The scientific goal of the Japanese small astrometric satellite, *Small-JASMINE*

Taihei Yano,[1] **Naoteru Gouda,**[1] **Yukiyasu Kobayashi,**[1]
Takuji Tsujimoto,[1] **Yoshito Niwa,**[1] **and Yoshiyuki Yamada**[2]

[1]National Astronomical Observatory, Mitaka, Tokyo, Japan
email: [yano.t, naoteru.gouda]@nao.ac.jp, yuki@merope.nao.ac.jp, [taku.tsujimoto,
kazin.niwa]@nao.ac.jp

[2]Graduate School of Science, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan
email: yamada@scphys.kyoto-u.ac.jp

Abstract. *Small-JASMINE* is a small Japanese astrometric satellite, developed mainly at the National Astronomical Observatory of Japan. The target launch date of *Small-JASMINE* is around 2017. The satellite will be equipped with a telescope with an aperture size of 30 cm and a focal length of approximately 3.9 m. The operational wavelength will be centered on the infrared Hw band, between 1.1 and 1.7 μm, using a HgCdTe detector with 4k×4k pixels. This will enable us to observe the central regions of our Galaxy and clarify the dynamical structure of the bulge region. A restricted region of the Galactic bulge will be observed using a frame-linking method, which is different from the approach taken by both *Hipparcos* and *Gaia*, both developed at ESA. The target accuracy of the annual parallax and proper motion is approximately 10 μas and 10 μas yr^{-1}, respectively, in the central region of the survey area of 0.3×0.3 deg^2. The target accuracy of the annual parallax, $\sim$50 μas, and that of the proper motion, $\sim$50 μas yr^{-1}, will be obtained within a region of 2×2 deg^2. The observing region covers a field of approximately 3×3 deg^2. The mission is required to continue for around three years to obtain reliable measurements. In the winter season, the angular distance between the Sun and the Galactic bulge region is small. Accordingly, we may have the chance to observe different regions which contain scientifically interesting targets, such as Cygnus X-1. If we are successful in observing the object over the course of a few weeks, the orbital elements of the star accompanying Cygnus X-1 can be resolved by *Small-JASMINE*.

**Keywords.** astrometry, Galaxy: structure

1. Introduction

Future astrometric space missions, including *Gaia* and *JASMINE* (Japan Astrometry Satellite Mission for Infrared Exploration), will yield astrometric parameters—such as positions, parallaxes, and proper motions—of stars in the Galactic bulge. These satellites will produce astrometric data with an accuracy of ~ 10 μas for parallaxes and ~ 10 μas yr^{-1} for proper motions. As such, kinematic and dynamical information about Galactic bulge stars will be obtained after an observing period of order three years. Accordingly, it is expected that our understanding of the dynamical structure of the Galactic bulge will improve significantly.

2. Specifications of *Small-JASMINE*

The telescope of the *Small-JASMINE* astrometric satellite will have a primary-mirror diameter of 30 cm, with a focal length of approximately 3.9 m (e.g., Yano *et al.* 2011). The optics layout of *Small-JASMINE* is shown in Fig. 1. The mission will use an observing

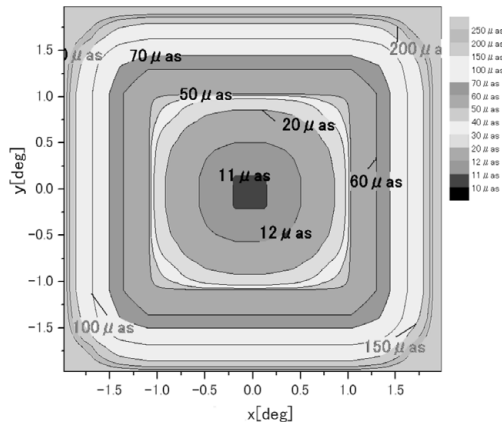|	
Optics	Modified Korsch (3 mirror)
Diameter of primary mirror	30 cm
Focal length	3.9 m
Focal plane on the sky	0.6×0.6 deg^2
Detector	HgCdTe
Target wavelength	1.4 μm ($1.1 \leqslant \lambda \leqslant 1.7$ μm)
Size of detector	4×4 cm^2 (4k$\times$4k)
Pixel size	10 μm
Number of detectors	1
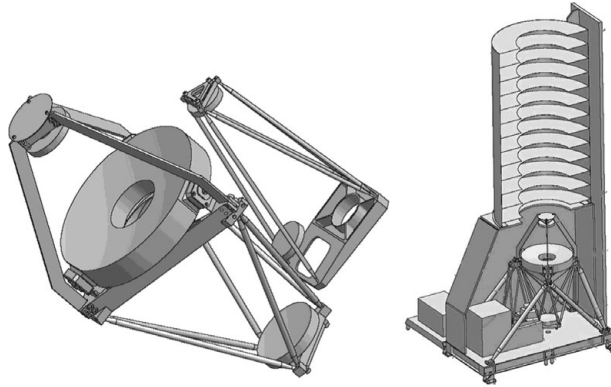
Figure 1. *Small-JASMINE*: Optics

