



THE ARAUCARIA PROJECT

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Main topics of the research within the Araucaria Project

- The extragalactic distance scale
 1. Calibration of the zero point of the distance scale
 2. Calibration of different methods of distance determination
 3. Determination of precise distances to members of Local Group and other close galaxy groups
- Determination and understanding of physical properties of stars used as standard candles:
 1. P-L (-colour) relations and p-factor for radially pulsating stars
 2. masses, radii, temperatures, etc.
 3. Recalibration of stellar surface brightness – color relations
 4. Evolution of interacting binary stars (BEPs, etc.)

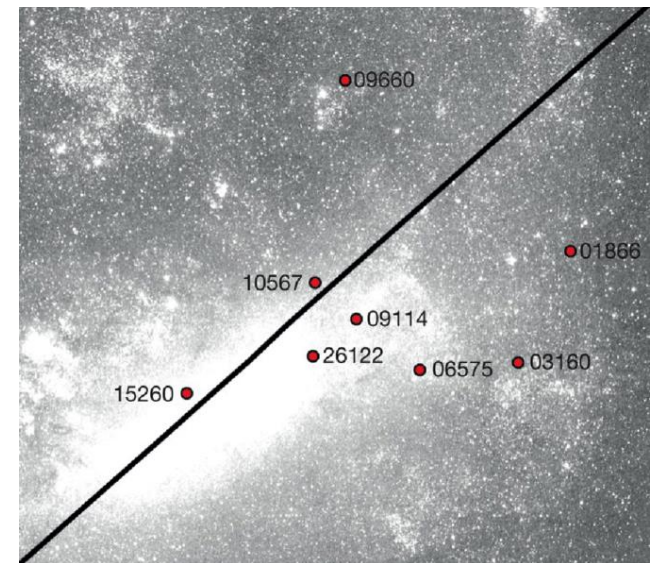
The calibration of the zero point of the extragalactic distance scale with a precision of 1% - 2%

- Proper one-step calibration of cepheid P-L relations by:
 1. using Galactic Cepheids with known trigonometric parallaxes (**3%-4%** - GAIA DR2)
 2. direct determination of a distance to an anchor galaxy:
 - a. the Large Magellanic Cloud (LMC)
 - b. nearby large spiral galaxies rich with Cepheids (e.g. megamaser galaxy NGC 4258, **3%** - Humphreys+2013)
- One-step distance to the LMC
 1. Baade – Wesselink distances for a number of LMC Cepheids (**5%**)
 2. Eclipsing binary distance from
 - a. Early type massive eclipsing binaries (**4%-5%** - Guinan,Ribas,Fitzpatrick+)
 - b. Eclipsing binaries consisting of late type giants (**1%-2%**)

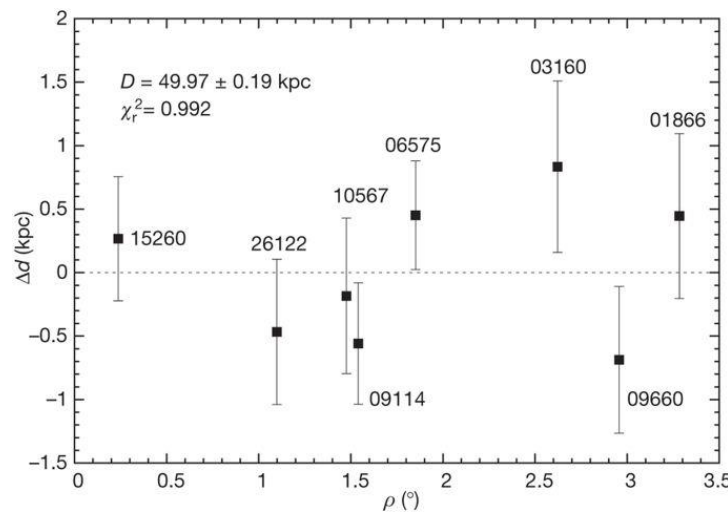
Eclipsing binary distance to the LMC

(Pietrzyński+2013)

- 8 eclipsing binary star giants lying close to a galaxy center



- standard candle used: the SBC relation from di Benedetto (2005), precision of about **2%** for G-K giant stars
- distance to LMC barycenter: $50.0 \text{ kpc} \pm 0.2 \text{ kpc} \pm 1.1 \text{ kpc}$

