



CEPHEIDS AND RR LYRAE AS STANDARD CANDLES FROM HIPPARCOS TO DR1 TO DR2 TO GAIA EDR3

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GAIA EARLY DATA RELEASE 3 – DECEMBER 3, 2020

THE HUBBLE LAW

“In standard big bang cosmology the universe expands uniformly; and locally, according to the Hubble law,

$$v = H_0 \times d$$

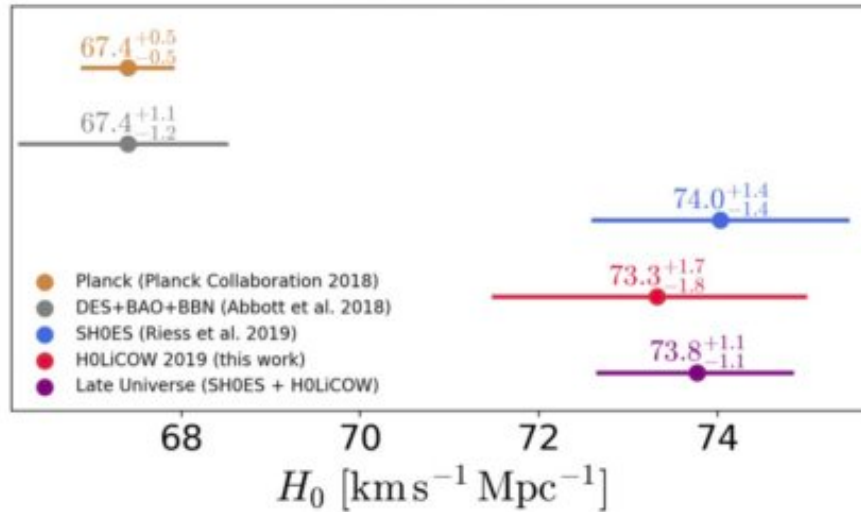
where v is the recession velocity of a galaxy at a distance d , and H_0 is the **Hubble constant**, the expansion rate at the current epoch.”

Freedman et al. 2001, ApJ, 553, 47

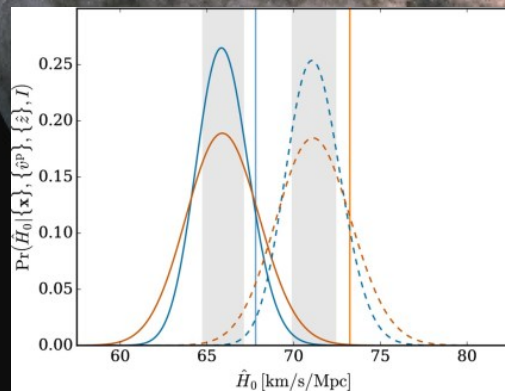
“The uncertainty in the distance is one of the major contributors to the error budget on H_0 ”

THE H_0 TENSION

flat Λ CDM

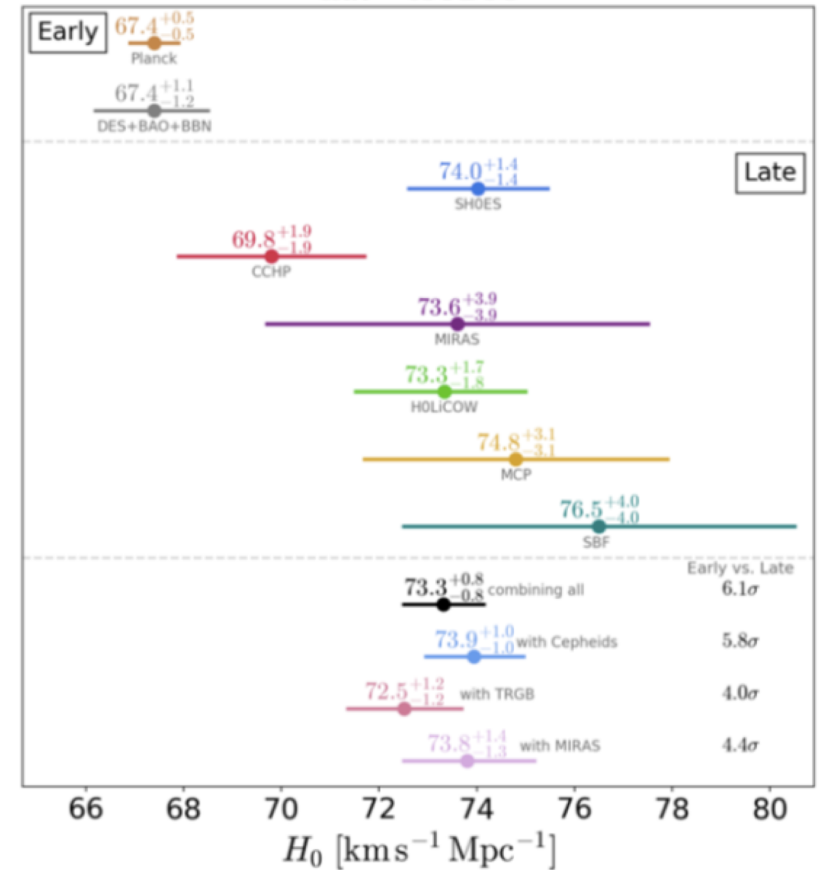


Wong et al. 2020, MNRAS, 498, 1420



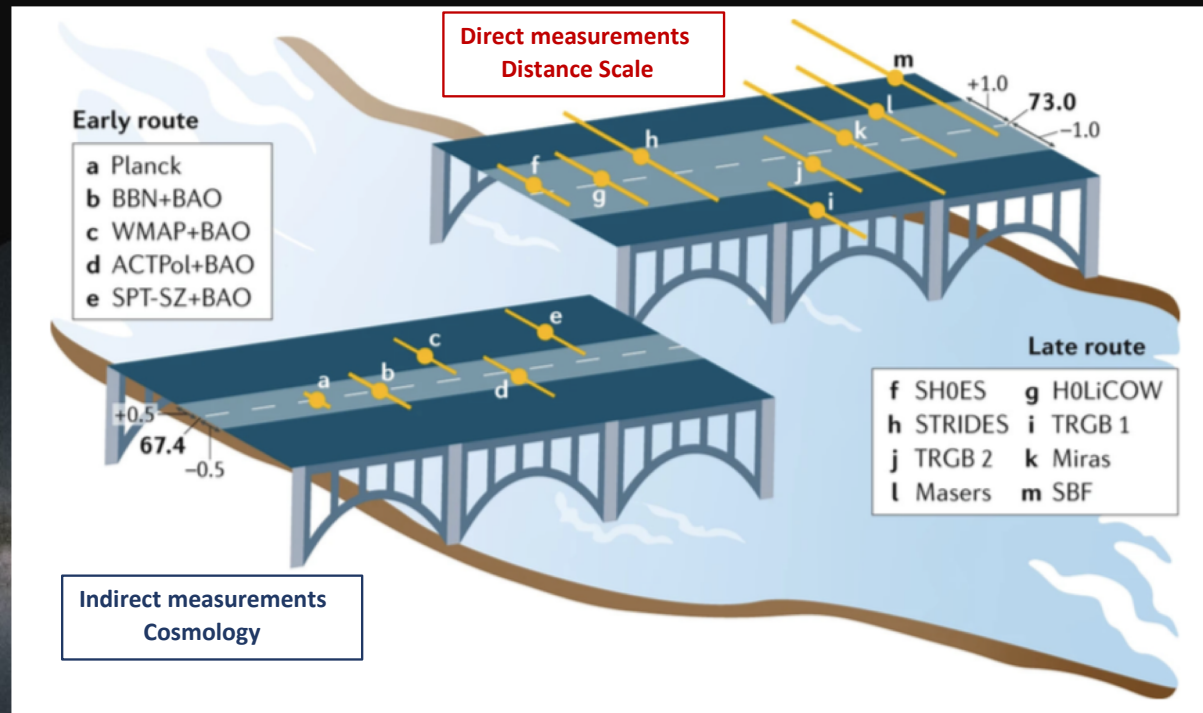
Feeney et al. 2019, Phys.Rev.Lett. 122, 061105

