CAMK Annual Meeting 2023

Grzegorz Pietrzynski

Araucaria PROJECT

The Araucaria team members (17 countries, 4 continents)

The Hubble constant

=> Physical and energetic scale in the Universe

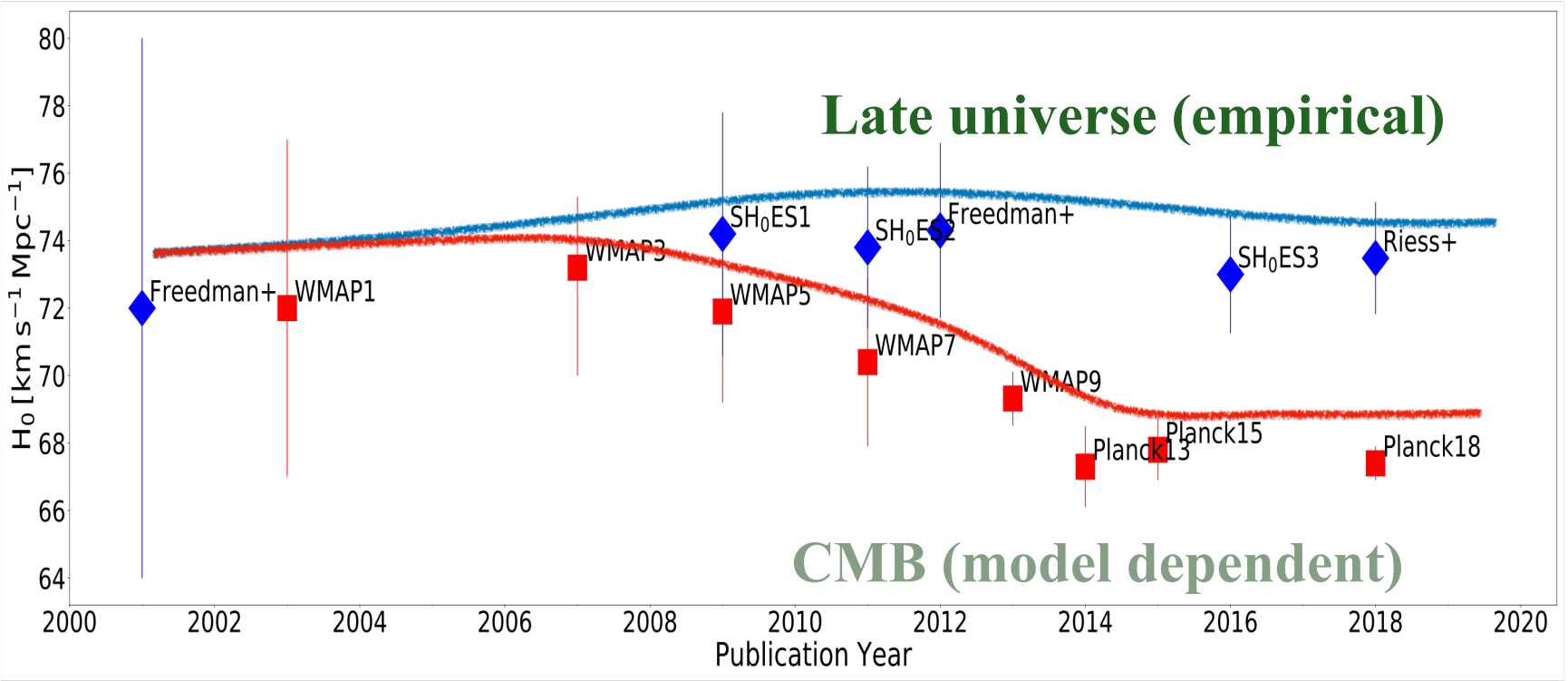
⇒ The evolution of the Universe

