Refining distance determinations with classical Cepheids – the distance to M33

Paulina Karczmarek
CAMK PAN

CAMK Annual Meeting
Warsaw, February 4-6, 2026

Science and outreach activities 2025 in a nutshell

Observations

- OCM: May, November, total of 30 nights in 2025
- CNTAC coordination of OCM time for Chilean community
- SALT: Directors Time granted, in collab. with Bożena Czerny

Outreah

- Dzień Otwarty CAMK

Conferences

- 42nd PTA Meeting, 8-12.09.2025, Warsaw (contributed talk)

Seminars

- Villanova University, USA
- Sapienza University, Rome

Science and outreach activities 2025 in a nutshell

Publications

- 3 published (co-authored)
  - **D. Graczyk+, 2025, A&A 694A, 65,** *Surface brightness-colour relations of dwarf stars from detached eclipsing binaries: II. Extension of the calibrating sample*
  - **R. Rathour+, 2025, A&A 695A, 114,** *Non-evolutionary effects on period change in Magellanic Cepheids: II. Empirical constraints on non-linear period changes*
  - **Narloch+, 2025, A&A 697A, 30,** *Period–luminosity relations for Galactic Type II Cepheids in the Sloan bands*
- 2 submitted (co-authored):
  - **A. K. Mandal+, 2025,** *HALO I: Photometric continuum reverberation mapping of Fairall 9*
  - **B. Zgirski+, 2025,** *Distance to the Globular Cluster M 3 from the Infrared Surface Brightness Technique applied to RR Lyrae stars*
- 2 proceedings (1st author, co-authored)
- 1 reviewed (AAS)

Distance to M33 from NIR PLR of Cepheids – revisited and refined

Then (2013)

- 8.2-m VLT (Paranal, Chile)
- HAWK-I: FoV 7.5 × 7.5 arcmin^2
- max. alt. 30°
- 3–5 epochs in K, 1 epoch in J
- 26 Cepheids (6–74 d)

Now (2026)

- 3.8-m UKIRT (MKO, Hawaii)
- WFCAM: FoV 55 × 55 arcmin^2
- alt. 60–80°
- 7–10 epochs in J and K
- 265 Cepheids (6–105 d)

THE ASTROPHYSICAL JOURNAL, 773:69 (9pp), 2013 August 10
doi:10.1088/0004-637X/773/1/69

THE ARAUCARIA PROJECT. A DISTANCE DETERMINATION TO THE LOCAL GROUP SPIRAL M33 FROM NEAR-INFRARED PHOTOMETRY OF CEPHEID VARIABLES*

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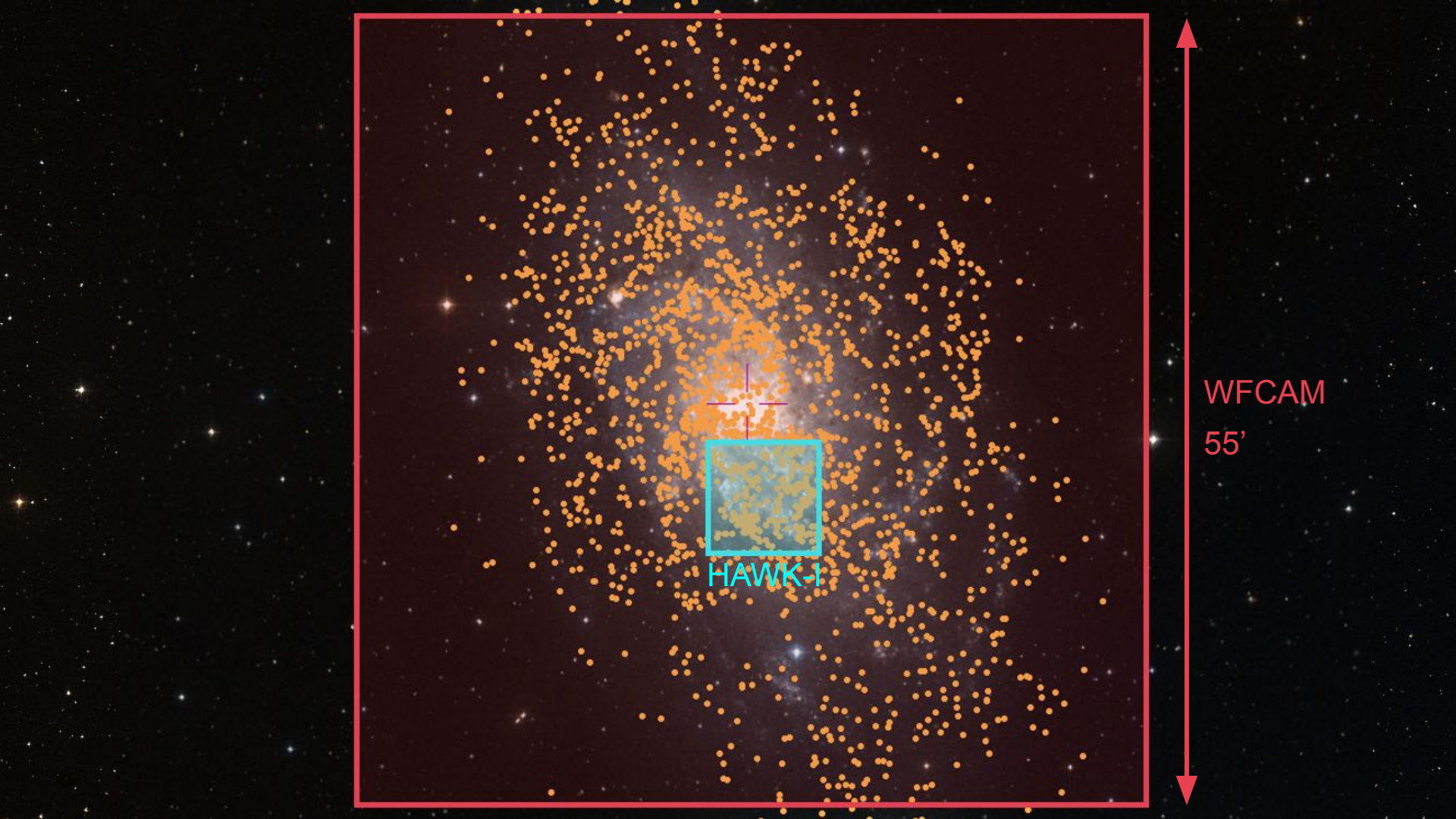
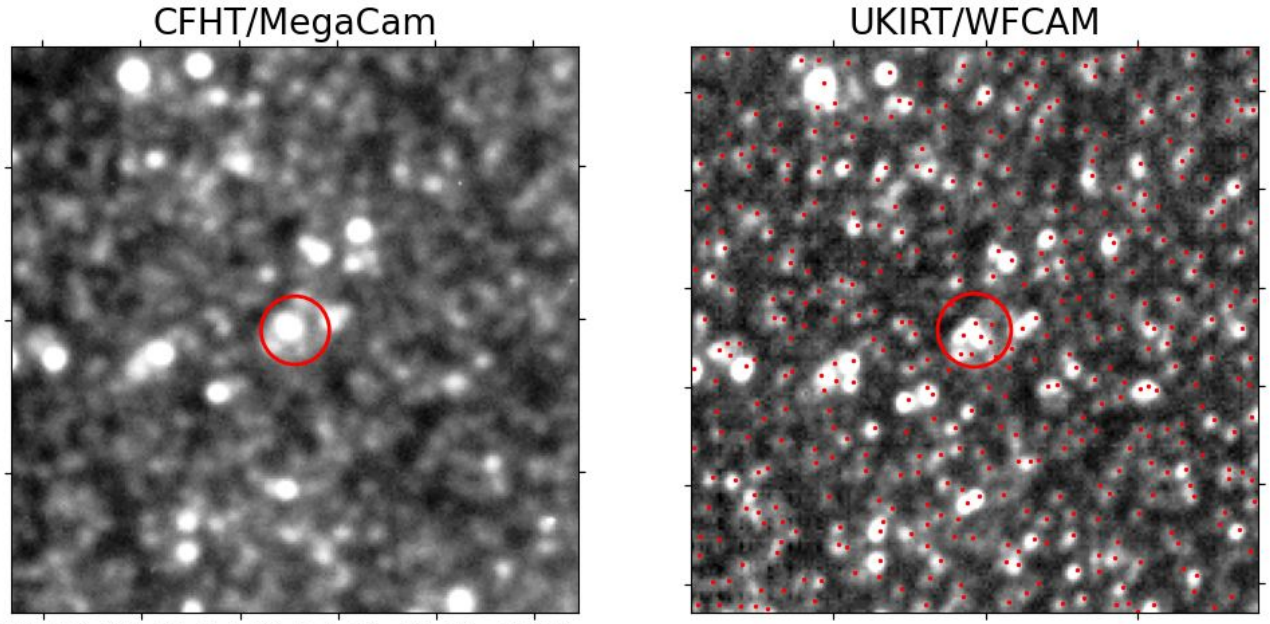
ABSTRACT