flat - Λ CDM



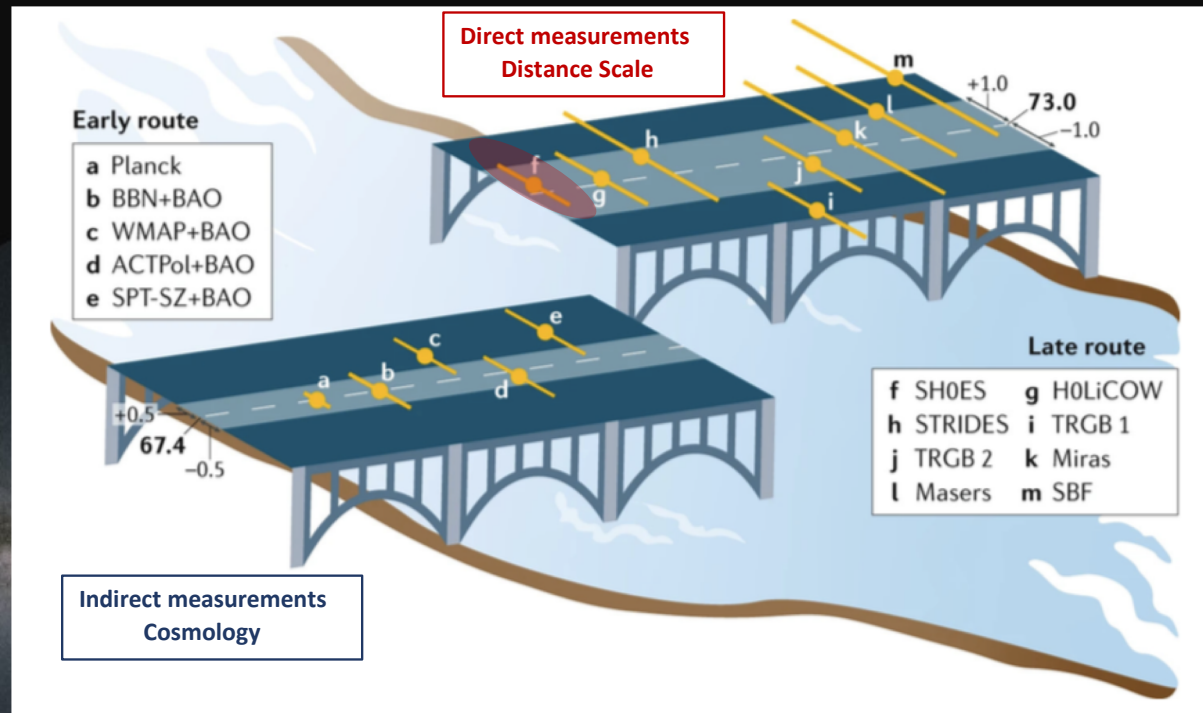
Verde et al. 2019, Nat. As, 3,891

THE H_0 TENSION



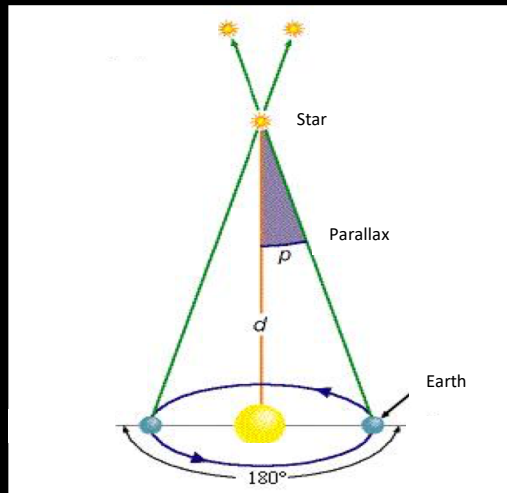
Adapted from Riess 2019, Nat. Rev. Phys.2, 10

THE H_0 TENSION



Adapted from Riess 2019, Nat. Rev. Phys.2, 10

STANDARD CANDLES



PARALLAX

A DIRECT MEASURE OF DISTANCE THROUGH PARALLAX IS POSSIBLE ONLY FOR NEARBY OBJECTS.

THE DISTANCE TO MORE DISTANT OBJECTS IS MEASURED USING “INDIRECT METHODS” THAT RELY ON THE USE OF SOURCES OF KNOWN LUMINOSITY, THE SO CALLED “STANDARD CANDLES”.