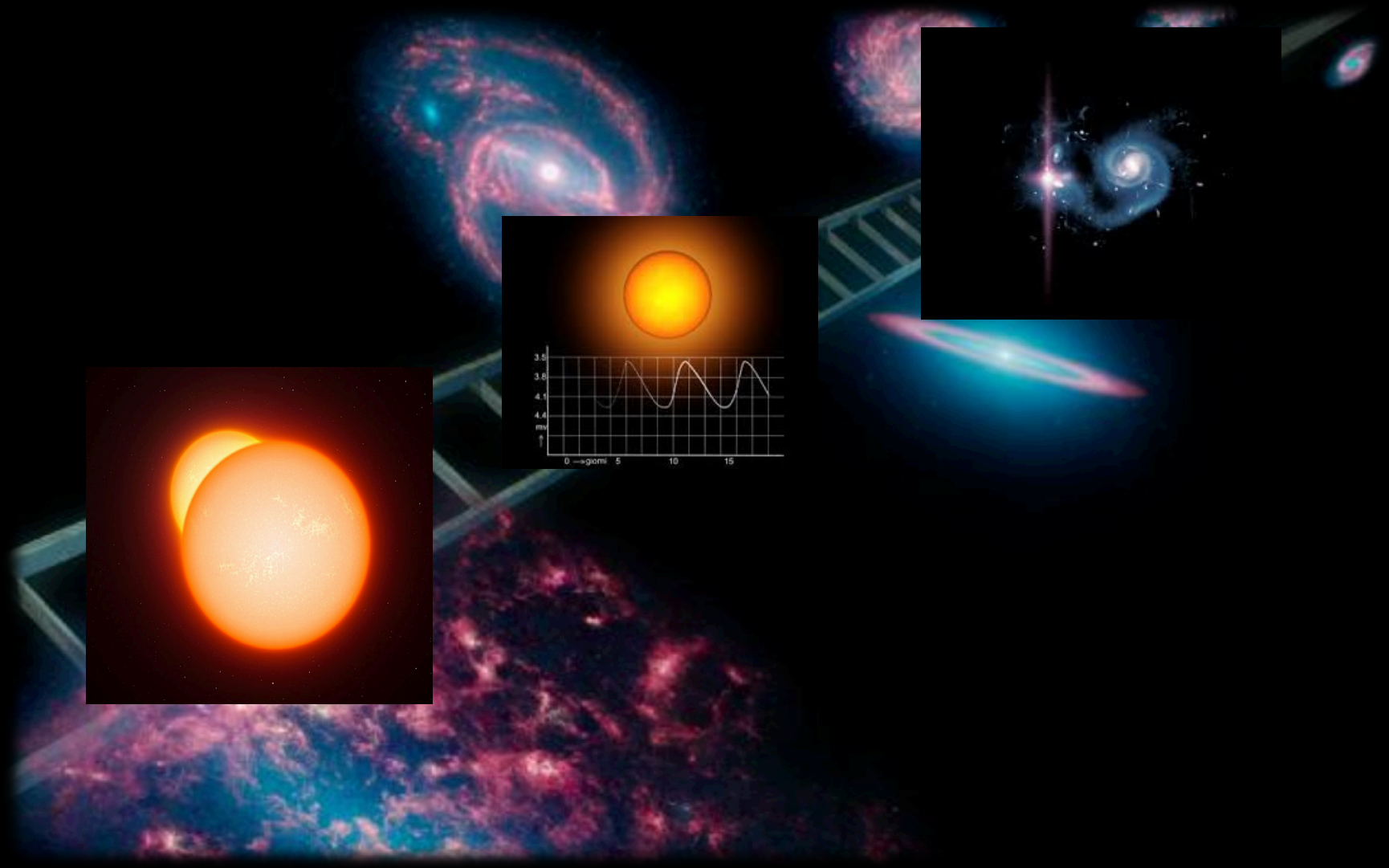
$$H^2 \equiv \left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G}{3}\rho - \frac{kc^2}{a^2} + \frac{\Lambda c^2}{3},$$

$$t_H \equiv \frac{1}{H_0} = \frac{1}{67.8(\mathrm{km/s})/\mathrm{Mpc}} = 4.55 \cdot 10^{17}\mathrm{s} = 14.4 \text{ billion years.}$$