Motivated by an amazing range of reported distances to the nearby Local Group spiral galaxy M33, we have obtained deep near-infrared photometry for 26 long-period Cepheids in this galaxy with the ESO Very Large Telescope. From the data, we constructed period–luminosity relations in the *J* and *K* bands which together with previous optical *VI* photometry for the Cepheids by Macri et al. were used to determine the true distance modulus of M33, and the mean reddening affecting the Cepheid sample with the multiwavelength fit method developed in the Araucaria Project. We find a true distance modulus of 24.62 for M33, with a total uncertainty of ±0.07 mag which is dominated by the uncertainty on the photometric zero points in our photometry. The reddening is determined as $E(B-V) = 0.19 \pm 0.02$, in agreement with the value used by the *Hubble Space Telescope* Key Project of Freedman et al. but in some discrepancy with other recent determinations based on blue supergiant spectroscopy and binary which yielded lower reddening values. Our derived M33 distance modulus is extremely We show that the possible effects of metallicity and crowding on our fore minor contributors to the total uncertainty


HAWK-I
WFCAM
55’

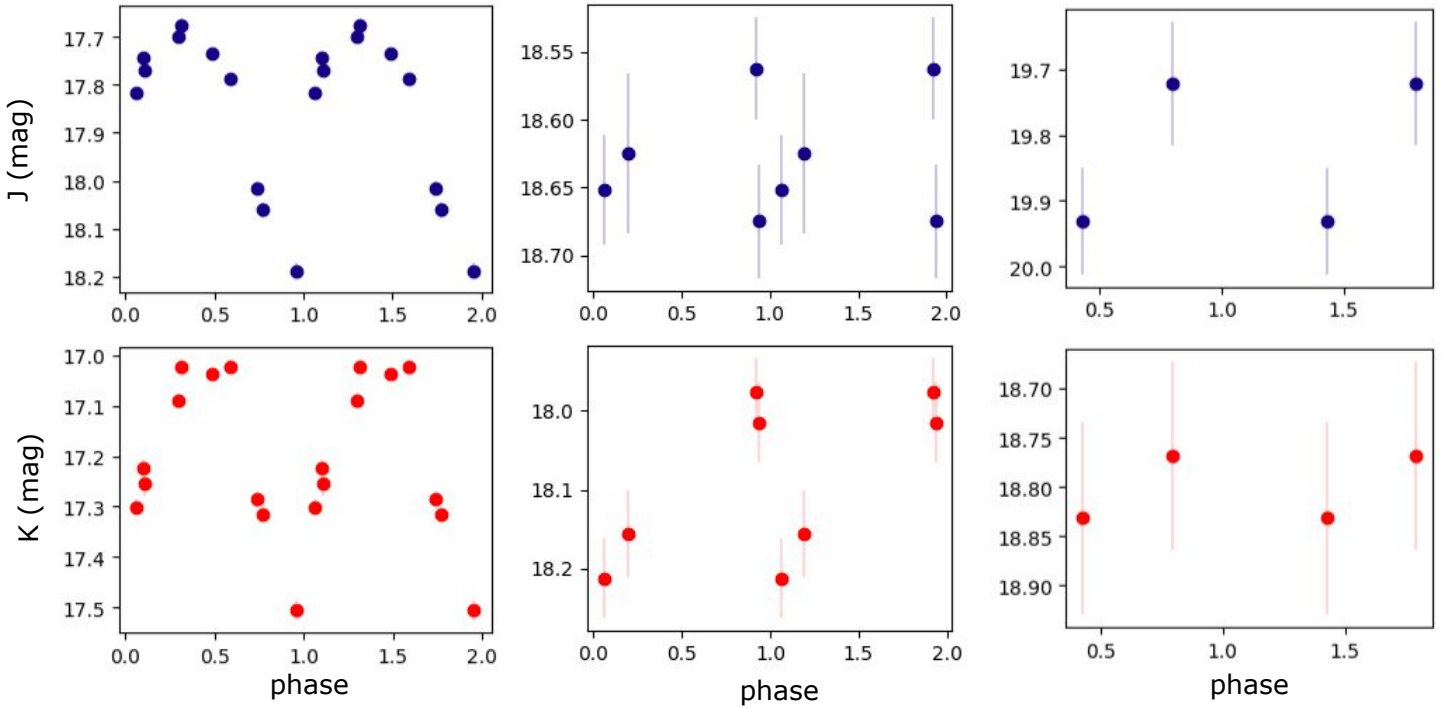
Detection of Cepheids

by location



Detection of Cepheids

by light curve



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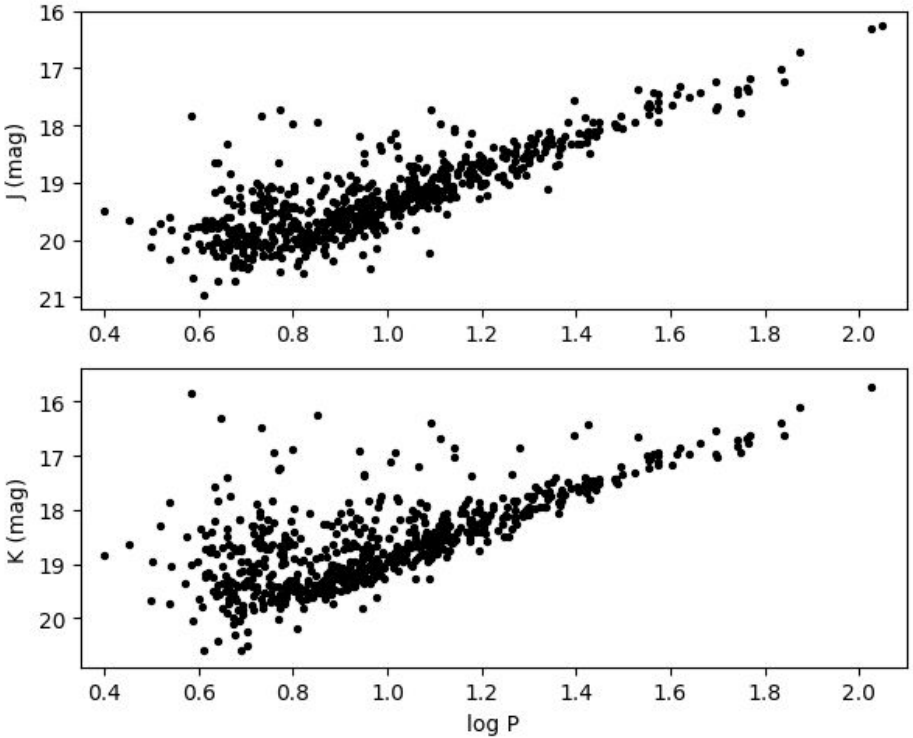
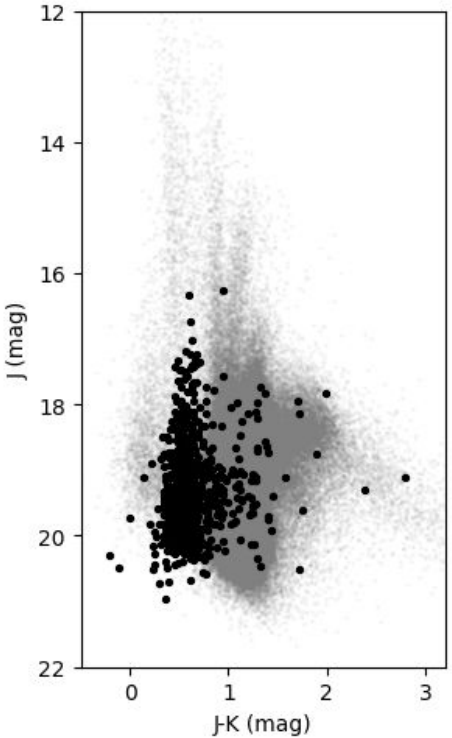
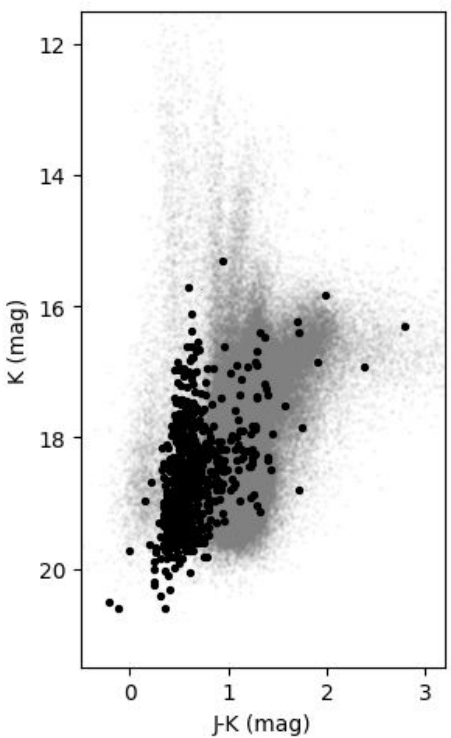
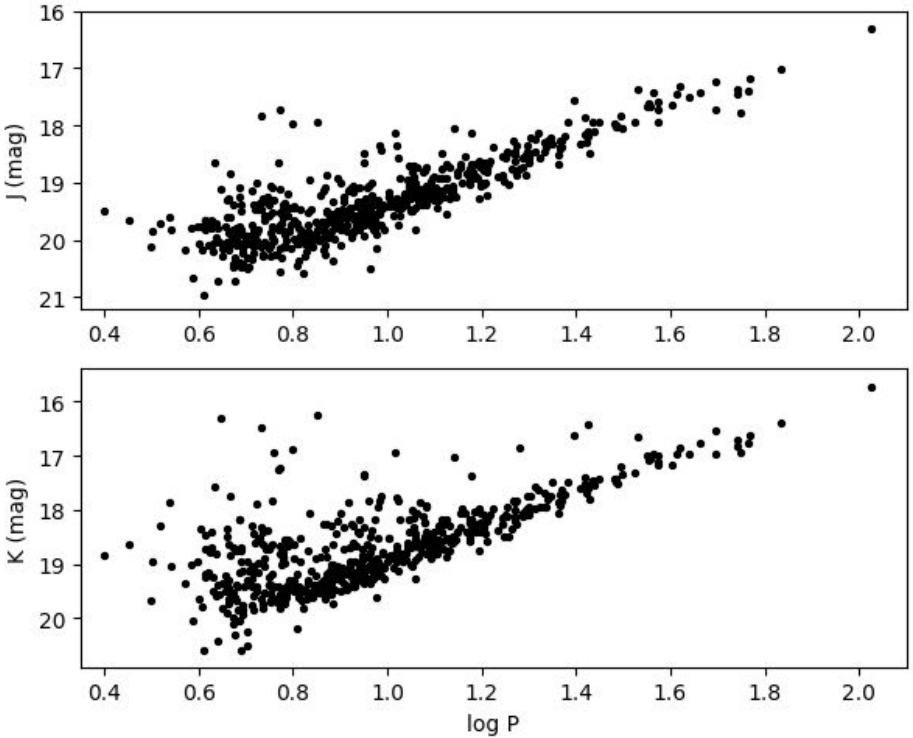


