

# A large-scale variability survey for the northern Galactic plane: KISOGP

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**Abstract.** We have conducted a large-scale survey of variable stars in the northern Galactic plane, about 320 square degrees using Kiso Wide Field Camera attached to the 105-cm Schmidt telescope at Kiso observatory. In the KISOGP (KWFC Intensive Survey of the Galactic Plane), we collected 40–100 epoch *I*-band images between 2012 and 2017. In our survey region roughly 5 million stars exist down to the limiting magnitude of  $\sim 16.5$  mag in *I*. In the initial data analysis, we detected a couple of thousands of variable stars including approximately 100 Cepheids and more than 700 Miras. More than 80 percents of them were not previously reported as variable stars, indicating that there are still many relatively bright variables to be found in the Galactic plane.

**Keywords.** stars: AGB and post-AGB, (stars:) binaries: eclipsing, stars: carbon, (stars: variables:) Cepheids, stars: variables: other, Galaxy: disk

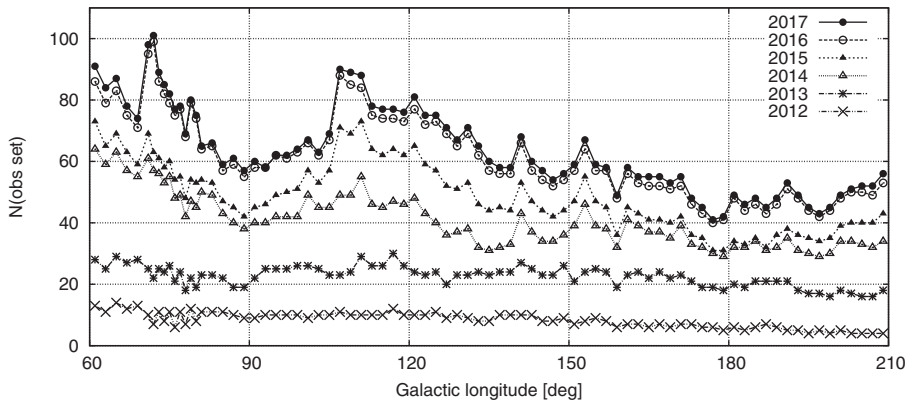
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## 1. KISOGP survey

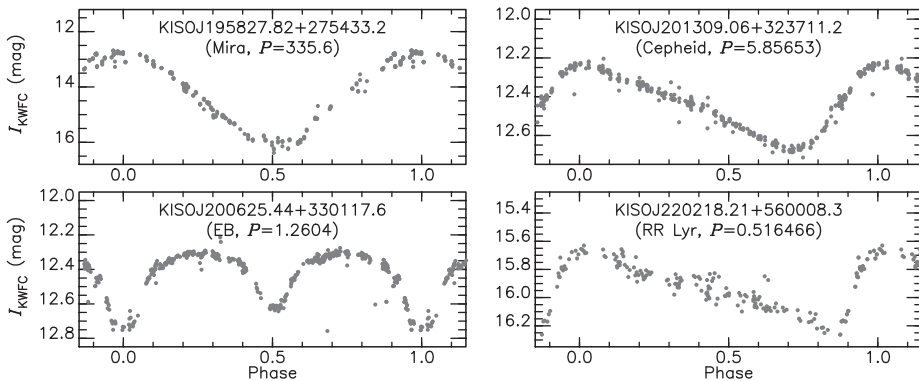
Strong interstellar extinction, at least in the optical wavelengths, prevented us from observing stars spread across a large volume of the Galactic disc. Recent surveys including those in the infrared regime have been gradually giving us the access to obscured stars, but massive observational efforts are still necessary to reveal stellar populations in the disc. Pulsating stars like Cepheids and Miras are useful as tracers of the Galactic structure (Feast & Whitelock 2014).

In order to discover pulsating stars in the northern Galactic plane, we have conducted a large-scale variability survey using a wide-field mosaic CCD camera, KWFC (Sako *et al.* 2012), attached to the 105-cm Schmidt telescope at Kiso observatory in Japan. With 80 KWFC fields-of-view aligned along the Galactic plane, our survey covers  $\sim 320$  square degrees between 60 and 210 degrees in Galactic longitude (map of the survey region is found in Matsunaga 2017). We collected 40–100 epoch *I*-band images for each of our fields-of-view between 2012 April and 2017 March (Fig. 1).

At each epoch, we obtained one exposure of 5 s and three exposures of 60 s with small offsets applied to fill the gaps between CCD chips of the mosaic unless the sequence was disturbed by bad weather. The shorter exposure allows us to observe stars as bright as  $I = 9$  mag, while each exposure of 60 s results in the limiting magnitude of approximately 16.5 mag in *I* (with the photometric accuracy of  $\sim 0.1$  mag). With this limiting magnitude, one can expect to find Cepheids and Miras further than 20 kpc and RR Lyrs up to 5 kpc, although these limits in distance depend on the interstellar extinction towards each line of sight (our survey fields are mainly located on the outer side of the Galaxy rather than the inner Galaxy for which the extinction is more severe).



**Figure 1.** Numbers of epochs for individual fields. A curve for each year labelled in the legend indicates the numbers collected between the start of the survey, April in 2012, and the end of the given year. Each epoch for each field has usually four images, one exposure of 5 s and three exposures of 60 s.



**Figure 2.** Example light curves of newly found variables of four different types: Mira, Cepheid, eclipsing binary (EB), and RR Lyr.

## 2. Initial results

Among  $\sim 5$  million stars detected in the KISOGP region, we found candidates of 50,000 variable stars in the analysis of data taken in the first 3 years. By searching for periodicity of them, we have identified  $\sim 100$  Cepheids and more than 700 Miras so far. More than 80 percent of them were not reported as variable stars previously. Examples of light curves of periodic variables are given in Fig. 2. We are also making follow-up observations of the variable stars we found to obtain various information, e.g. radial velocities and chemical abundances, useful for studying the structure and evolution of the Galactic disc.

## References

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 Sako, S., et al. 2012, *Proc. SPIE*, 8446, 6L