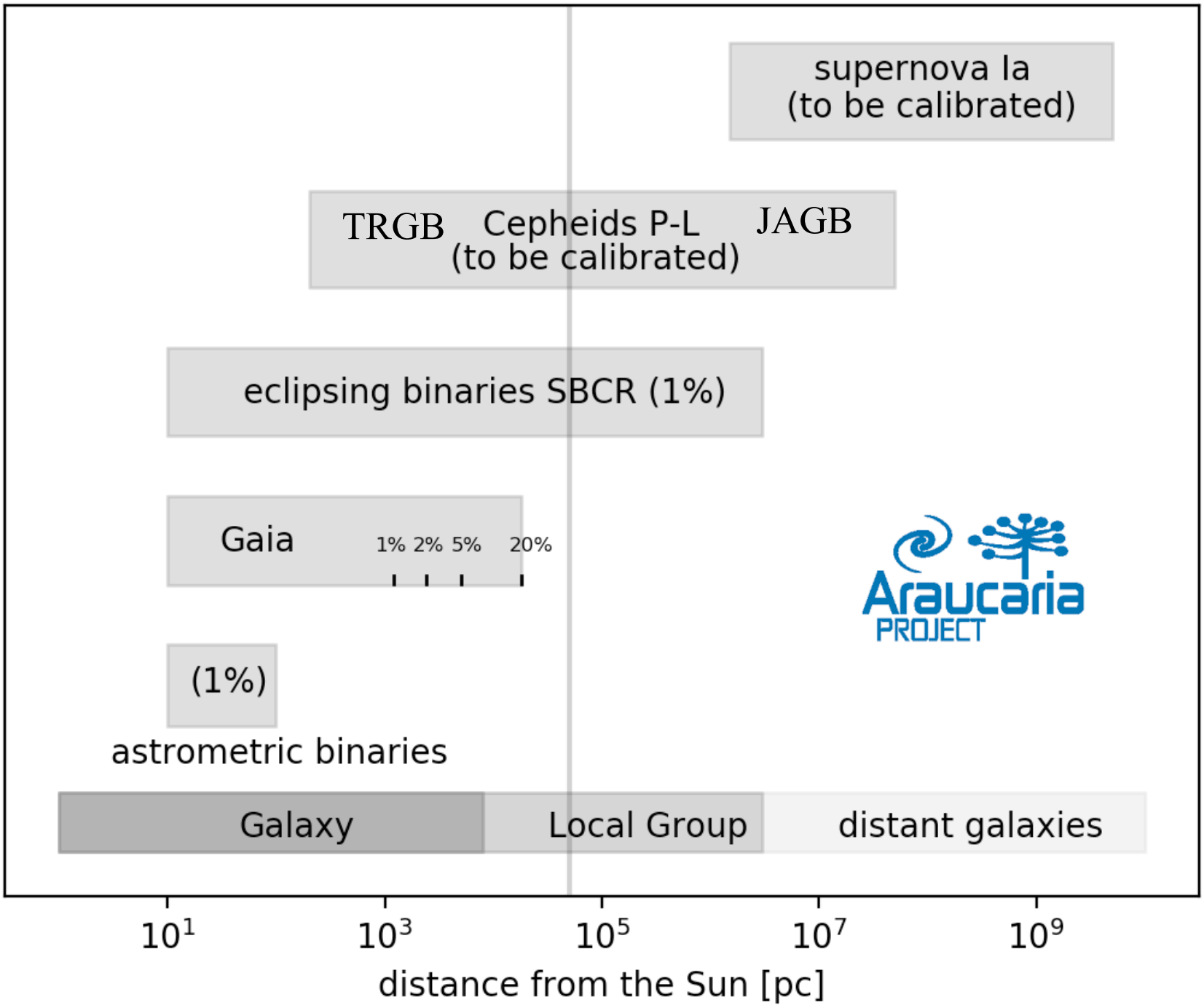
=> Testing modern physics and unique way to verify the physical nature of mysteriuos dark energy

The Hubble constant tension





„Classical” method based on geometrical distances and standard candles.