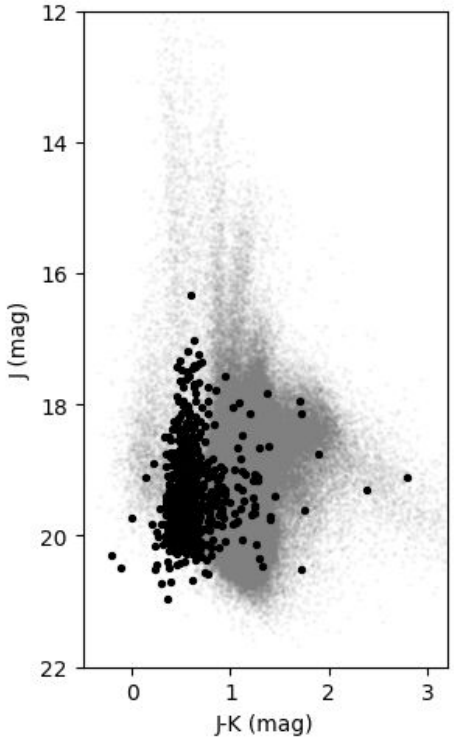


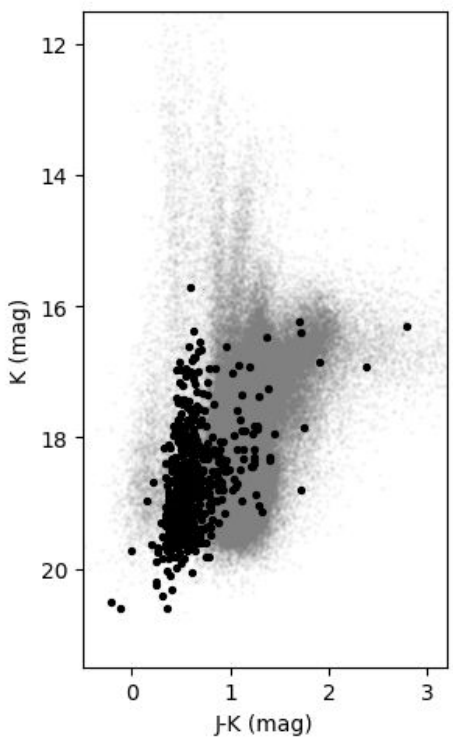


PLR & CMD

~~dubious location~~



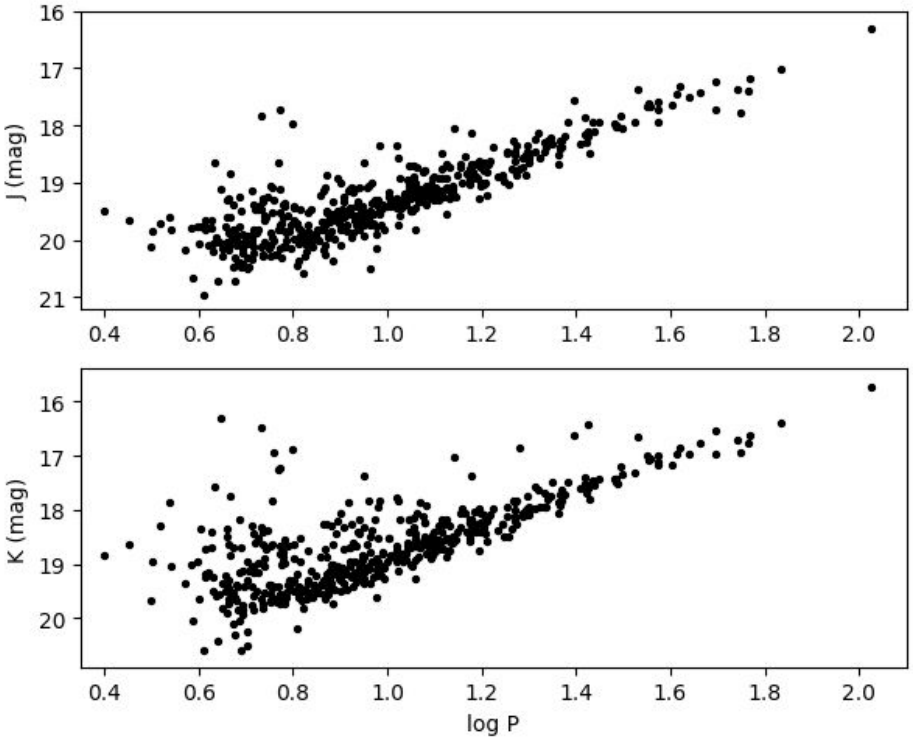


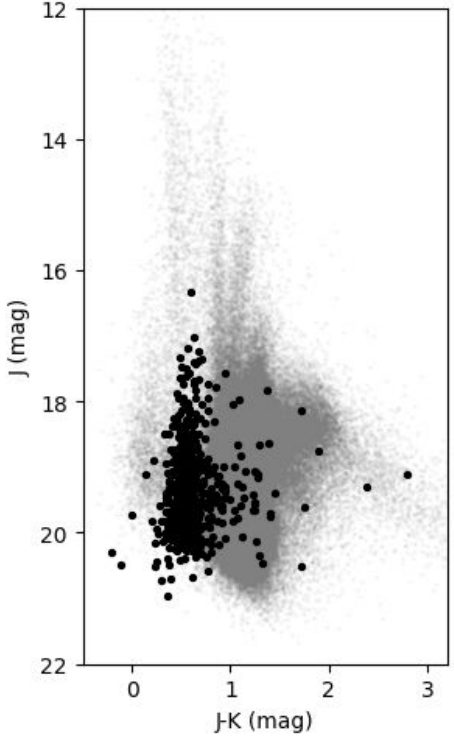


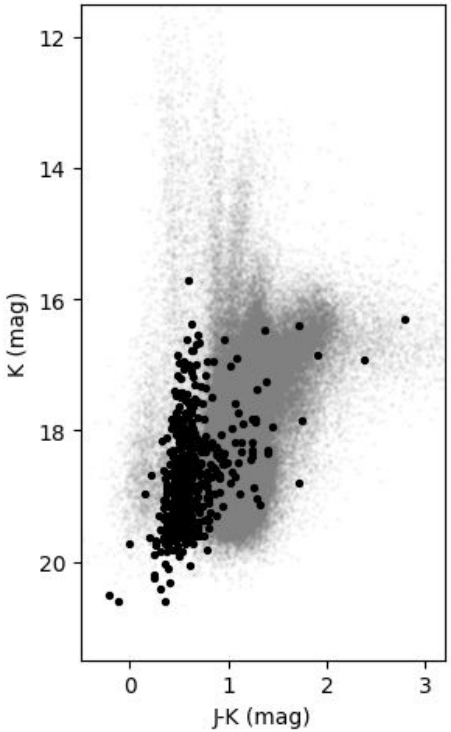
