Araucaria Project – Main Goal Improve the cosmic distance scale based on observations of several primary distance indicators in nearby galaxies. Cepheids (VIJK, HR Spec.) Blue supergiants (VIJK, MR Spec.) red clump (IJHK, HR Spec.) **RR** Lyrae (VIJK) TRGB (IJK)

Eclipsing binaries (VIJK, HR Spec.)



We can explain it with the current cosm. model - NO We have to revise: physics and / or errors ...



Eclipsing binaries

$d(pc) = 1.337 \times 10^{-5} \times r(km)/\varphi(mas)$



Light + RV curves analysis => $\sim 1 \%$ radii (e.g. Andersen 1991)



Late-type eclipsing binaries

$$d(pc) = 1.337 \times 10^{-5} \times r(km)/\varphi(mas)$$

 φ is derived from the surface brightness - color relation, very well established for late-type stars based on interferometric data (di Benedetto 1998, 2005; Kervella et al. 2004)

$$S_V = 2.656 + 1.483 \times (V - K)_0 - 0.044 \times (V - K)_0^2$$

$$\phi \,[\mathrm{mas}] = 10^{0.2 \cdot (S - m_0)}$$

Currently rms on such relation is 0.014 mag (0.8 % !)



20 systems in the LMC: 49.59 ± 0.09 (statistical) ± 0.54 (systematic) kpc (Pietrzynski et al. 2013 Nature, 567, 200)

15 systems in the SMC: 62.44 ± 0.47 (st.) ± 0.81 (sys.) kpc (Graczyk et al. 2020, ApJ, 904, 13)





Astrometric binaries



TZ For independent distances

Our method + SBCR: 185.1 \pm 2.0 (stat) \pm 1.9 (sys) pc The statistical error is dominated by error on the radius determination of the giant (better photometry needed). (Pietrzynski et al 2019)

spectroscopic and astrometric orbits 186.1 ± 1.0 (stat+syst) pc (Gallenne et al. 2016)

Gaia DR2 parallax is: 183.4 ± 0.8 (stat) pc

However TZ For is an astrometric binary whose aparent orbital motion is unmodeled in the DR2 data reduction.

We will provide a check on Gaia parallaxes at a 1% precision level in a large range of distances ...



OCA – dedicated observatory

1) Eclisping binaries < 0.7% (SPICA, PIONIER)
 2) Distances to more galaxies
 3) 25 astrometric binaries to check on DEB