supernova Ia
(to be calibrated)
TRGB
Cepheids P-L
(to be calibrated)
JAGB
eclipsing binaries SBCR (1%)
Gaia
1% 2% 5% 20%
Araucaria
PROJECT
(1%)
astrometric binaries
Galaxy
Local Group
distant galaxies
10^1
10^3
10^5
10^7
10^9
distance from the Sun [pc]

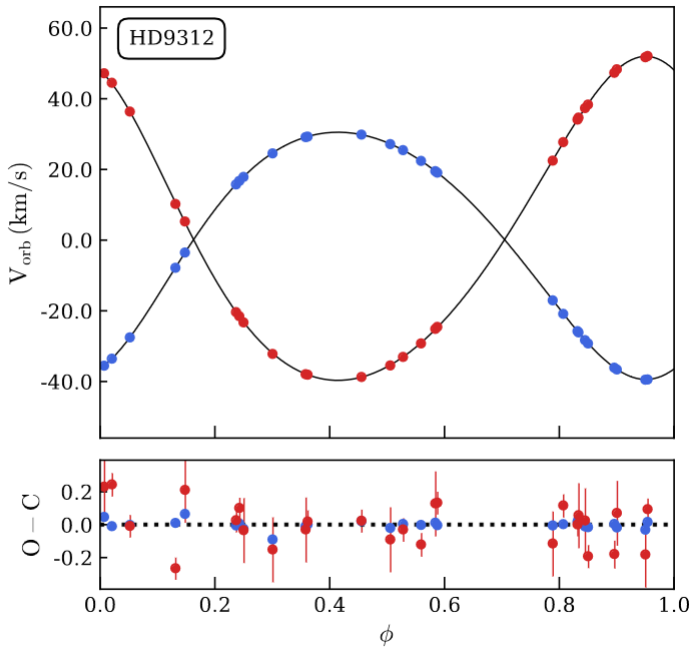
A&A 672, A119 (2023)
https://doi.org/10.1051/0004-6361/202245712

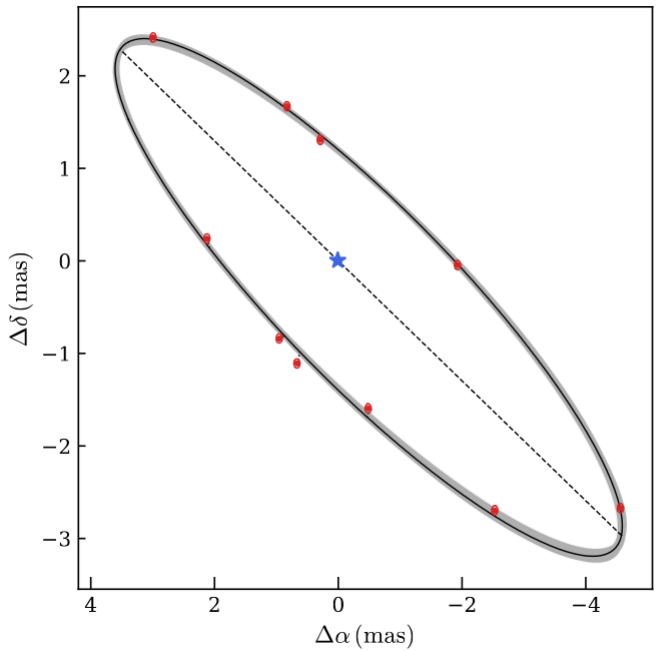
Astronomy & Astrophysics

The Araucaria project: High-precision orbital parallaxes and masses of binary stars