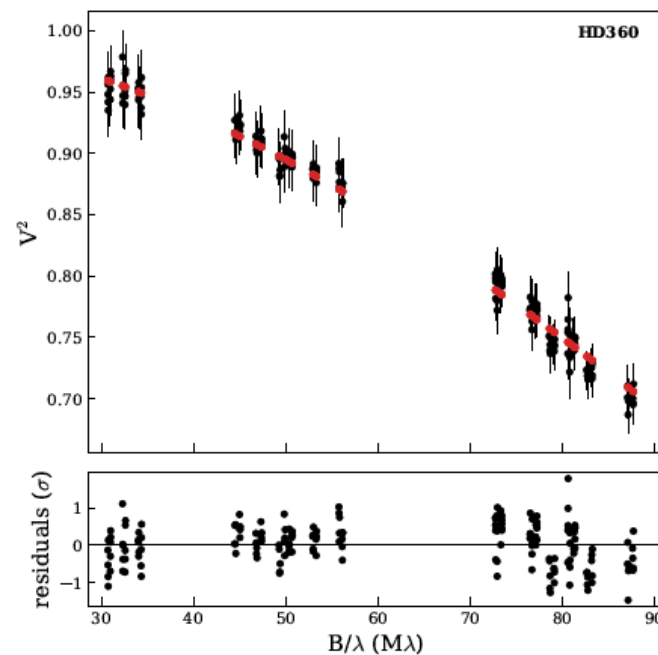
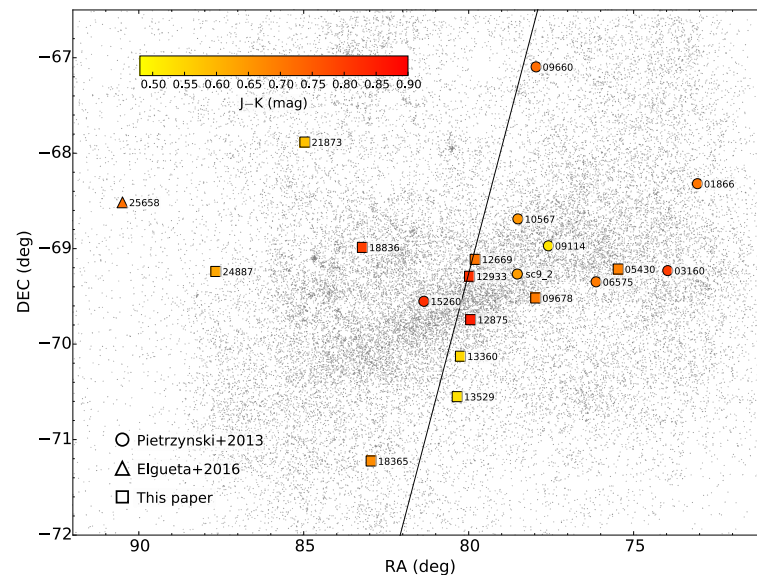


Revised eclipsing binary distance

(Graczyk+2018, Gallenne+2018, Pietrzyński+2019)

- 20 eclipsing binary late type stars
(Graczyk+2018)