wavelength centered on the infrared Hw band, between 1.1 and 1.7 μm (and a central wavelength of 1.4 μm), using a HgCdTe detector. This will enable us to observe the central regions of our Galaxy and clarify the dynamical structure of the bulge region. The size of the detector is approximately 4×4 cm^2. The number of pixels is 4k$\times$4k for a single detector, with a pixel size of 10×10 μm^2. The focal plane of a single detector covers an area on the sky approximately 0.6×0.6 deg^2. The target launch date of *Small-JASMINE* is around 2017. These parameters are summarized in Table 1.
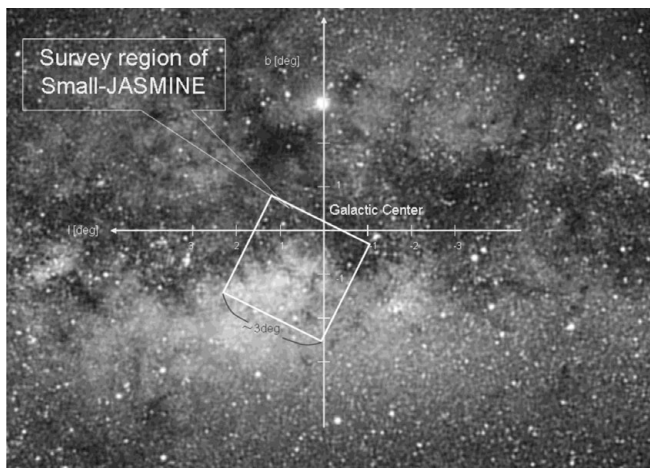
Figure 2. Survey region of *Small-JASMINE*

Table 2. Accuracy for objects with $Hw = 11.5$ mag based on a three-year observing campaign.

Parameter	Accuracy for a region of 2×2 deg^2	Accuracy for the central region $(0.3 \times 0.3$ deg$^2)$
Positional accuracy (σ_{pos})	46 μas	9 μas
Parallax accuracy (σ_{par})	53 μas	11 μas
Proper-motion accuracy (σ_{prop})	53 μas/yr	11 μas yr^{-1}

Figure 3. Expected accuracy of parallaxes for objects with $Hw = 11.5$ mag based on a three-year observing campaign.
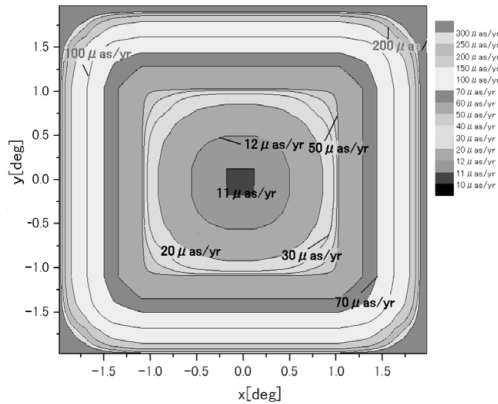
Figure 4. Expected accuracy of proper motions for objects with $Hw = 11.5$ mag based on a three-year observing campaign.

3. Observing Region

Small-JASMINE will observe the central regions of the Galactic bulge. The observations will produce astrometric parameters, including positions, parallaxes, and proper motions of stars. The Galactic bulge will be observed using a frame-linking method, which is different from the approach taken by both *Hipparcos* and *Gaia*, both developed at ESA. Observations using this method will cover roughly 3×3 deg^2 of the central region of the Galactic bulge. The proposed region to be observed is shown in Fig. 2.

Table 3. Accuracy for objects with $Hw = 11.5$ mag after one year of observations.

Parameters	Accuracy for a region of 2×2 deg^2	Accuracy for the central region (0.3×0.3 deg^2)
Positional accuracy (σ_{pos})	79 μas	16 μas
Parallax accuracy (σ_{par})	140 μas	28 μas
Proper-motion accuracy (σ_{prop})	280 μas/yr	55 μas yr^{-1}

Table 4. Accuracy for objects with $Hw = 10$ mag after one year of observations.

Parameters	Accuracy for a region of 2×2 deg^2	Accuracy for the central region (0.3×0.3 deg^2)
Positional accuracy (σ_{pos})	40 μas	8 μas
Parallax accuracy (σ_{par})	71 μas	14 μas
Proper-motion accuracy (σ_{prop})	140 μas/yr	23 μas yr^{-1}

4. Observing Accuracy

Small-JASMINE will have a mission duration of 1–3 years. A three-year observing campaign will facilitate parallax and proper-motion accuracies of ∼10 μas and ∼10 μas yr^{-1}, respectively, for objects with $Hw = 11.5$ mag. The region for which these accuracies can be achieved is located in the center of the target observing region of 0.3×0.3 deg^2. In addition, parallaxes with an accuracy of approximately 50 μas and proper motions of ∼50 μas yr^{-1} will be attained within a region of 2×2 deg^2. These accuracies are summarized in Table 2. The observing region covers a field of approximately 3×3 deg^2. Accuracy maps for parallaxes and proper motions are shown in Figs 3 and 4, respectively. Based on the first year of observations, we expect to obtain parallaxes with an accuracy of 28 μas and proper motions with an accuracy of 55 μas yr^{-1}, again for objects with $Hw = 11.5$ mag: see Table 3. In this case, we cannot derive distances to bulge stars with high accuracy. However, for objects with $Hw = 10$ mag, we can obtain parallaxes and proper motions with accuracies of 14 μas and 23 μas yr^{-1} after one year: see Table 4. In this case, we expect that we can obtain distances to bulge stars with high accuracy. Kinematic and dynamical information about Galactic bulge stars will be obtained after an observing period of roughly 1–3 years. Accordingly, it is expected that our understanding of the dynamical structure of the Galactic bulge will improve significantly.

References

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