PLR & CMD

~~dubious location~~

~~dubious light curve~~



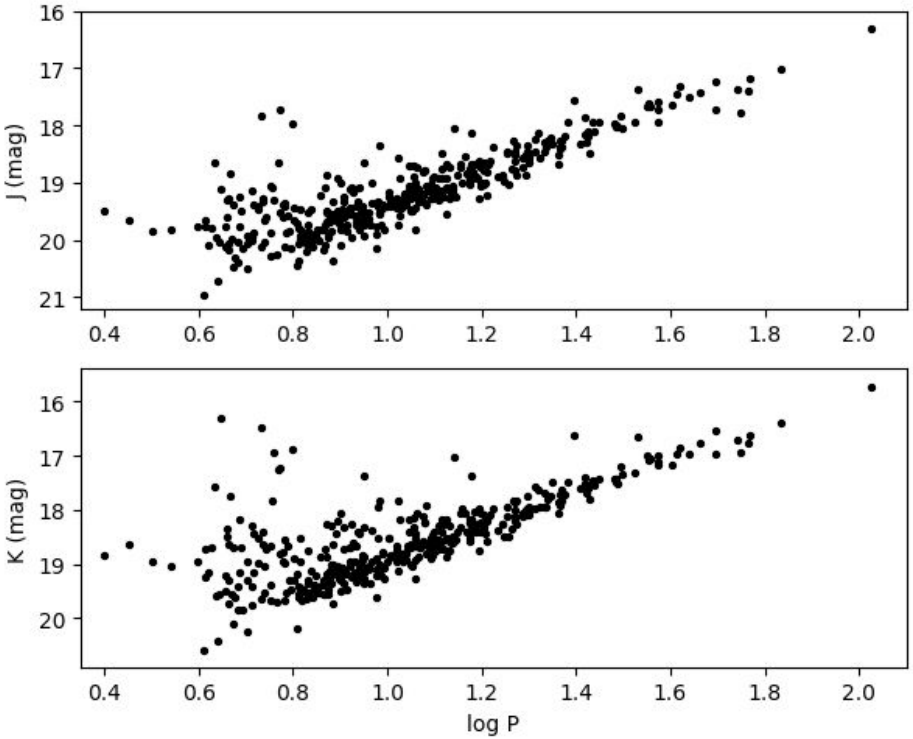


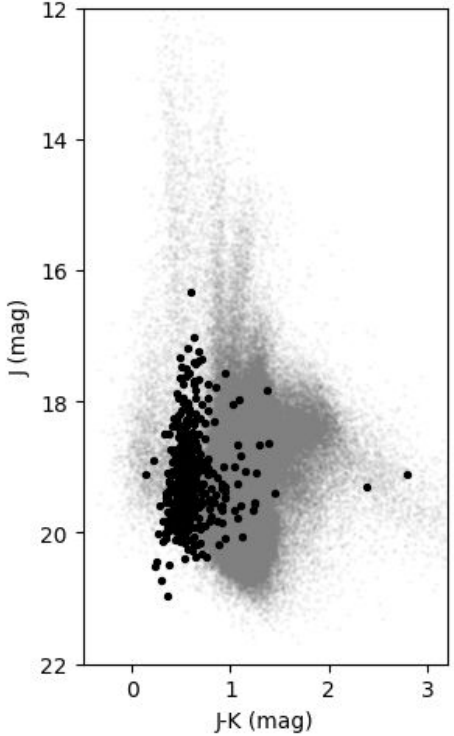


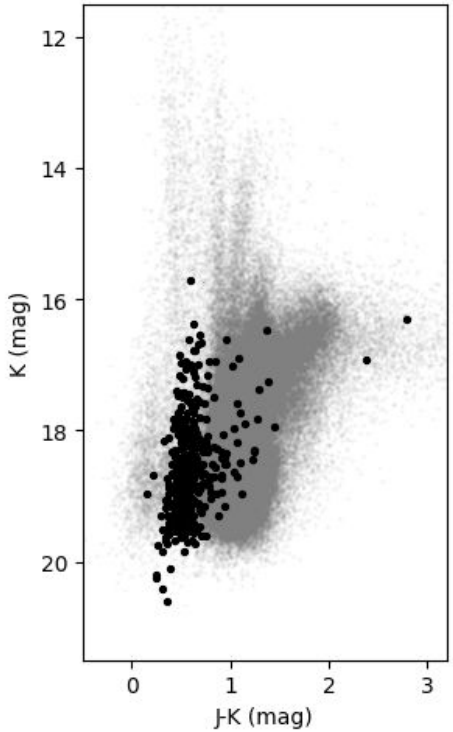
PLR & CMD

~~dubious location~~ ~~too few points~~