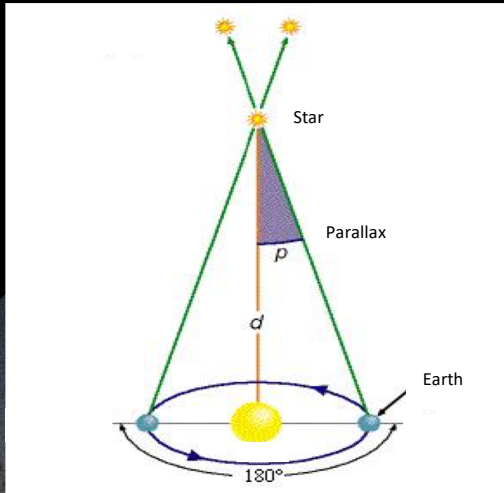
HOWEVER, THE “STANDARD CANDLES” MUST BE CAREFULLY “CALIBRATED”



1000 WATT

**STANDARD
CANDLE**

MEASURING ASTRONOMICAL DISTANCES WITH GAIA



PARALLAX

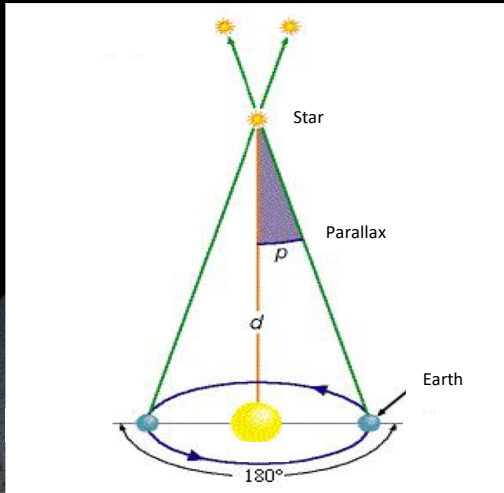


STANDARD CANDLES

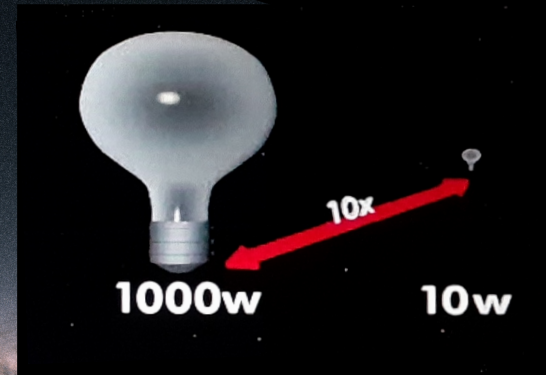
“STANDARD CANDLES” IN GAIA: CEPHEIDS AND RR LYRAE STARS