I. VLTI/GRAVITY observations of ten double-lined spectroscopic binaries★

A. Gallenne[1,2], A. Mérand[3], P. Kervella[4], D. Graczyk[5], G. Pietrzyński[6], W. Gieren[1], and B. Pilecki[6]



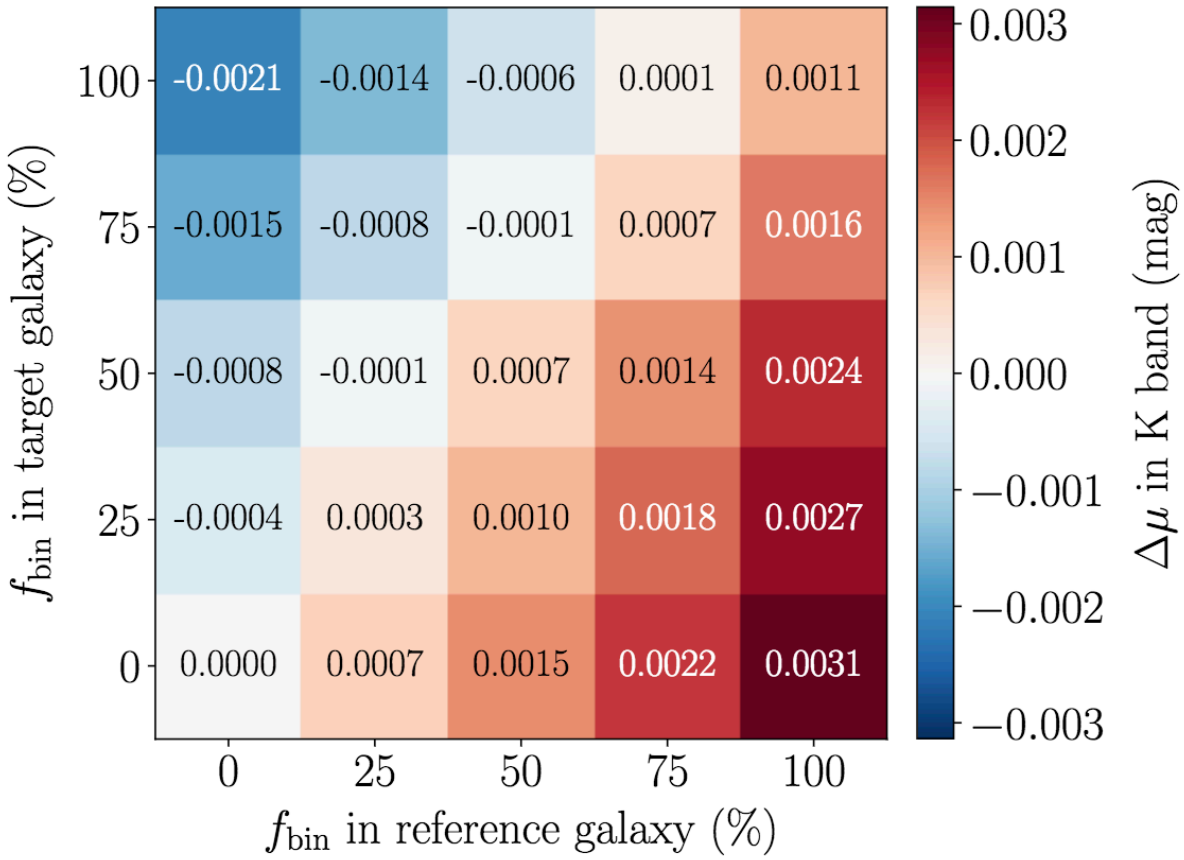


10 systems:

masses **0.03%** (0.2% average)
distances **0.08%** (0.3% average)