~~dubious light curve~~



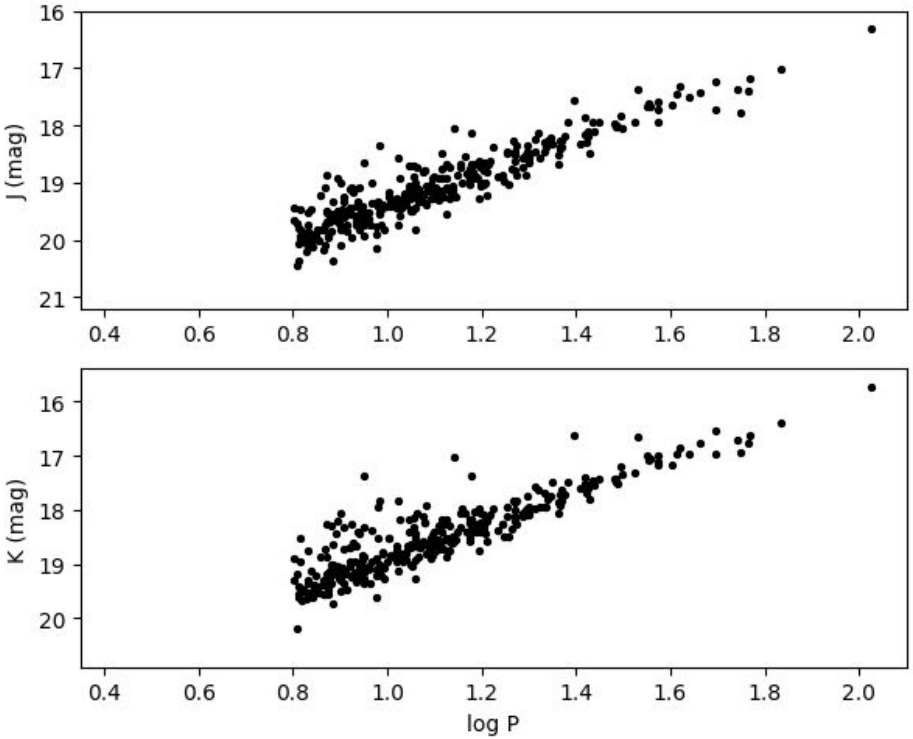


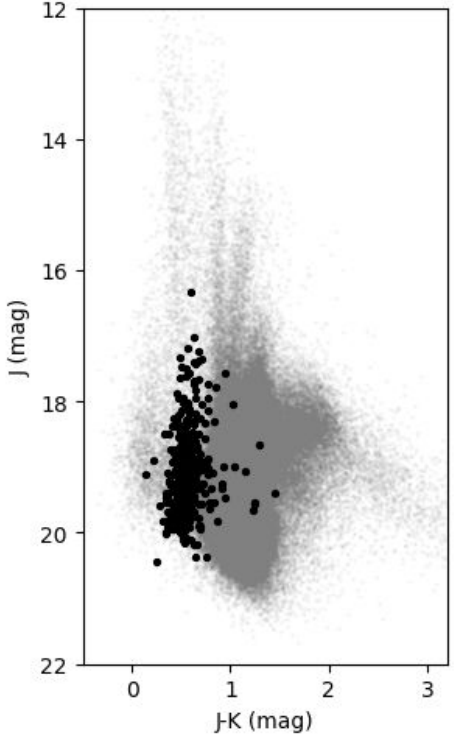


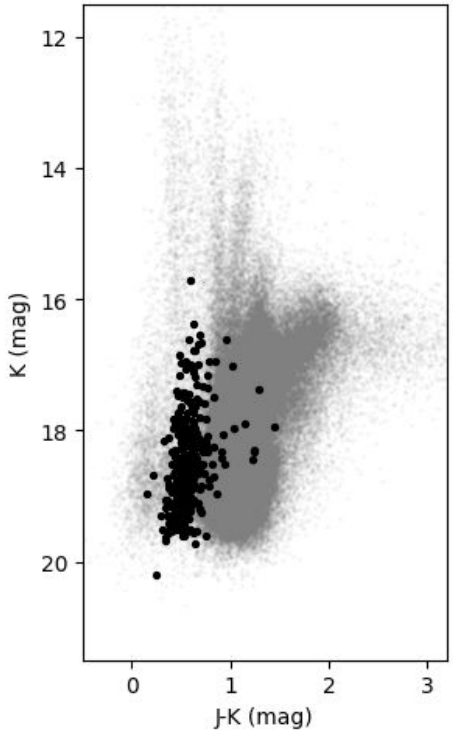
PLR & CMD

~~dubious location~~ ~~too few points~~

~~dubious light curve~~ ~~too short period~~