PERIOD – LUMINOSITY RELATIONS

MEASURING ASTRONOMICAL DISTANCES WITH GAIA



PARALLAX



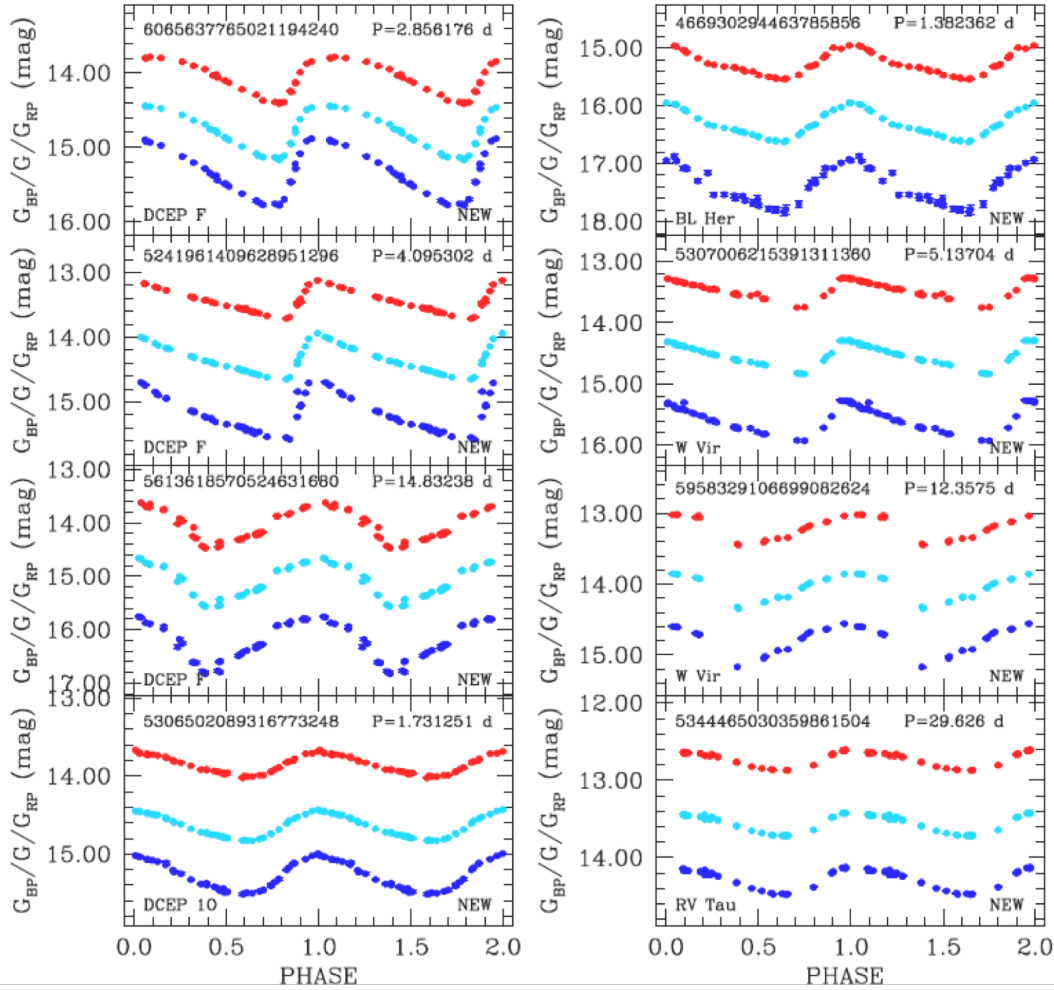
STANDARD CANDLES

“STANDARD CANDLES” IN GAIA: CEPHEIDS AND RR LYRAE STARS

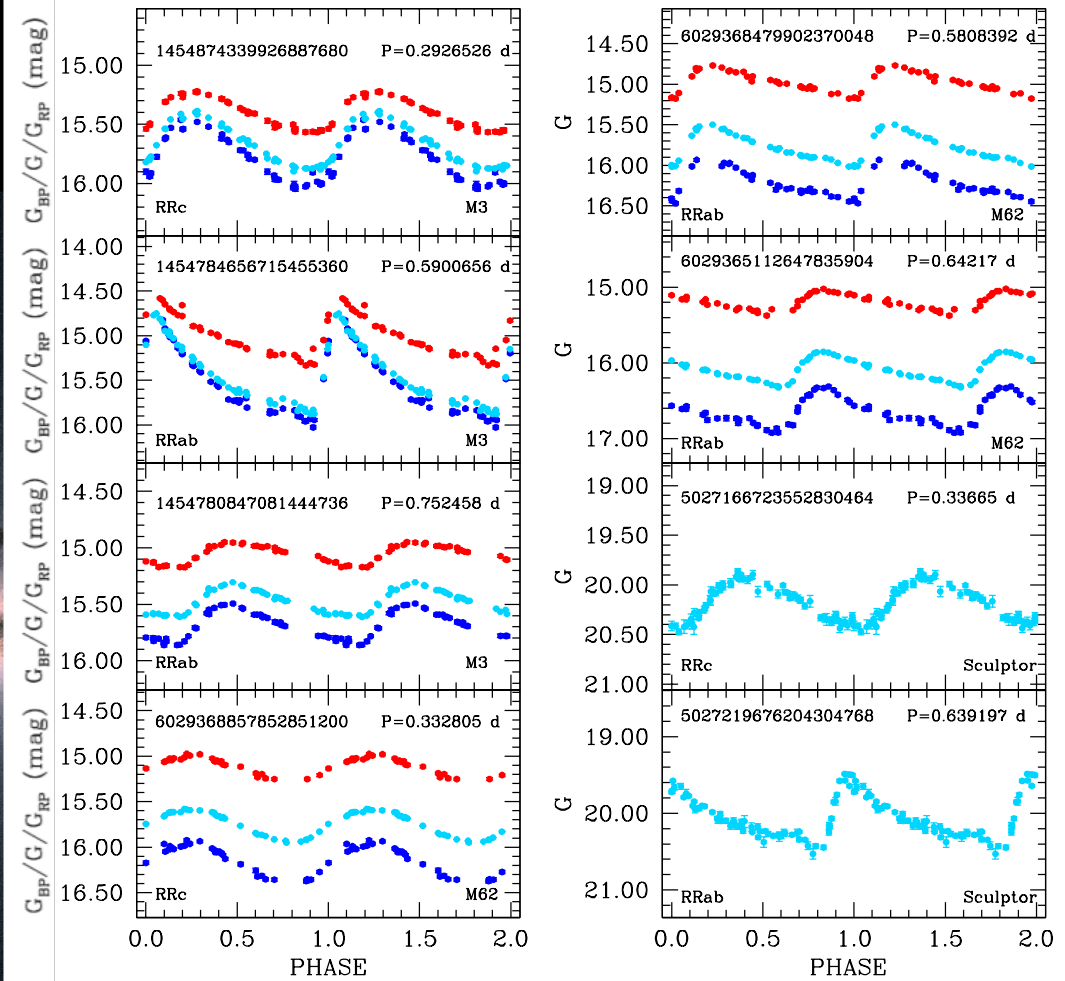
PERIOD – LUMINOSITY RELATIONS