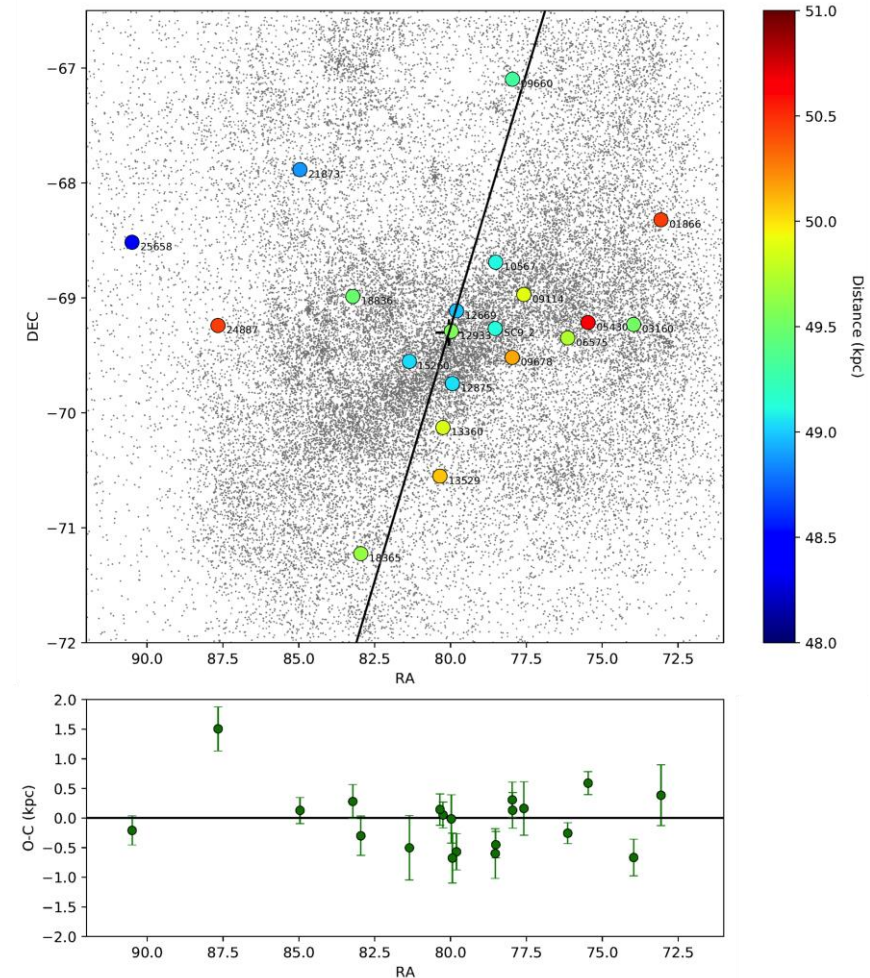
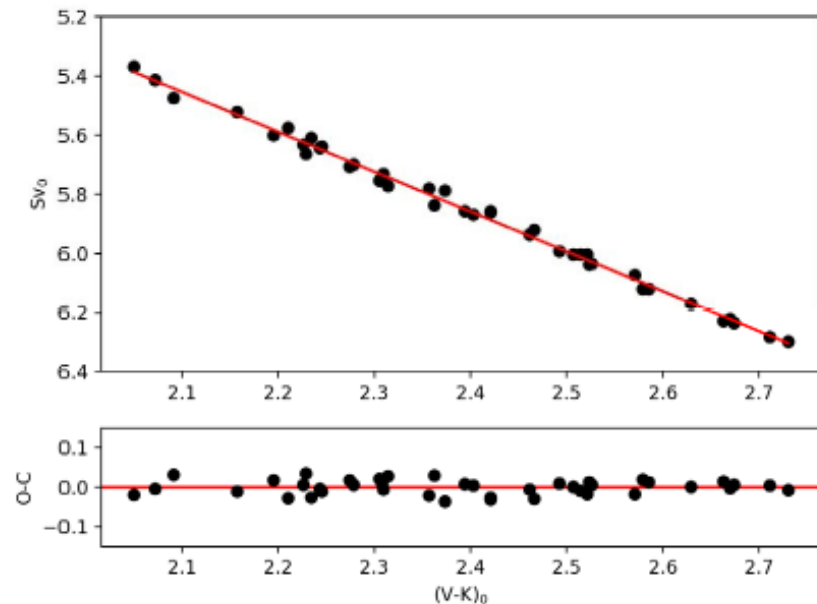
- Angular diameters of 40 nearby red clump stars (PIONIER, VLTI, Gallenne+2018)



Revised eclipsing binary distance

(Graczyk+2018, Gallenne+2018, Pietrzyński+2019)

- The new surface brightness - color calibration (**0.8%** precision)



- The revised distance is precise to **1.1%** (Pietrzyński+2019, Nature)

The Cerro Murphy/Armazones Observatory

1995 – 2018/19
Bochum University/Catholic
University of the North
(German/Chile)

2019/20 –
CAMK (Poland)



- 80 cm / IRIS / IR camera 1k x 1k
 - 40 cm / VYSOS 16 / visual CCD 4k x 4k
 - 25 cm / BEST / visual CCD 4k x 4k
 - 15 cm / VYSOS 6 / 2 visual CCD 4k x 4k
- BESO HR spectrograph (1.5 m Hexapod)
- Potsdam 0.5m telescope

The Cerro Murphy/Armazones Observatory

- **ONGOING** projects:
 1. IRIS: IR photometry of Galactic Cepheids, T2 Cepheids, RR Lyr stars and eclipsing binary stars
 2. VYSOS 16: used mostly by Bochum group (AGNs), optical photometry of RR Lyr stars and T2 Cepheids
 3. BEST and VYSOS 6 are used by Bochum group (extragalactic research)
- **PLANNED** projects:
 1. A new 1.4m telescope for HR spectroscopy and optical photometry
 2. A new 0.6m all-sky survey telescope, multi-band optical photometry