made outstanding discoveries on star and planet formation, evolution of galaxies and so on.

In Japan, rockets and balloon experiments had been attained in 1970's and 1980's. Following these experiences, the first Japanese Space Infrared Telescope, IRTS was launched on 1995 (Murakami et al. 1996). IRTS was a 15 cm aperture telescope cooled by super fluid liquid helium. The telescope size is relatively small, but IRTS was optimized for the observations of diffuse infrared radiation such as background radiation, interstellar dust emission, etc.

Based on the IRTS heritage, the first dedicated space infrared astronomical satellite in Japan, ASTRO-F was proposed and approved. ASTRO-F is an infrared survey satellite to update the IRAS catalog with much higher sensitivity and angular resolution. The launch of ASTRO-F was delayed due to the failure of the telescope support system, but now is expected to be in 2005FY.

The main purpose of the ASTRO-F mission is to publish the far and mid infrared catalog that will be opened to the world wide astronomers. Furthermore, deep imaging observations at near and mid wavelengths will provide important data base for the astronomy. With these new data base, the science on the formation and evolution of stars, planets and galaxies will be performed.

ASTRO-F is now in the final stage of the development. We present here the status of the mission, performance of the focal plane instruments, observation plan, etc.

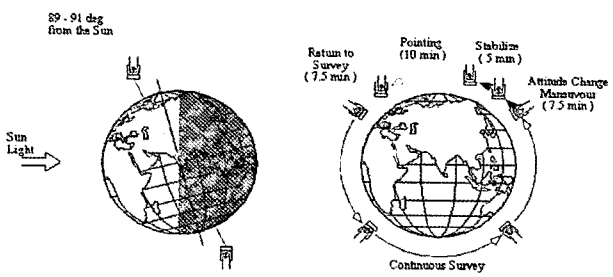

Fig. 1.— Maneuvering of ASTRO-F is indicated. Thy left side shows the mode of all sky survey, while the right side indicates the attitude control for the pointing observation.

II. ASTRO-F SATELLITE

ASTRO-F is a survey satellite which will be thrown into sun-synchronous orbit like IRAS. Generally all sky survey is performed by rotating the satellite axis once in one orbital period keeping the telescope axis to be zenith. Observation for half a year will make it possible to survey almost all sky area. Besides survey observation, pointing observation is possible by keeping the telescope axis to inertia space for 10 min. (right figure of Fig. 1). Imaging observation will be attained with this pointing mode. Fig. 1 shows the schematic view of the maneuver of the attitude control.

Fig. 2 shows the cutaway picture of the ASTRO-F satellite. The telescope is cooled by super fluid liquid Helium. Incident heat load to the liquid Helium tank is drastically reduced using the 2-stage Stirling Cooler at the inner radiation shield. Holding time of liquid Helium in space is estimated to be 550 days with 170 liter liquid Helium, which is much more efficient than previous infrared astronomical satellites.

The telescope is a Ritchey-Chretien type with 70cm

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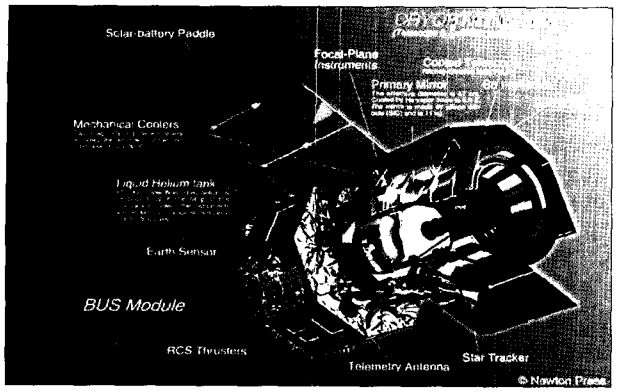

Fig. 2.— Cutaway view of the ASTRO-F. Courtesy of NEWTON press.

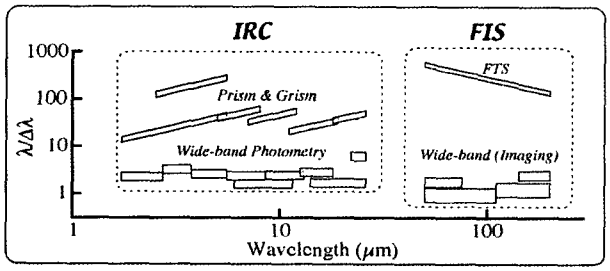

Fig. 3.— Photometric and spectroscopic capability of ASTRO-F.

aperture, and light weight mirrors are made of SiC. Diffraction limited image at 5 μm was achieved at 5.8K. The telescope support system caused trouble during the vibration test, but the refurbishment was successfully done.

