James Webb Telescope again strengthen the Cosmology's biggest controversy

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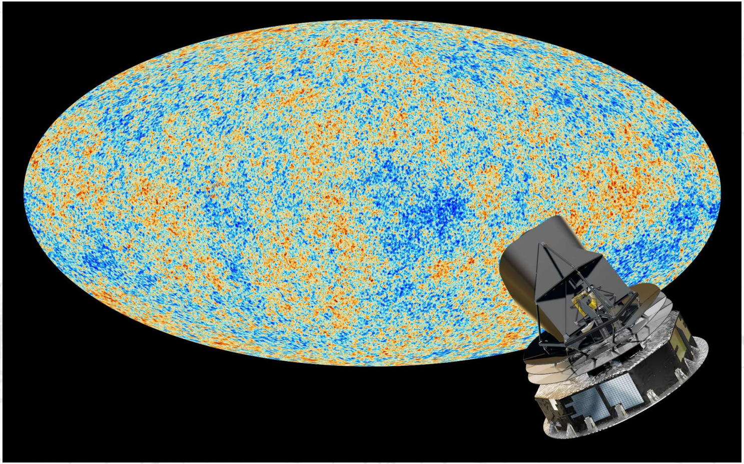
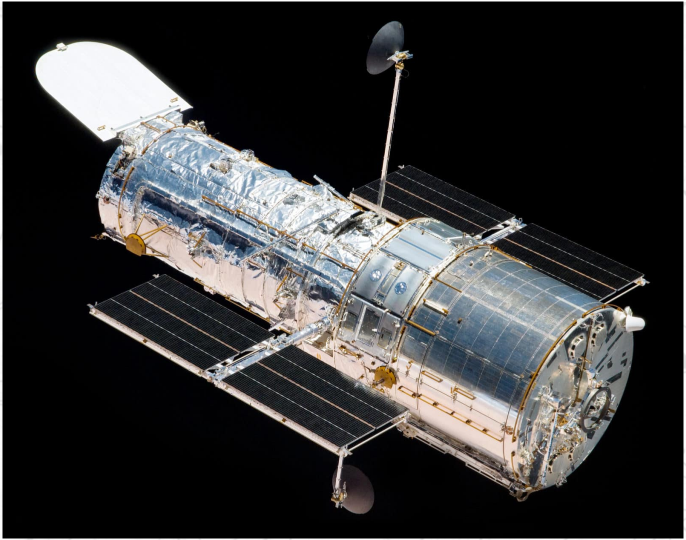
Monday 23 September 2024 at 11:00 A.M.

arXiv: 2401.04773

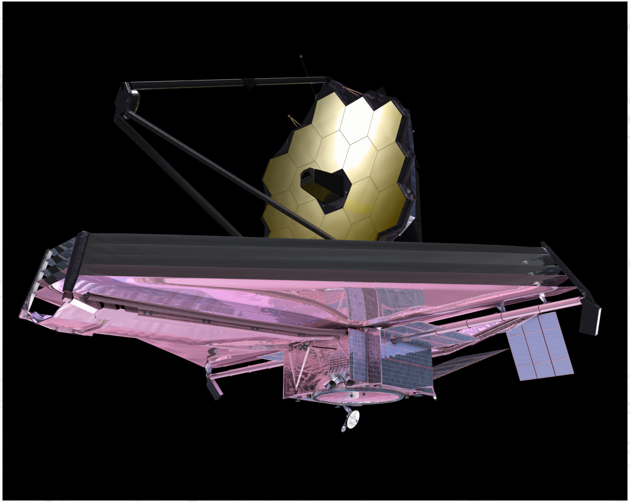
Astrophysics - Cosmology and Nongalactic Astrophysics