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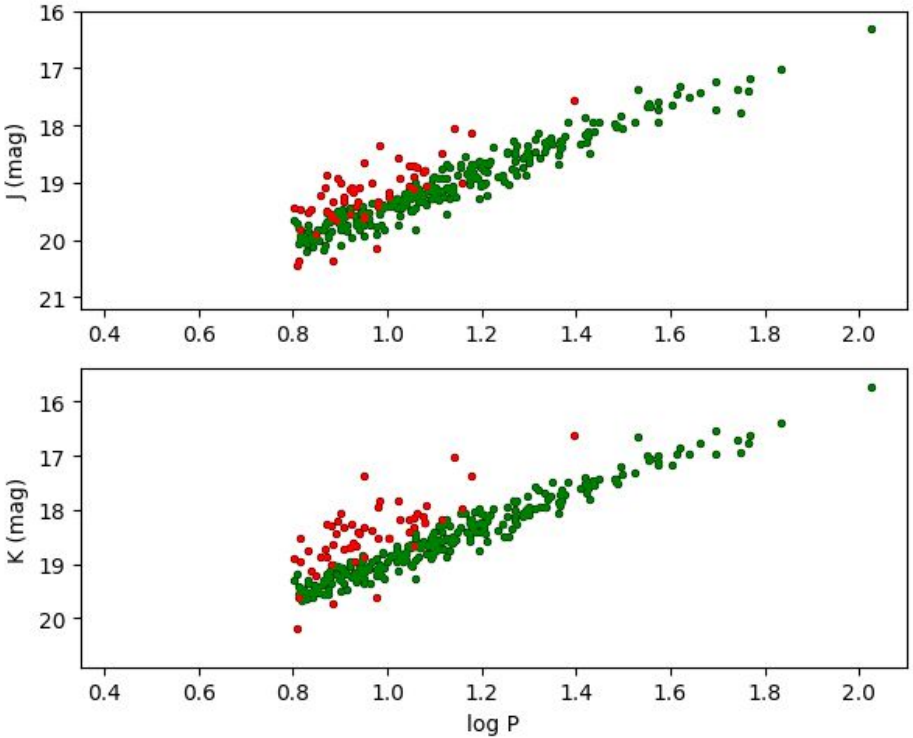
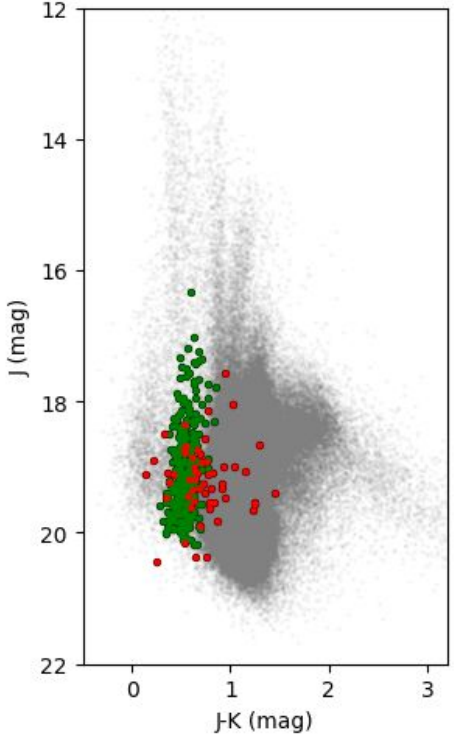
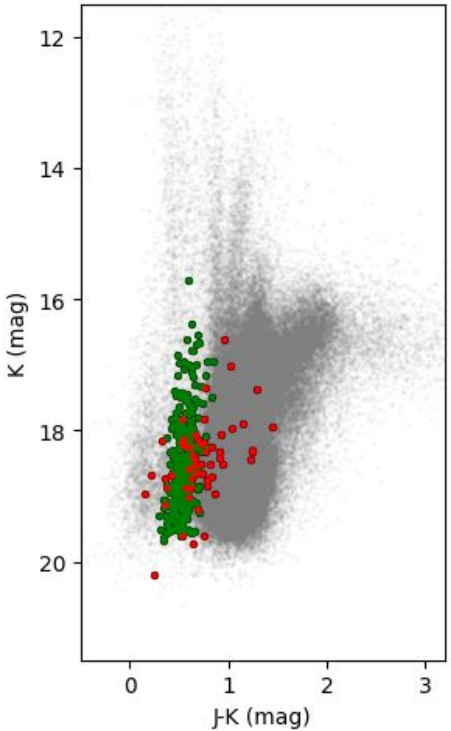
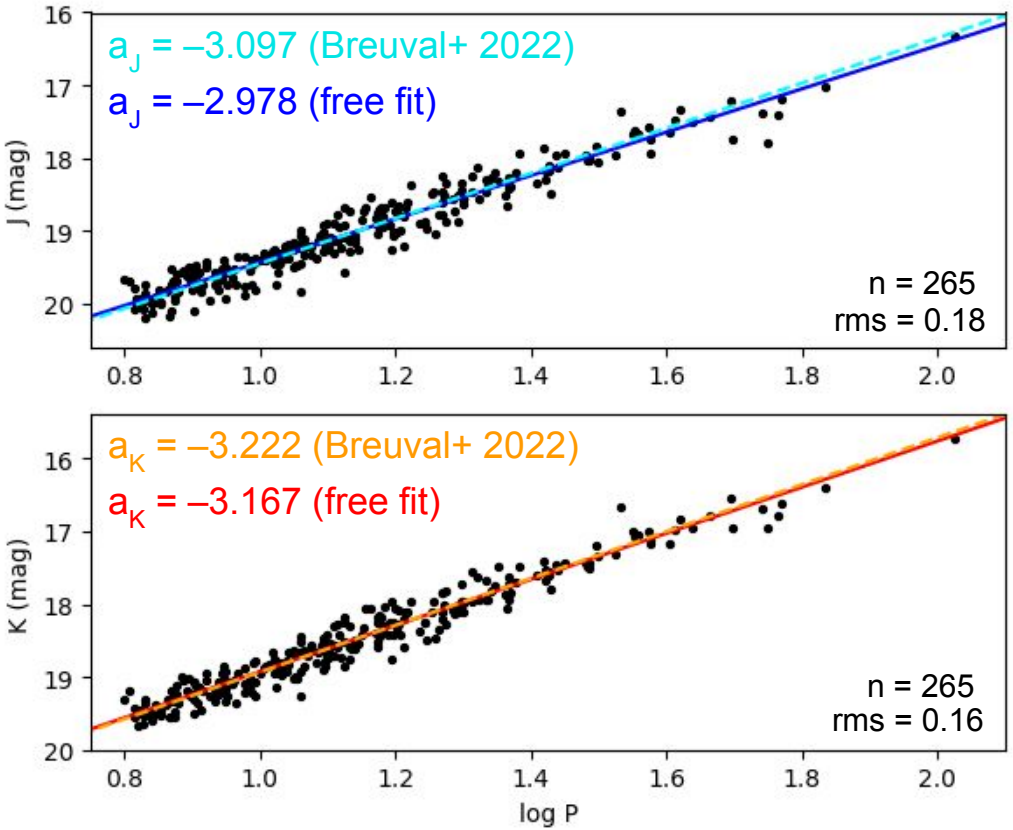
Gaussian Mixture Model







