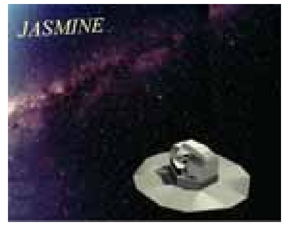
Overall Design of JASMINE



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JASMINE (Japan Astrometry Satellite Mission for INfrared Exploration) is a mission to determine positions and parallaxes accurate to ～10μarcsec, with proper motion errors ～10μarcsec/year for Galactic stars observed in z-band(0.9μm). The JASMINE spacecraft rotates slowly with a rotation axis aligned 3.5° from the Galactic pole-spacecraft line to perform a continuously scanning observation. This precession makes the JASMINE spacecraft to scan around the Galactic plane with 360°×7° area.

The JASMINE instrument uses a beam combiner to observe two fields of view separated by 99.5° simulataneously. It makes possible to perform global measurements to get absolute parallaxes. The two fields of view is fed into a common telescope whose detailed design is described in Yano's poster presentation. The present mission and instrument design is summarized in the below table.

Mission Parameter	
Mission Time	5 years
Rotation Period	～5.0 hours
Precission Period	28.6 days
Rotation Axis	Around the garactic pole
Optical System Parameter	
Aperture size	～1.5m
Focal length	～50.0m
Pixel size	15μm
Pixel on the sky	～61.9mas
Basic angle	99.5 degree

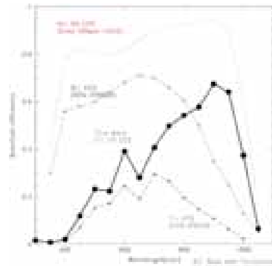
For achieving an accuracy of 10 μas, we need about 100 detectors on the focal plane.

$$\frac{\lambda}{D}\frac{f}{w} = N_{PSF} = 2,$$
$$\alpha_{s/c} = \frac{N_{pix-s/c}w}{f} = \frac{N_{pix-s/c}}{N_{PSF}}\frac{\lambda}{D},$$
$$\sigma = c\frac{\lambda}{D\sqrt{N_{ph}}} = 10\mu\mathrm{arcsec}$$
$$F_m = A\varepsilon E_0 10^{-0.4m}/h,$$
$$t_{int} = \frac{N_{ph}}{F_m},$$
$$R_c F_{m*} t_{int} = N_*,$$
$$T = \frac{2\pi}{\alpha_s}t$$
$$T_{pole} = \frac{2\pi \sin i}{S\alpha_c n_c}T,$$
$$X = \beta\frac{1\mathrm{yr}}{T_{pole}}N_{BC}n_s\frac{2}{S},$$
$$X T_{mis} t = t_{int}$$
$$n_c n_s \sim 88\left(\frac{c}{0.5}\right)^2\left(\frac{\sigma}{10\mu\mathrm{as}}\right)^{-2}\left(\frac{A}{1.55m^2}\right)^{-1}\left(\frac{\varepsilon}{0.1}\right)^{-1}\left(\frac{\beta}{0.4}\right)^{-1}\left(\frac{T_{mis}}{5\mathrm{yr}}\right)^{-1} \times\left(\frac{N_{pix-s}}{4096}\right)^{-1}\left(\frac{N_{pix-c}}{2048}\right)^{-1}\left(\frac{\sin i}{\sin 3.5\mathrm{deg}}\right).$$

$\alpha_{s/c}$ is viewing angle of detector for cross-scan or scann direction, F_m is number of photons for mag. m star, t_{int} is integration time, t is detection time, T is spin, T_{pole} is precession, $n_{c/s}$ is number of detector. (see detail in proceedings)

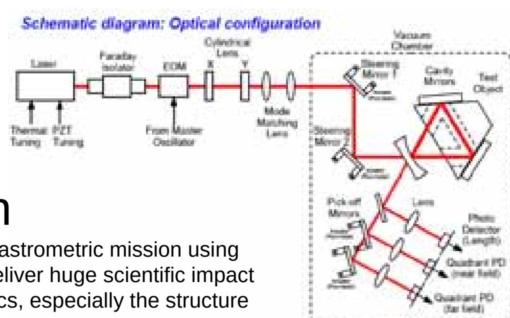
On the focal plane, about 7×14 CCDs are assembled and they measure the stellar images in time-delayed integration(TDI)mode. We are developing a new type of CCD, a back-illuminated fully-depleted CCD for infrared astronomy. The quantum efficiency of a prototype of the CCD is shown below as the solid line(see figure). The efficiency at 0.9 μm will be 90% in the near future. Impurity gettering techniques during the processing are employed to move impurities from the active sensor regions.

In our observation, quality of final scientific output is strongly dependent on a centroiding accuracy. In our simulation of centroiding algorithms, a satellite attitude is required to be controlled within the length of 1 pixel for both scan and cross-scan direction.



Observed number of star(z < 17mag) is estimated to be 32000/square degree. We assumed that communication is enable during 8 hours/day. For telemetry data for faint stars, pixels of cross-scan direction are integrated and 5×20bit stream is used. By doing this, data rates are reduced to 1.3Mbps. Applying an appropriate loss-less data compression method, phased array antenna can be applied for our telecommunication system.
For data compression, Karhunen Loeve transformation and Rice compression may be applied.

JASMINE will measure the speed and position of a billion stars with extremely high precision (10μas accuracy). The lines-of-sight of the two telescopes are separated by an angle (called ``basic angle'') of about 99.5 degrees. The basic angle stability should be within 10 μas rms over the satellite revolution period of 5 hours, or should be at least monitored with this accuracy.
We start ground based experiments of basic angle monitor. The design of instruments are shown in figure.



Conclusion

JASMINE is the unique space astrometric mission using infrared band. JASMINE will deliver huge scientific impact across the whole of astrophysics, especially the structure and evolution of the Galaxy. But JASMINE will observe only the Galactic disk and bulge. Maintaining close contact between the various proposed space astrometry missoins is strongly required for understanding whole the Galactic structure. From FY 2003, we have started collaboration with NASDA, ISAS (both institutes are unified to JAXA), Tokyo University, and Gravitational wave detection team in NAOJ. System investigation progressed very much. Until 2009, a mission proposal will be performed.