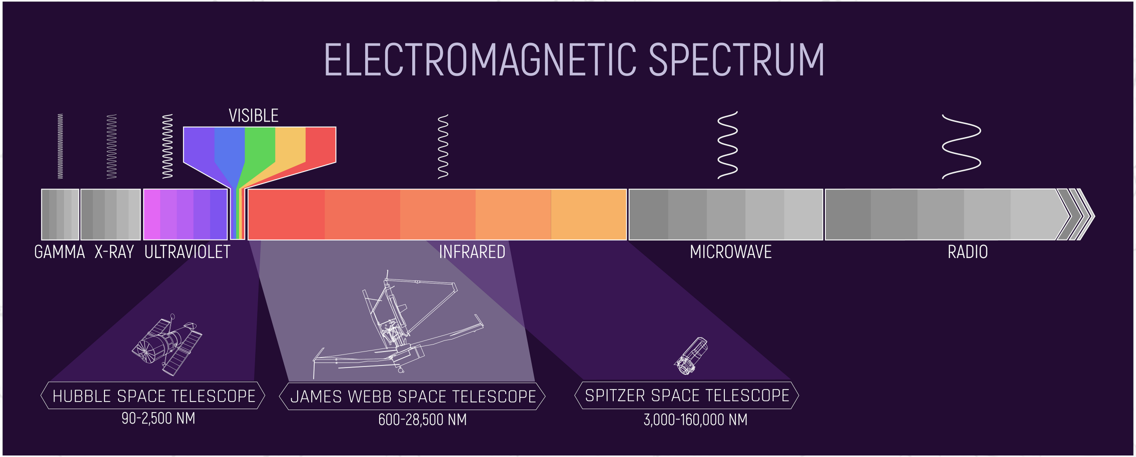
Planck is a European satellite (ESA) launched by an Ariane 5 rocket on May 14, 2009 from the Kourou spaceport. Its objective was to advance cosmology and astrophysics. Consisting of two instruments HFI (High Frequency Instrument) and LFI (Low Frequency Instrument), it carried out observations of the fossil radiation associated with the birth of the universe observable according to the Big Bang theory over the entire celestial vault from the Lagrange point L2.

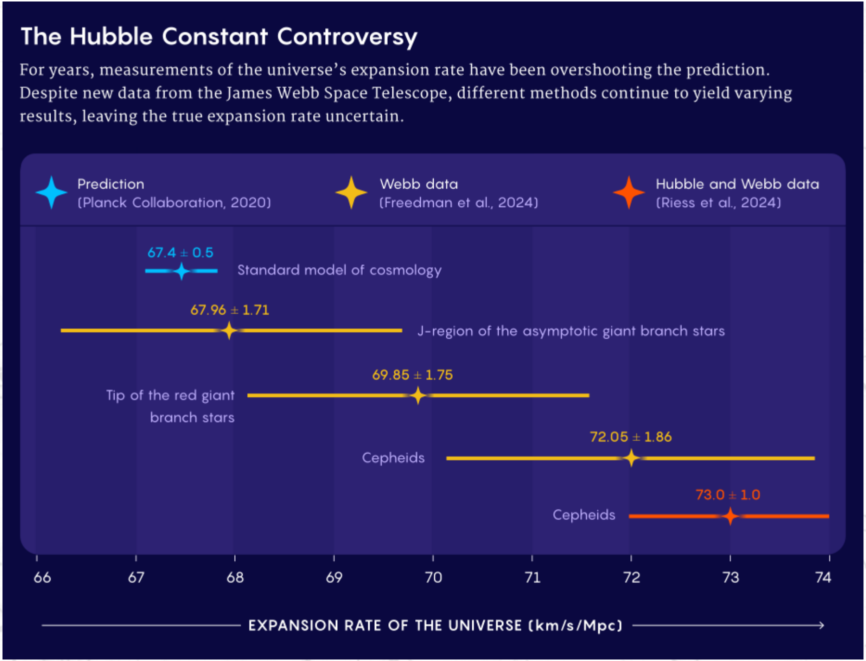


The Hubble Space Telescope is a joint NASA and ESA (European Space Agency) project that launched on April 24, 1990. The project's mission is to capture astronomical images and data that cannot be captured from telescopes on Earth.



The Webb was launched on 25 December 2021 on an Ariane 5 rocket from Kourou, French Guiana. In January 2022 it arrived at its destination, a solar orbit near the Sun–Earth L2 Lagrange point, about 1.5 million kilometers (930,000 mi) from Earth. The telescope's first image was released to the public on 11 July 2022.