LIGHT CURVES OF CEPHEIDS AND RR LYRAE STARS FROM DR2

CEPHEIDS

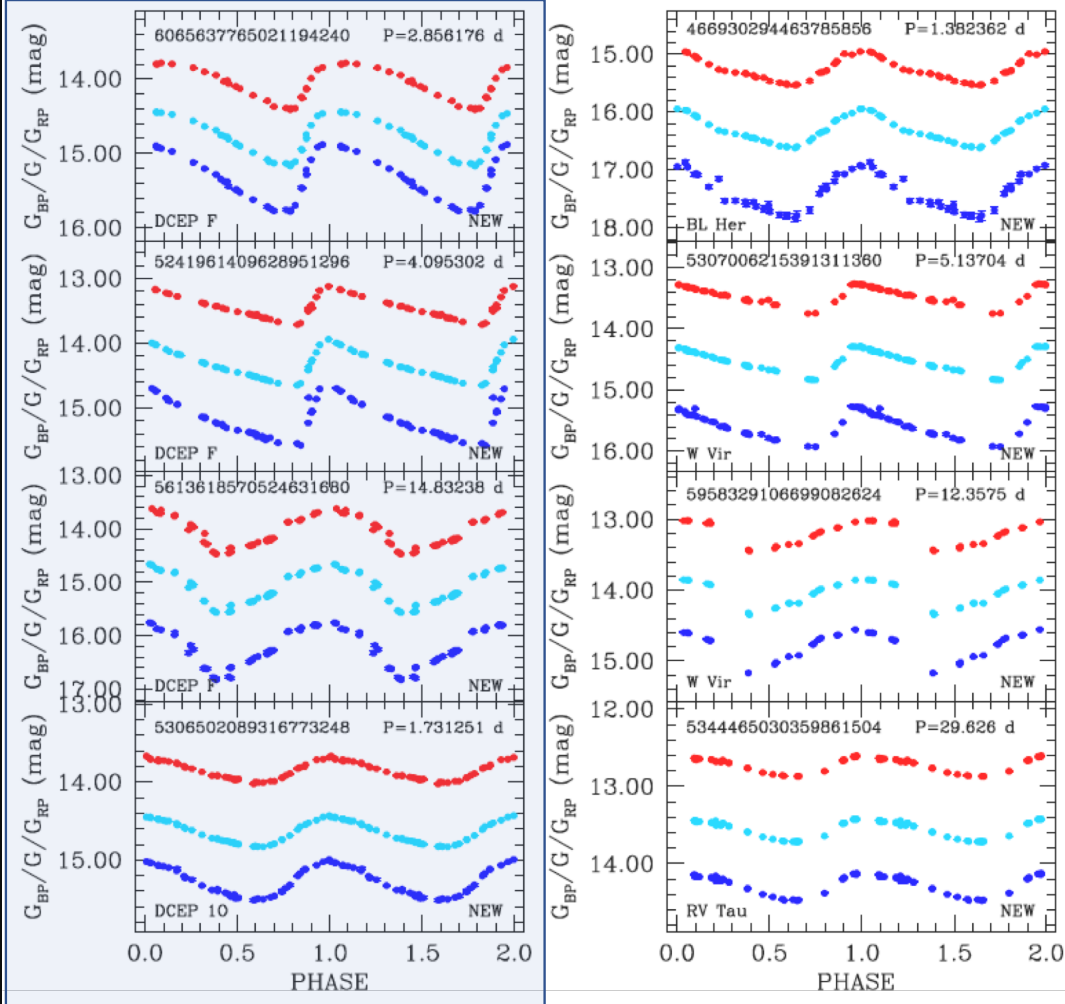


RR LYRAE

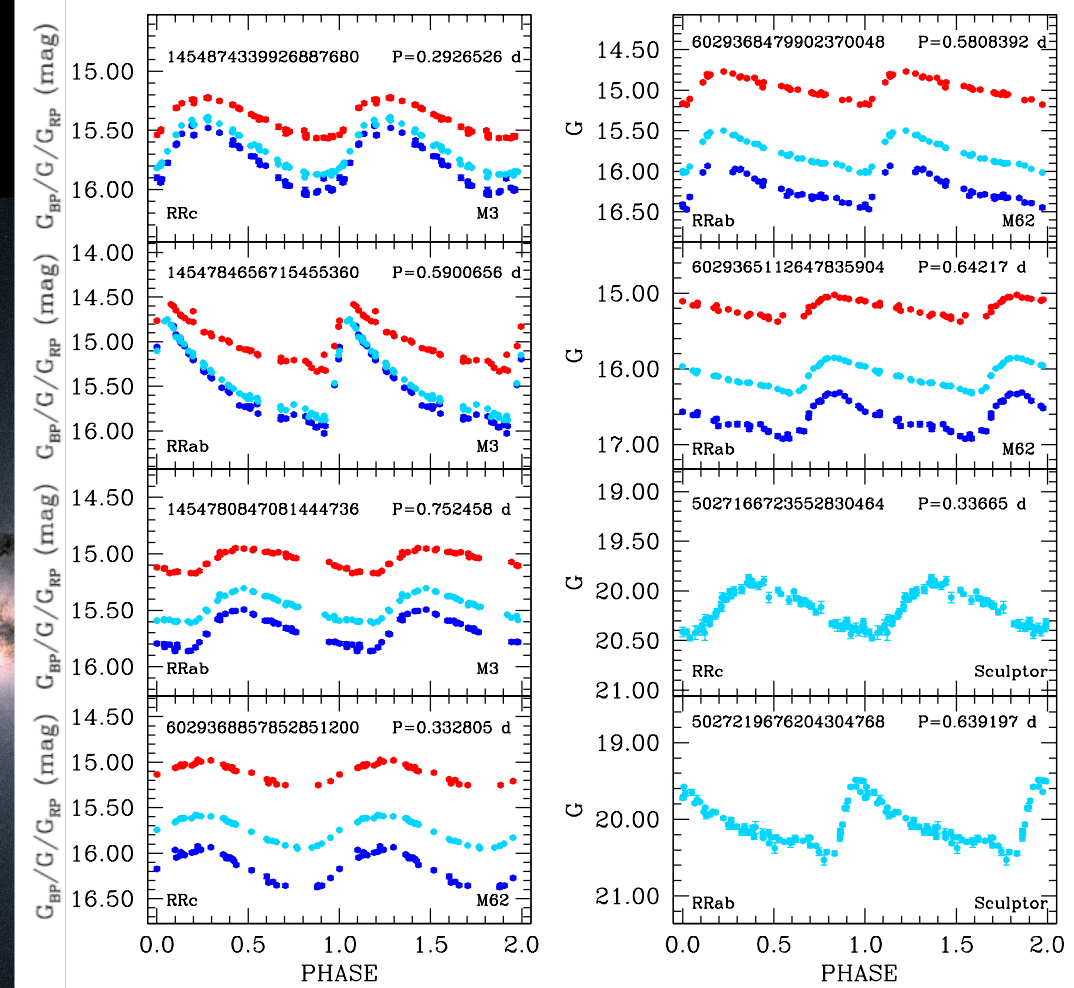


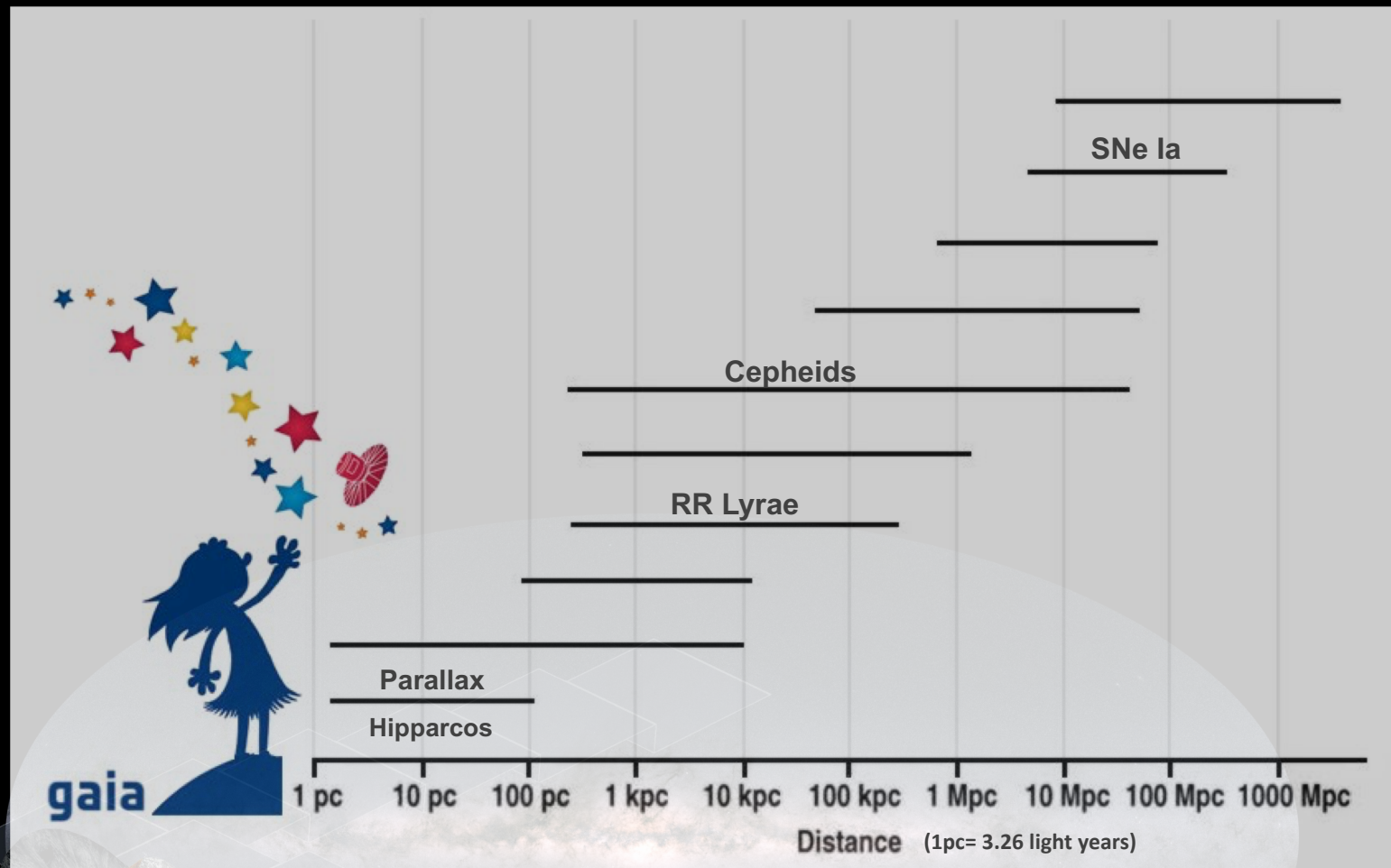
LIGHT CURVES OF CEPHEIDS AND RR LYRAE STARS FROM DR2