Distance modulus



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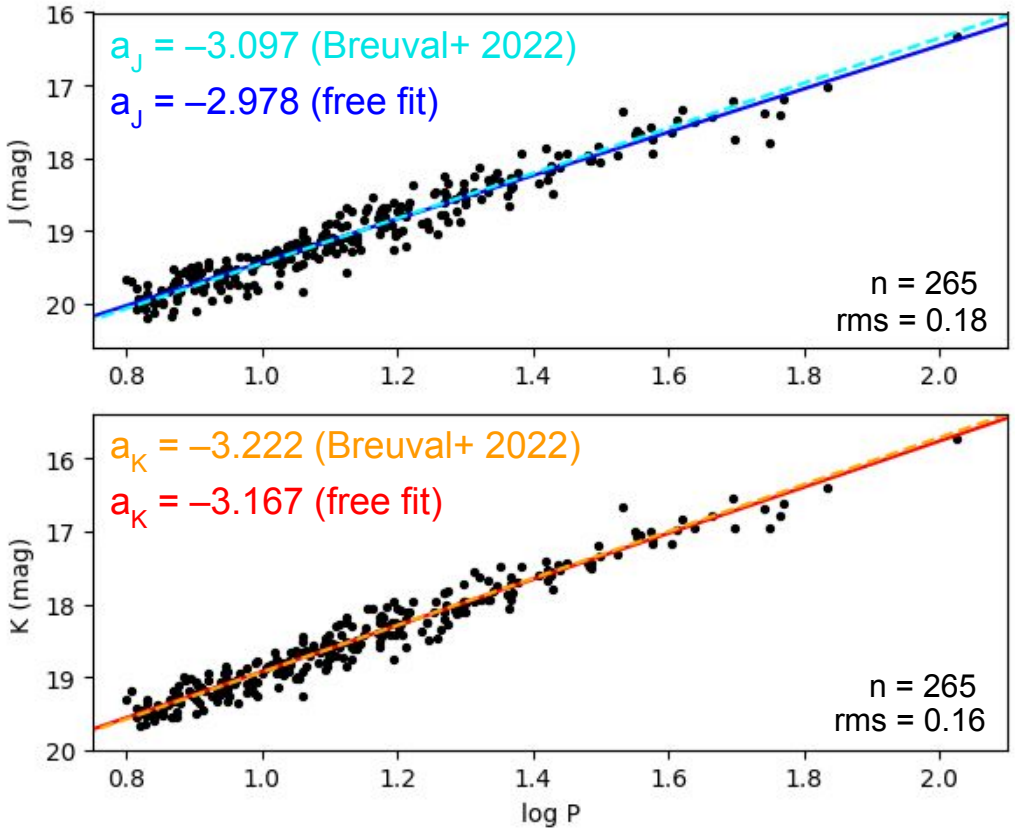

[Fe/H] = –0.3 dex

E(B-V) = 0.19 mag

LMC μ_0 = 18.477 mag

$$\mu_0 = 24.606 \pm 0.010_{stat} \pm 0.053_{syst}$$ mag

(Karczmarek+, in prep.)

Prospects for 2026-2027

- improved precision of the distance to M33
- metallicity gradient towards the center of M33
- distance determinations from TRGB, J-AGB
- distance determinations for M31, NGC 6822, Draco dSph