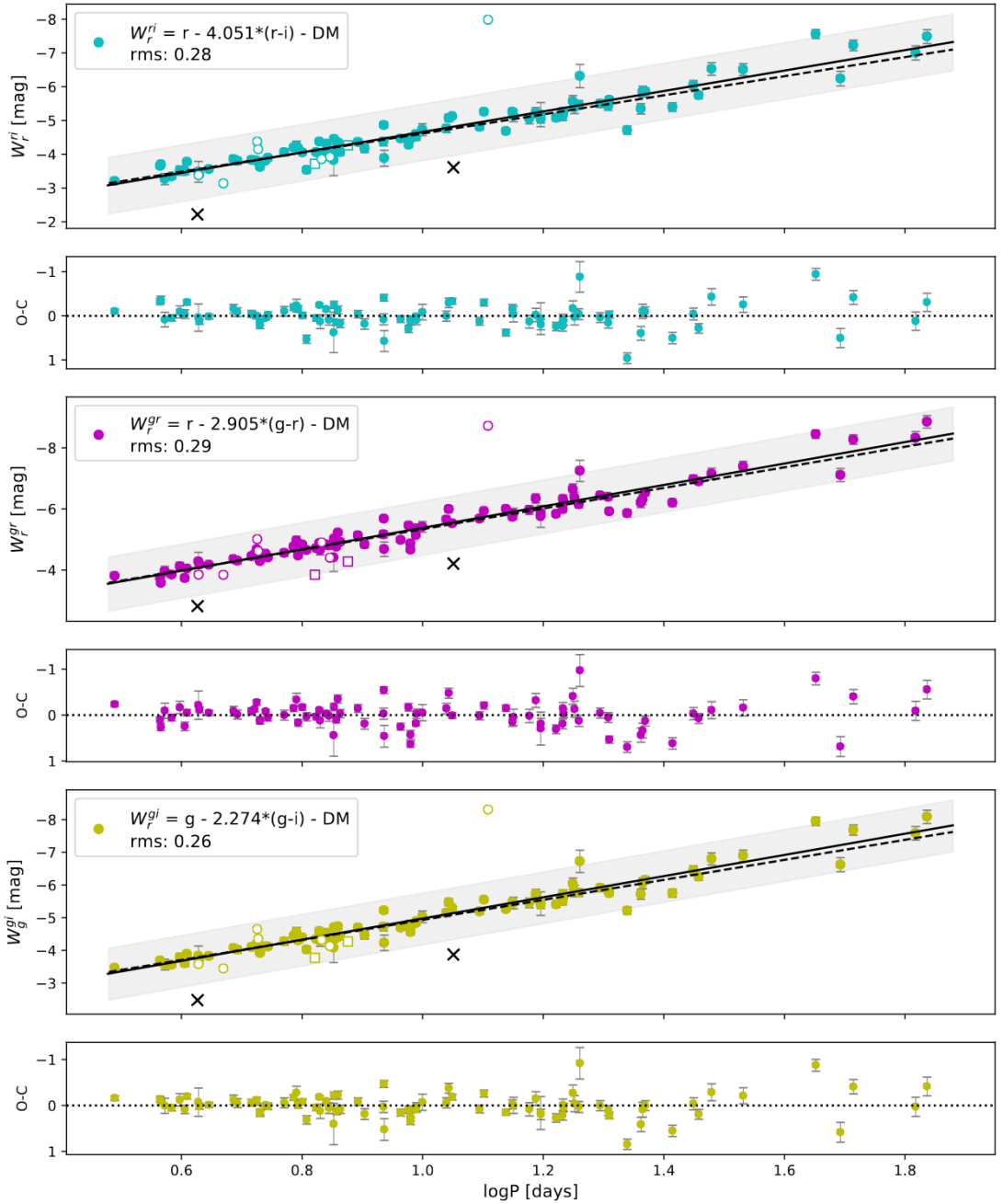
Araucaria PROJECT

Standard candles – binarity Cepheids
Karczmarek et al. 2023 (Belczynski)

