The Araucaria Project. The Distance to the Sculptor Group Galaxy NGC 7793 from Near-Infrared Photometry of Cepheid Variables

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We have performed deep near-infrared J- and K-band photometry of a subsample of Cepheids in the Sculptor Group spiral galaxy NGC 7793. It allowed to derive the distance to this galaxy with a higher accuracy than what was possible from optical photometry alone, by minimizing the effects of reddening and metallicity on the distance result. Combining our new near-infrared period-luminosity relations with the previous optical photometry, we obtain the true distance modulus to NGC 7793 of 27.66 ± 0.04 mag (statistical) ± 0.07 mag (systematic), i.e. the distance of 3.40 ± 0.17 Mpc. We also determine the mean reddening affecting the Cepheids to be $E(B-V) = 0.08 \pm 0.02$ mag.

We present our first near-infrared period-luminosity relations for Cepheids in NGC 7793. Using these data and optical data published before by Pietrzyński et al. (2010), we measured an accurate distance to this galaxy based on four filters (V, I, J, K). The near-infrared (NIR) data were collected with the HAWK-I camera installed on the VLT telescope in Cerro Paranal Observatory, Chile during two observing nights of 5 and 18 September 2011. From the optical catalogue of 14 Cepheids in NGC 7793 (Pietrzyński et al., 2010), we were able to identify 11 of them in our NIR images. Ten Cepheids have photometry from two HAWK-I nights and additionally one Cepheid has photometry from one of these nights.

Assuming well-defined slopes in the near-infrared relations of the Large Magellanic Cloud (LMC) by Persson et al. (2004), we fitted straight lines to the period-luminosity relations of Cepheids in NGC 7793 using the least-squares method. We adopted well-determined distance to the LMC with Pietrzyński et al. (2013)'s result as a zero point and fiducial intercepts of period-luminosity relations for near-infrared bands for the LMC established by Persson et al. (2004).

The observed distance modulus can be expressed in the following way:

$$(m-M)_\lambda = (m-M)_0 + R_\lambda E(B-V) \tag{1}$$

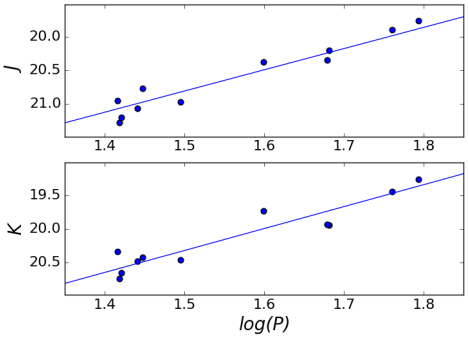

Fig. 1: NIR period-luminosity relations for Cepheids in NGC 7793. Corresponding slopes were adopted from Persson et al. (2004). Periods are in days.

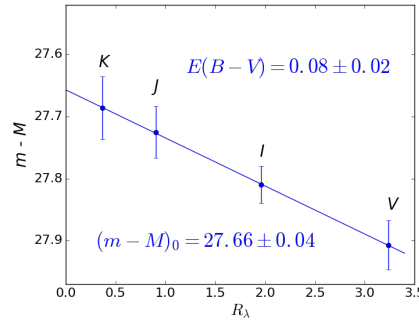

Fig. 2: Apparent distance moduli to NGC 7793 plotted against the ratio of total to selective extinction as adopted from Schlegel et al. (1998).

where $(m-M)_0$ is the true distance modulus, $E(B-V)$ is color excess, and R_λ is the ratio of extinction in a given band to color excess.

Assuming the reddening law of Schlegel et al. (1998), we calculate the true distance modulus to NGC 7793:

$$(m-M)_0 = 27.66 \pm 0.04(statistical) \pm 0.07(systematic) \quad (2)$$

This result agrees with previous TRGB (Tip of the Red-Giant Branch) determinations, and it is significantly improved compared to the optical work Pietrzyński et al. (2010). A paper concerning this research has been published in The Astrophysical Journal under the same title (Zgirski et al., 2017).

Acknowledgements. The research leading to these results has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 695099). Research supported from the IdP II 2015 0002 64 grant of the Polish Ministry of Science and Higher Education.

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