CEPHEIDS



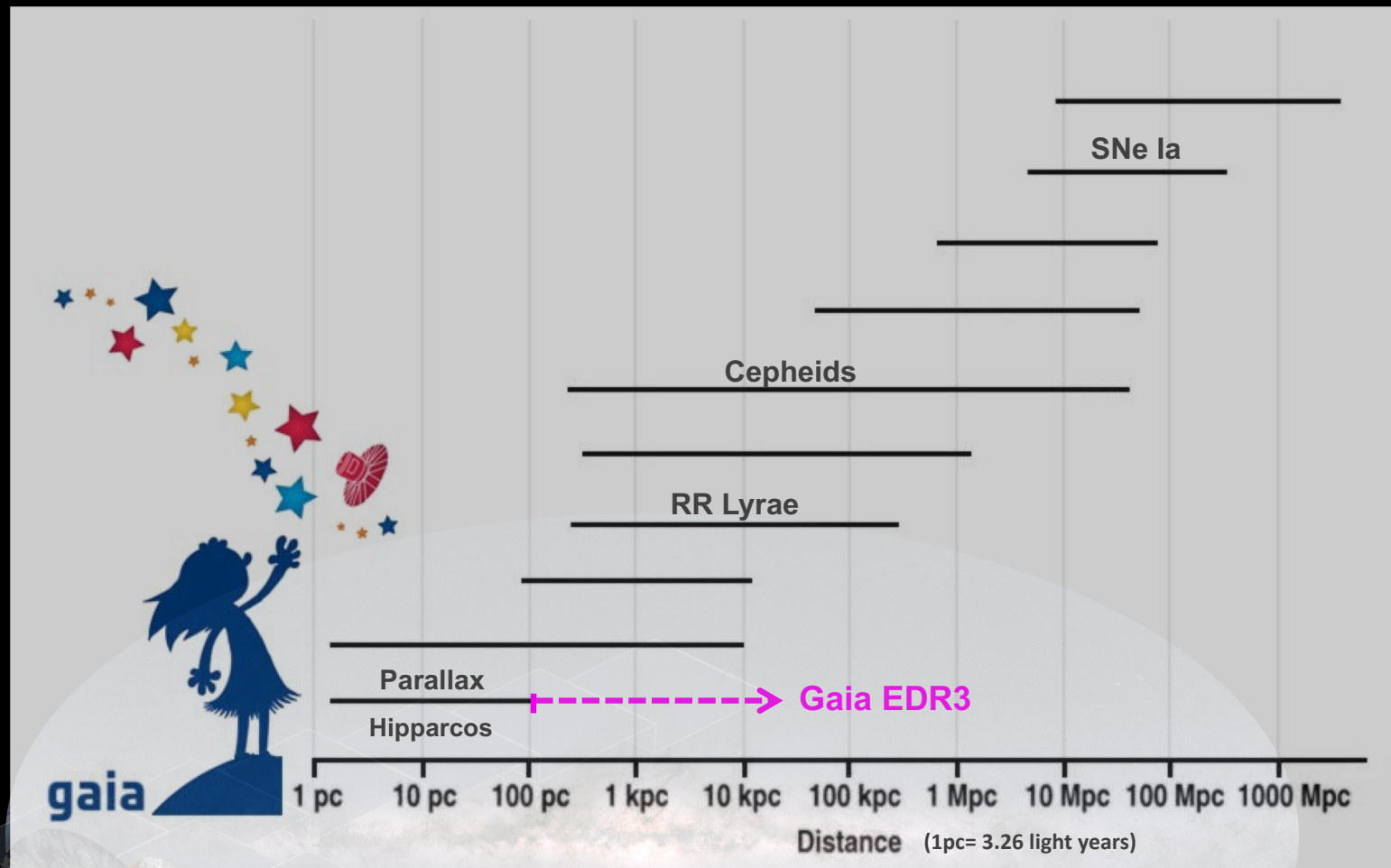
RR LYRAE





CLIMBING THE DISTANCE LADDER WITH GAIA

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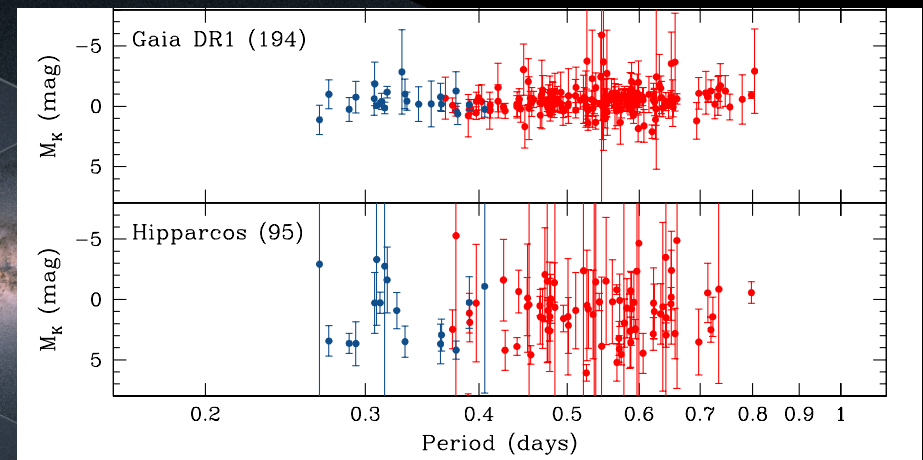
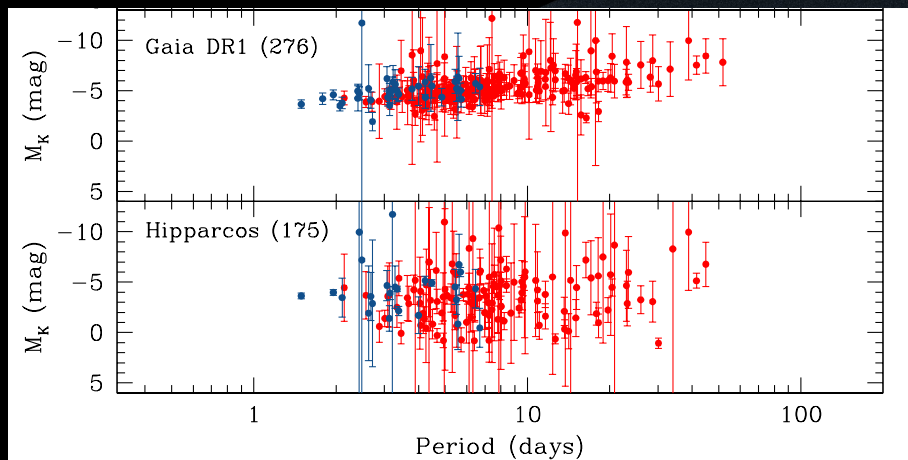
CLIMBING THE DISTANCE LADDER WITH GAIA