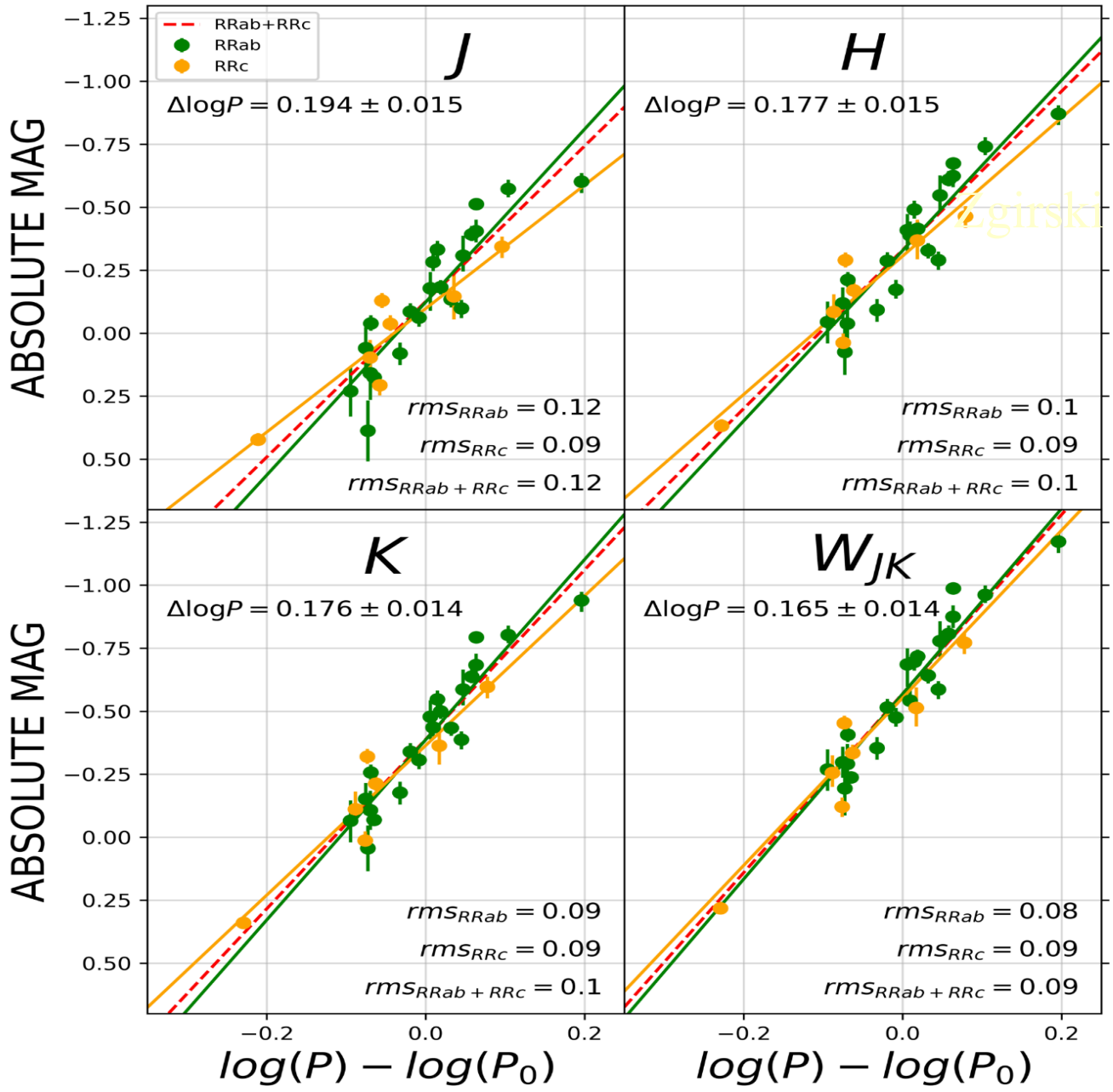


the binarity of Cepheids
does not change the value of H0, but does increase the statistical error on H0 by 0.07 km/s/Mpc or 0.1%

