AS-8P

Variability analysis of K-type giants for their use as mid-infrared standard stars

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Abstract. We analyzed the mid-infrared (MIR) variability of K-type giants (K giants) to investigate the utility of K giants as MIR standard stars. We found that 80.4% of K-giant samples can serve as MIR standard stars. This result suggests the high potential of K giants and expands the potential of time-domain MIR observations using TAO/MIMIZUKU, which we are currently promoting. By utilizing K giants, the area where MIMIZUKU can observe a target and a standard star simultaneously expands to 7,000 deg^2, which is 25 times larger than previously assumed. To support observers with MIMIZUKU, we are developing a web-based tool to easily check properties of standard stars close to a target star.

1. Introduction

MIMIZUKU (Fig. 1): an instrument for TAO telescope that aims for monitoring observations with an accuracy of ~1% in 2–38 μm of the mid-infrared (MIR) region.

Field stacker (Fig. 2): an optical device on MIMIZUKU that realizes accurate calibrations by enabling simultaneous observations of a target and a standard star separated by ≤ 25'.

Standard stars: photometrically stable stars with known brightnesses needed for calibration.

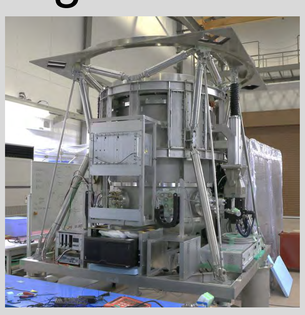


Fig. 1: MIMIZUKU

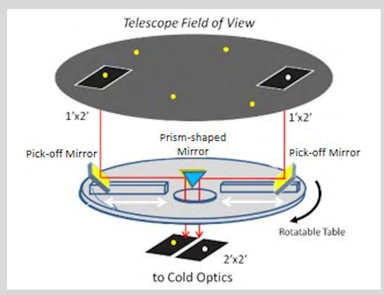


Fig. 2: Field Stacker

For the observation using Field stacker, the 436 known MIR standard stars are not enough.

K-type giants (**K giants**): bright in the MIR, numerous, and widely distributed on the sky.

→Good candidates for MIR standard stars

→We analyzed MIR variability of K giants to evaluate their utility as MIR standard stars.

2. Sample and Data

Sample: 5,615,041 K giants from Gaia DR3 with:

T_{eff} (effective temperature) : 3,700–5,200 K,

R (stellar radius) : > 10R_{sun}

Data: >10yr data in two MIR bands, *W*1 (3.4μm) and *W*2 (4.6μm) of NEOWISE.

3. Variability Analysis and Result

To know precise variability, we only used stars with:

- 8 < *W*1 [mag] < 8.5 and 8 < *W*2 [mag] < 8.5
- high-quality data (e.g., without contamination)

then, averaged data in each epoch (Fig. 3) and extracted stars with >19 epochs whose S/N > 300 in the *W*1 and *W*2.

→ 312 K giants remained.

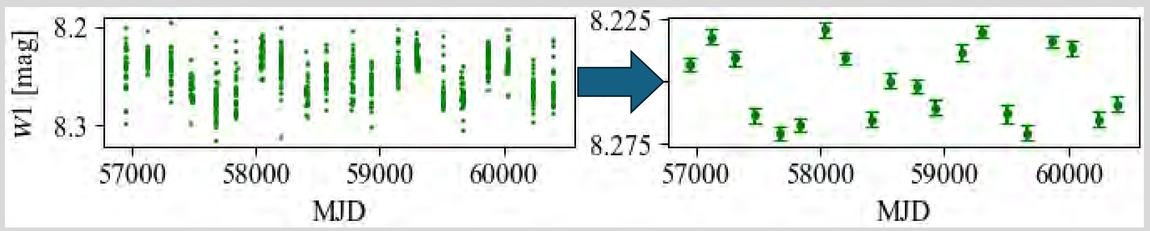


Fig. 3: Averaging data in epoch

We calculated three types of variability indicators:

- σ_{obs}: standard deviation of epoch-averaged magnitudes (Fig. 4)
- PV: peak-to-valley value of epoch-averaged magnitudes (Fig. 5)
- σ_{lim}: observational limit due to measurement error

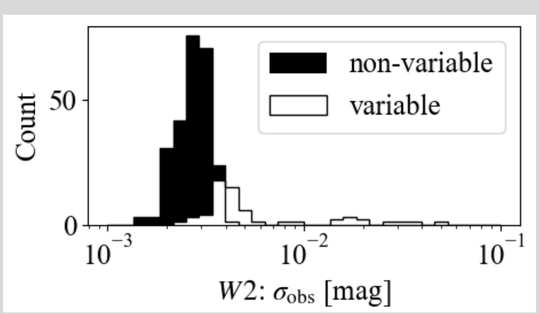


Fig. 4: Distribution of σ_{obs} in *W2*

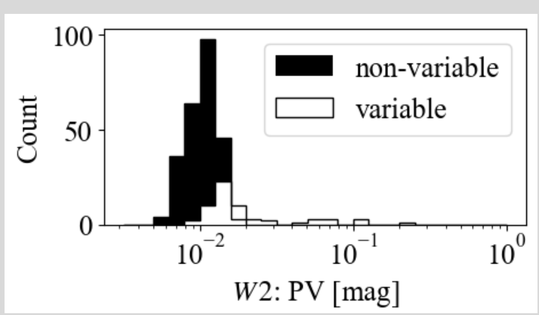


Fig. 5: Distribution of PV in *W2*

Stars satisfying the following criteria in both bands are judged as stable enough as MIR standard stars:

①$\sigma_{obs} < 1.469\sigma_{lim}$ (99.7% of non-variables meet this)

②$PV < 7.32\sigma_{lim}$ (false-positive rate ≤ 0.5%)

→ **80.4%** (251/312) meet them, suggesting that **80.4% of K giants can be MIR standard stars.**

4. Discussion

With the value 80.4%, we simulated the area expected that at least one standard star is present within 25' and MIMIZUKU can observe (Fig. 6).

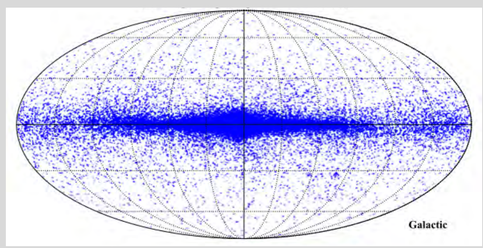


Fig. 6: Observable area

~7,000 deg^2 is observable (blue), 25 times wider than the area with 436 known standard stars.

We are developing an observation support tool that can check standard stars close to a target, their properties and MIMIZUKU's observational image with them (Fig. 7).

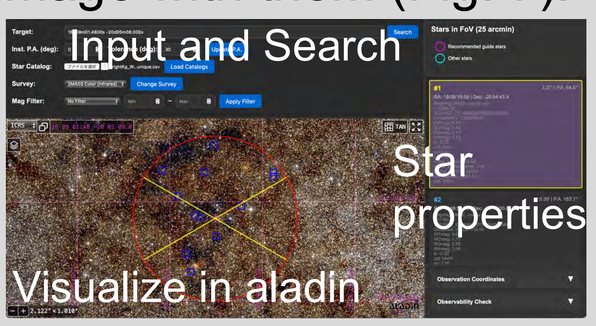


Fig. 7: Main screen and image on MIMIZUKU