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CEPHEIDS AND RR LYRAE AS STANDARD CANDLES FROM HIPPARCOS TO GAIA DR1

CEPHEIDS

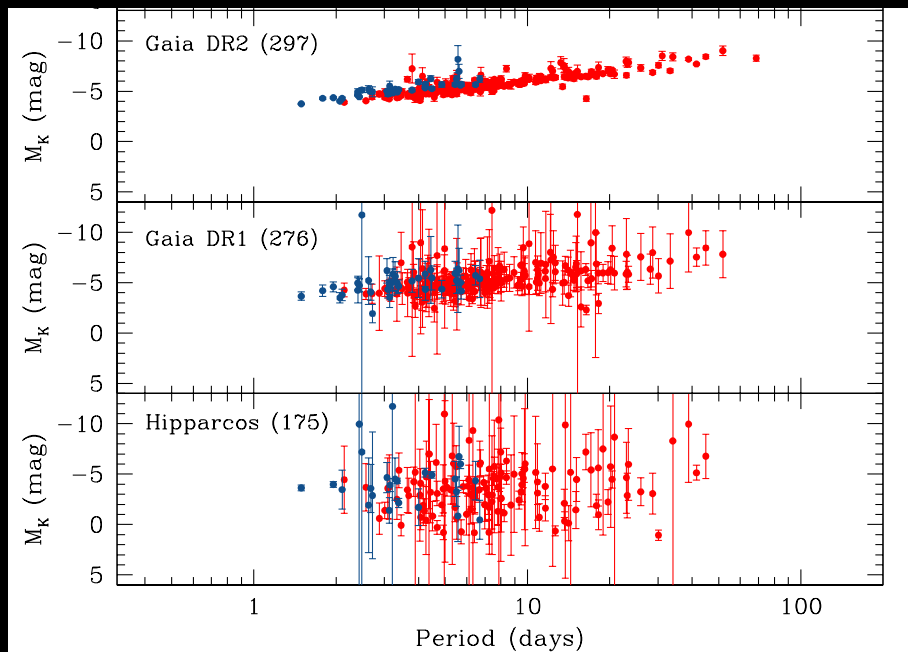
RR LYRAE



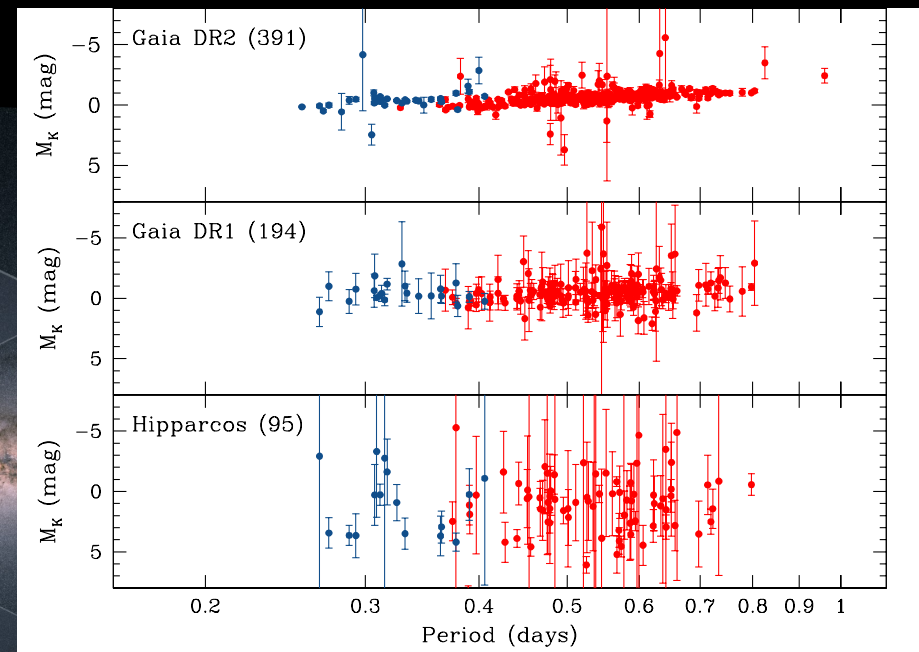
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CEPHEIDS AND RR LYRAE AS STANDARD CANDLES FROM HIPPARCOS TO DR1 TO GAIA DR2