Narloch et al.2023, Cepheid P-L in Sloan bands



Zgirski et al. 2023 P-L ralations for RR Lyrae



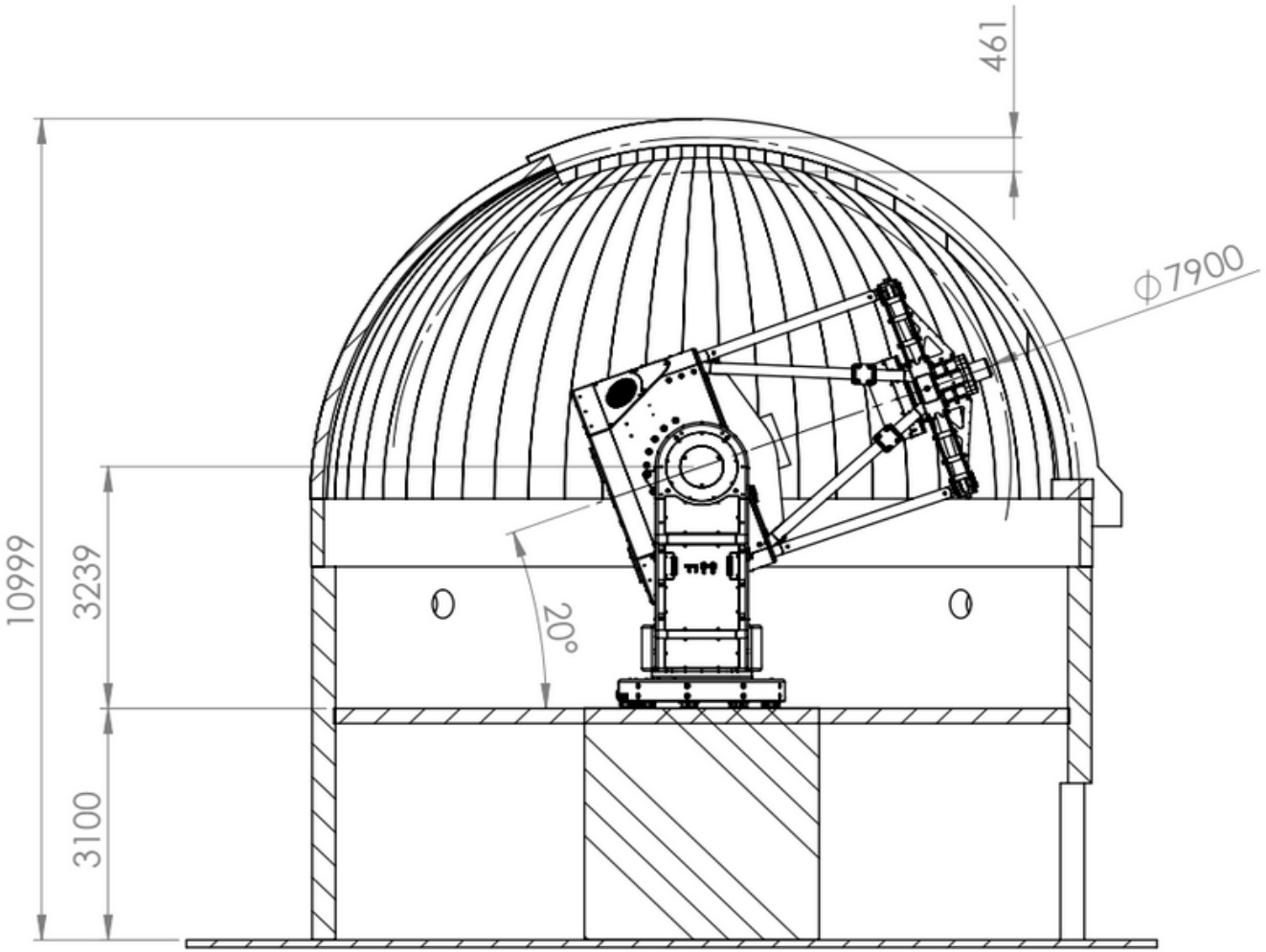
Rolf Chini Cerro Murphy Observatory

Survey of nearby galaxies AGN survey
Surveys of the LMC / SMC Milky Way Cepheids / DEBs etc
Software development (Górski, Kałuszyński, Kicia)

2.5 m telescope (first light expected in 2025)

Instruments:

1) 10k x 10k WF imager (0.12”/pix resolution)
2) NIR 2kx2k camera
3) HR spectrograph (R=80.000, RV ~ 1 m/s)



Various

Books:

1) Springer Series in Astrophysics and Cosmology book chapter on DEBs (Pietrzynski and Graczyk) „The Hubble tension”

2) The Araucaria Project: Improving the cosmic distance scale

Talks: Five invited / plenary talks (G. Pietrzynski)

Outreach: ~ 50 articles in newspapers ~ 20 TV / radio auditions, ESO PR

Grants:

ERC Synergy 2022 – 2027 ongoing good progress

MIN/DIR 2019 - 2023 finished

MAESTRO / Beethoven finished on 2023


ASA
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