

Infrared space astrometry mission for survey of the Galactic nuclear bulge: Small-JASMINE

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Abstract. Small-JASMINE will provide astrometric data with high precisions in a near infrared band for stars in the Galactic nuclear bulge and other specific targets. The primary scientific objective is to carry out the Galactic Center Archeology by exploring the Galactic nuclear bulge that leads to the elucidation of the Galactic structures and the evolution of the supermassive black hole at the center. Small-JASMINE has been selected as the unique candidate for the competitive 3rd M-class science satellite mission by ISAS/JAXA. The launch date is mid-2020s.

Keywords. infrared space astrometry mission, the Milky Way, the Galactic nuclear bulge, supermassive black hole

1. Introduction

The Galactic nucleus region whose radius is about 100pc, is called the Galactic nuclear bulge. The nuclear bulge has different physical characters from those of the outer bulge. The nuclear bulge is the place where the material elements of the Galaxy, such as stars, gas, and dark matter, are the most concentrated, and it is the place where the history from the early Galaxy formation to the present is intensively hidden. The Galactic center contains the stellar population history from the first star formation to the present. In addition, the nuclear bulge region is an important area that links the physical relationship between the outer bulge, the bar structure and the supermassive black hole at the Galactic center. The key to deciphering the history of the central region of the Galaxy is the positional distribution and movement of stars of various ages that still remain in the nuclear bulge. Small-JASMINE (<http://www.jasmine-galaxy.org/index.html>) is the first satellite mission in the world to perform high precision astrometry from the space with stable stellar images captured by a space telescope using infrared wavelengths that are transparent to dust and gas, and Small-JASMINE provides the information of the positional distribution and movement of stars in the Galactic nuclear bulge region, which are not yet understood. Moreover, Small-JASMINE has advantage in analyzing phenomena with short periods because of its high frequent measurements of the same targets (every 100 minutes). Hence Small-JASMINE is complementary to the Gaia mission. Institute of Space and Astronautical Science (a branch of JAXA (Japan Aerospace Exploration Agency)) selected Small-JASMINE in May of 2019 as the unique candidate of the competitive 3rd M-class science satellite. The launch date is mid-2020s.

2. Outline of Small-JASMINE

Small-JASMINE will determine positions and parallaxes accurate to 25 micro-arc seconds, and proper motions accurate to 25 micro-arc seconds/year for ~ 7000 bulge

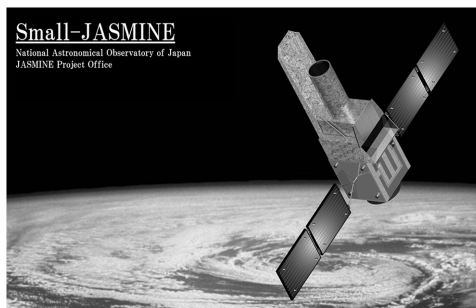


Figure 1. Artist's impression of the Small-JASMINE satellite.

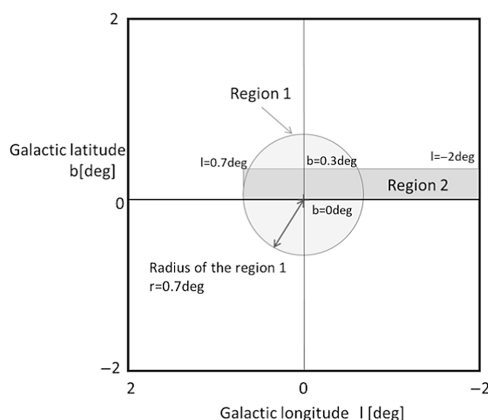


Figure 2. The observation regions of Small-JASMINE in the main operation mode.

stars ($H_w < 12.5$ mag) in the observation regions around the Galactic center (H_w -band: 1.1 \sim 1.7 micron). The observation regions are shown in Fig. 2. Furthermore Small-JASMINE provides about 67000 bulge stars with proper motion precisions of less than 125 micro-arc seconds/year for brighter than $H_w \sim 15$ mag. The survey will be done with a single beam telescope of which the diameter of the primary mirror is about 30 cm. The development of the data analysis in Small-JASMINE is going on in collaboration with some members of Gaia DPAC team (data analysis team). Furthermore the verification of the specifications of a detector (H4RG) and also the development of a detector box which controls the thermal condition around the detector will be carried out by US team (USNO, SDL, MIT, JPL, etc.).

3. Scientific objectives

The primary scientific objective of Small-JASMINE is to carry out the Galactic center archeology, in particular, Small-JASMINE has the following concrete scientific objectives. (1) Clarification of the Galactic nuclear disk, which leads to the classification of the Galactic bar and bulge structure by the use of Mira variables, (2) Reconstruction of the gravitational field which leads to the mass evolution of the supermassive black hole and the activity of the Galactic central region, (3) Characterize the global dynamical structure around the Galactic nuclear disk to clarify the origin of its structure by the use of the stellar phase space distribution. Next to these objectives, Small-JASMINE will have many other scientific targets. For examples, Small-JASMINE can search stellar clusters hidden in the Galactic nuclear bulge and hyper velocity stars by the use of proper

motions, and search of stellar black holes and/or intermediate mass black holes by the use of the gravitational lens effects. In periods when astrometric observations towards the Galactic center direction are not possible due to satellite operations, we plan to observe other specific astronomical objects in the Galaxy. An example is the transit observation utilizing continuous photometric observations of Small-JASMINE. It is possible to search for Earth-type planets in the habitable zone around M-type stars. For this exploration, Small-JASMINE dominates the other missions for the explorations of exo-planets. In addition, the Galactic mid-plane survey, observations of X-ray or gamma-ray binary systems, exploration and analysis of exoplanets by the use of astrometric methods, and analysis of stellar seismology, etc. can also be targeted. Small-JASMINE aims to make a catalogue which includes time series data of stellar positions on the celestial sphere and also the annual parallaxes, proper motions and etc., which are led by the time-series data. We will release the final catalogue to the public in the world in around FY2030.