CEPHEIDS



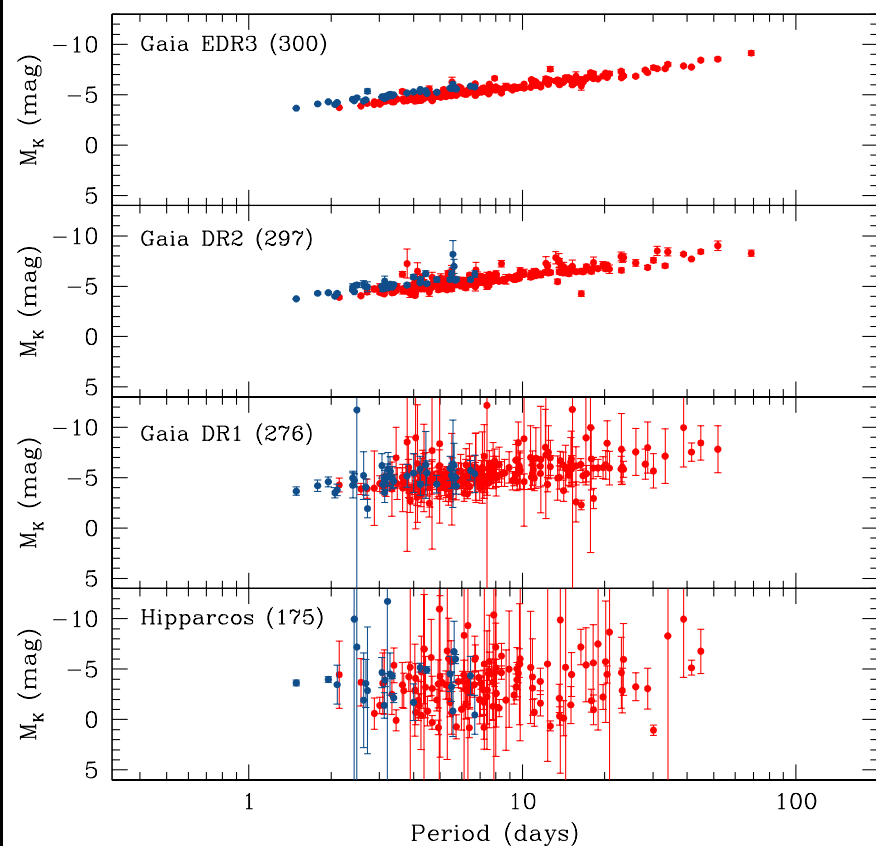
RR LYRAE



CEPHEIDS AND RR LYRAE AS STANDARD CANDLES

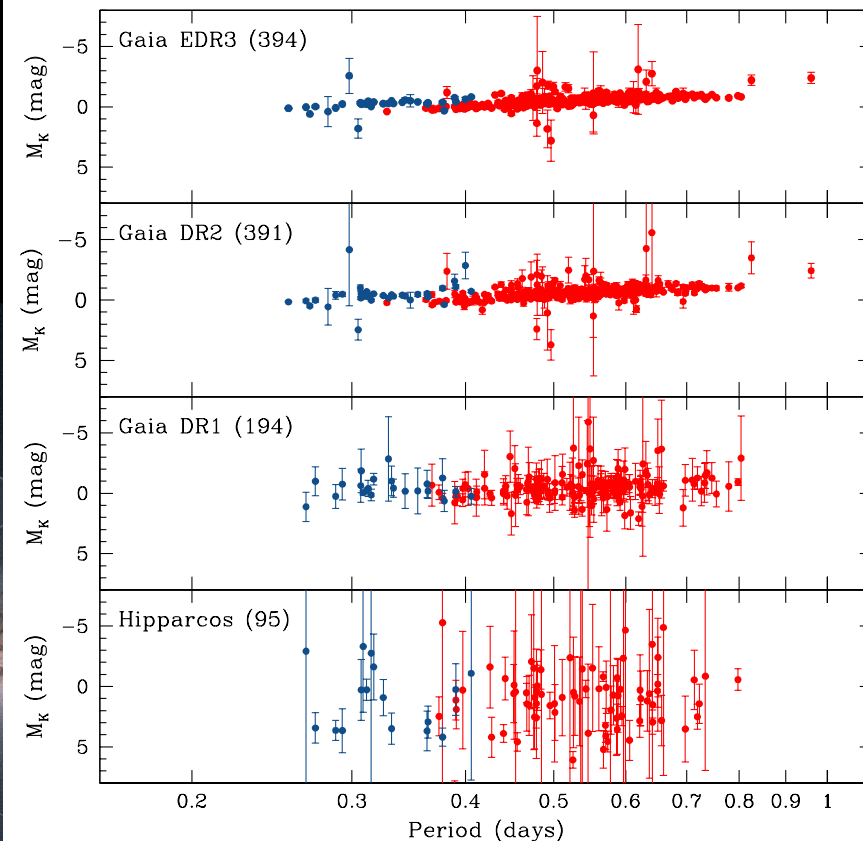
FROM HIPPARCOS TO DR1 TO DR2 TO GAIA EDR3

CEPHEIDS



CREDIT: ESA/GAIA/DPAC, CREATED BY: V. RIPEPI

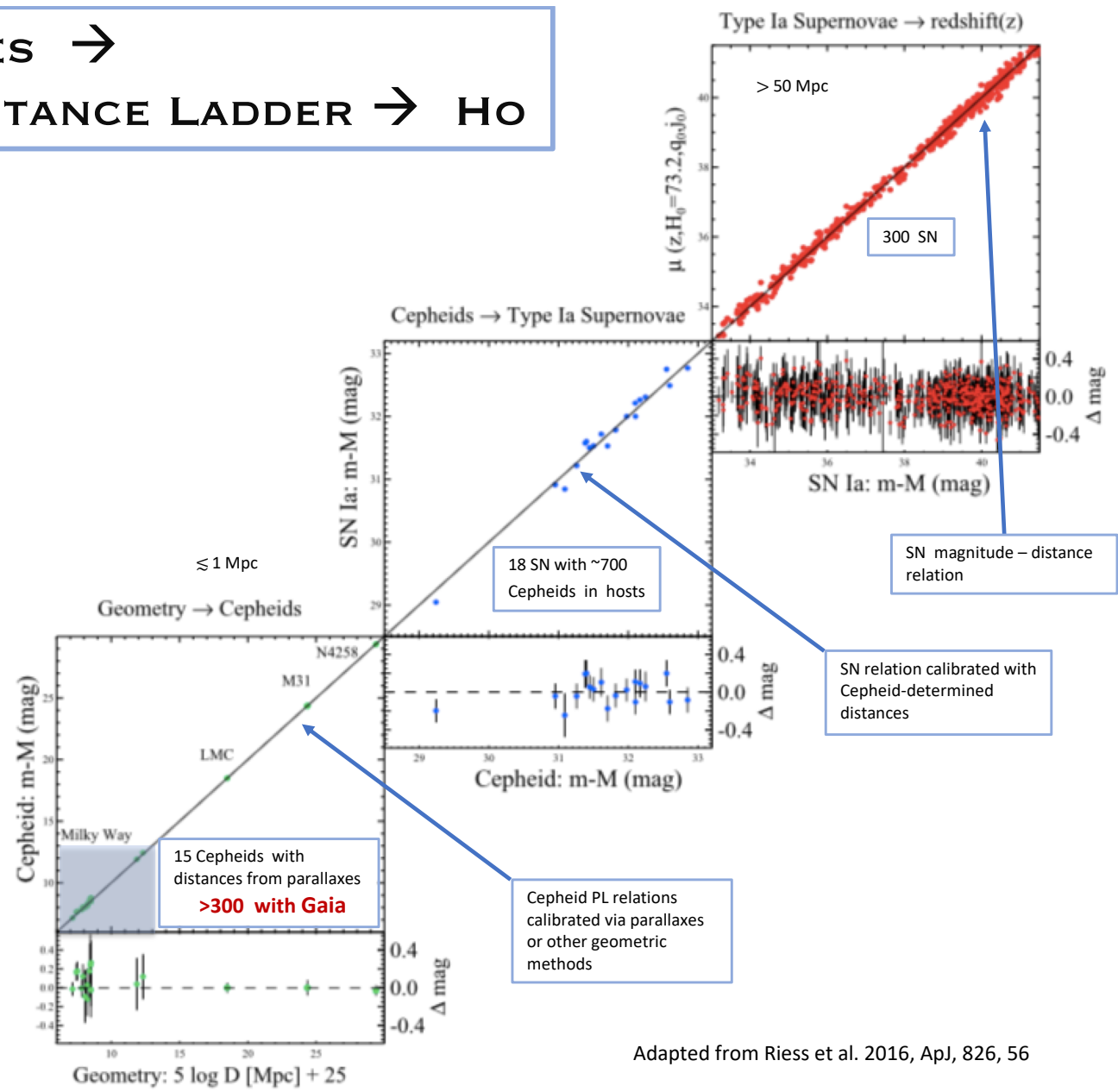
RR LYRAE



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GAIA DISTANCES →
DISTANCE LADDER → H₀



Adapted from Riess et al. 2016, ApJ, 826, 56



THANK YOU

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