III. FOCAL PLANE INSTRUMENTS

Two focal plane instruments are installed. One is FIS (Far Infrared Surveyor) and the other is IRC (InfraRed camera). FIS is used for the far infrared survey and has a capability of Fourier spectroscopy. IRC consists of three cameras that cover near and mid infrared bands. IRC is mainly used for the pointing mode, but one mid infrared band is used for the all sky survey. IRC also has a capability of slitless spectroscopy with low resolution. Fig. 3 shows the photometric and spectroscopic capabilitiese.

Both for IRC and FIS, large format arrays are used. One 512x412 InSb array, and two 256x256 SiAs BIB arrays are installed on IRC, while far infrared arrays of 20x3 (non stressed Ge:Ga) and 15x3 (stressed Ge:Ga) with low temperature read out electronics were used for FIS. Fig. 4 shows the pixel scales for IRC and FIS.

The performance of FIS and IRC has been tested in these years, and the final detection limits in orbit are obtained and are shown in Fig. 5. ULIRG at high z, β Pic at 1 kpc, brown dwarfs (0.03 solar mass) at 10 pc,

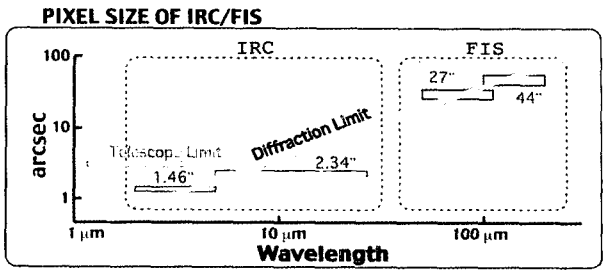

Fig. 4.— Pixel scales of IRC and FIS.

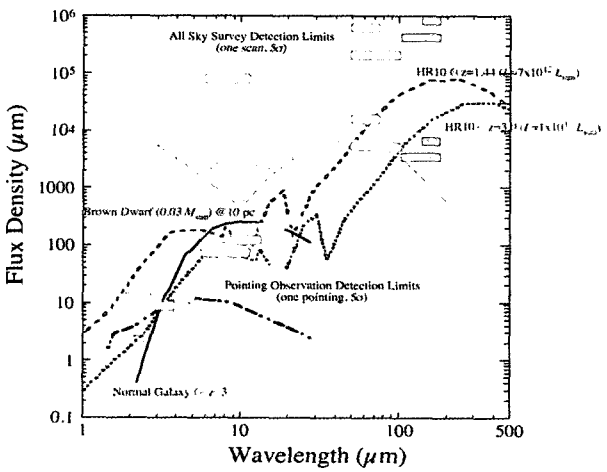

Fig. 5.— Detection limits of FIS and IRC, and expected fluxes of some target objects

etc are found to be detectable.

IV. OBSERVATION PLANNING AND SCHEDULE

Since ASTRO-F is not the observatory type but survey telescope, observation program for the pointing mode must be carefully coordinated and prepared before the launch.

We divide the observing period into four stages. The first 60 days after the launch will be used for the checkout of the system. During the next 180 days after checkout, the first priority is devoted to the all-sky survey with small amount of pointing observations (Phase 1). Until the run-out of liquid Helium, pointing observations will be mainly performed with supplementary survey observations (Phase 2). Even after the liquid Helium runs out, near infrared camera will be still available. We expect to continue near infrared observations until the end of the life of the satellite (Phase 3).

A criterion in organizing the pointing observations is to maximize the scientific significance of the ASTRO-F mission. We are going to have large area pointing observations that are used for the several scientific purposes. NEP (North Ecliptic Pole) survey, LMC (Large Magellanic Cloud) survey are examples.

A small amount of open time observations is also provided. 10% of pointing observations is assigned to the ESA community, while 20% to Japan and Korea.

The release of the ASTRO-F catalog is also an important issue. We plan that the first Bright Source Catalog will be released to the ASTRO-F team by March 2008, and to public by March 2009. The release of faint source catalog will follow 1.5 year later.

V. INTERNATIONAL COLLABORATION

The hardware of ASTRO-F has been developed in Japan, but the international collaboration on the data analysis has been actively attained.

We concluded a treaty (MOU) with ESA on ASTRO-F. ESA provides receiving station at Kirna, and makes pointing reconstruction. While, ISAS provides observation opportunity (10% of pointing observations) for ESA astronomers.

In order to release ASTRO-F catalog as soon as possible, we have international collaborations to construct the pipeline software for the FIS all sky survey. One is IKSG (Imperial College, University of Kent, University of Sussex, and SRON-Groningen), and another is Seoul National University. Both the collaborations are going well. In particular, the commitment of Korean astronomers to ISAS satellite is the first case and could be valuable for the future collaboration with Asian countries.

No official opportunity of the pointing observations is opened to Asian countries except Korea. However, there exists a possibility to be a co-PI under the PI of ASTRO-F members. It is recommended to take a contact with Japanese or Korean astronomers.

REFERENCES

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