ELECTROMAGNETIC SPECTRUM
VISIBLE
GAMMA
X-RAY
ULTRAVIOLET
INFRARED
MICROWAVE
RADIO
HUBBLE SPACE TELESCOPE
90-2,500 NM
JAMES WEBB SPACE TELESCOPE
600-28,500 NM
SPITZER SPACE TELESCOPE
3,000-160,000 NM


The Hubble Constant Controversy
For years, measurements of the universe's expansion rate have been overshooting the prediction. Despite new data from the James Webb Space Telescope, different methods continue to yield varying results, leaving the true expansion rate uncertain.
Prediction
(Planck Collaboration, 2020)
Webb data
(Freedman et al., 2024)
Hubble and Webb data
(Riess et al., 2024)
67.4 ± 0.5
Standard model of cosmology
67.96 ± 1.71
J-region of the asymptotic giant branch stars
69.85 ± 1.75
Tip of the red giant branch stars
72.05 ± 1.86
Cepheids
73.0 ± 1.0
Cepheids
66
67
68
69
70
71
72
73
74
EXPANSION RATE OF THE UNIVERSE (km/s/Mpc)

THE ASTROPHYSICAL JOURNAL LETTERS

OPEN ACCESS

JWST Observations Reject Unrecognized Crowding of Cepheid Photometry as an Explanation for the Hubble Tension at 8σ Confidence

Adam G. Riess[1,2], Gagandeep S. Anand[1], Wenlong Yuan[2], Stefano Casertano[1], Andrew Dolphin[3], Lucas M. Macri[4], Louise Breuval[2], Dan Scolnic[5], Marshall Perrin[1], and Richard I. Anderson[6]

Published 2024 February 6 •

The Astrophysical Journal Letters, Volume 962, Number 1

Citation Adam G. Riess *et al* 2024 *ApJL* **962** L17

Astrophysics > Cosmology and Nongalactic Astrophysics

[Submitted on 12 Aug 2024]

Status Report on the Chicago-Carnegie Hubble Program (CCHP): Three Independent Astrophysical Determinations of the Hubble Constant Using the James Webb Space Telescope

Wendy L. Freedman, Barry F. Madore, In Sung Jang, Taylor J. Hoyt, Abigail J. Lee, Kayla A. Owens

We present the latest results from the Chicago Carnegie Hubble Program (CCHP) to measure the Hubble constant using data from the James Webb Space Telescope (JWST). This program is based upon three independent methods: (1) Tip of the Red Giant Branch (TRGB) stars, (2) JAGB (J-Region Asymptotic Giant Branch) stars, and (3) Cepheids. Our program includes 10 nearby galaxies, each hosting Type Ia supernovae, suitable for measuring the Hubble constant (Ho). It also includes NGC 4258, which has a geometric distance, setting the zero point for all three methods. The JWST observations have significantly higher signal-to-noise and finer angular resolution than previous observations with the Hubble Space Telescope (HST). We find three independent values of Ho = 69.85 +/- 1.75 (stat) +/- 1.54 (sys) for the TRGB, Ho = 67.96 +/- 1.85 (stat) +/- 1.90 (sys) for the JAGB, and Ho = 72.05 +/- 1.86 (stat) +/- 3.10 (sys) km/s/Mpc for Cepheids. Tying into supernovae, and combining these methods adopting a flat prior, yields our current estimate of Ho = 69.96 +/- 1.05 (stat) +/- 1.12 (sys) km/s/Mpc. The distances measured using the TRGB and the JAGB method agree at the 1% level, but differ from the Cepheid distances at the 2.5-4% level. The value of Ho based on these two methods with JWST data alone is Ho = 69.03 +/- 1.75 (total error) km/sec/Mpc. These numbers are consistent with the current standard Lambda CDM model, without the need for the inclusion of additional new physics. Future JWST data will be required to increase the precision and accuracy of the local distance scale.

Comments: 61 pages, 20 figures
Subjects: **Cosmology and Nongalactic Astrophysics (astro-ph.CO)**
Cite as: arXiv:2408.06153 **[astro-ph.CO]**
(or arXiv:2408.06153v1 **[astro-ph.CO]** for this version)
https://doi.org/10.48550/arXiv.2408.06153

arXiv > astro-ph > arXiv:2403.18902

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Astrophysics > Cosmology and Nongalactic Astrophysics

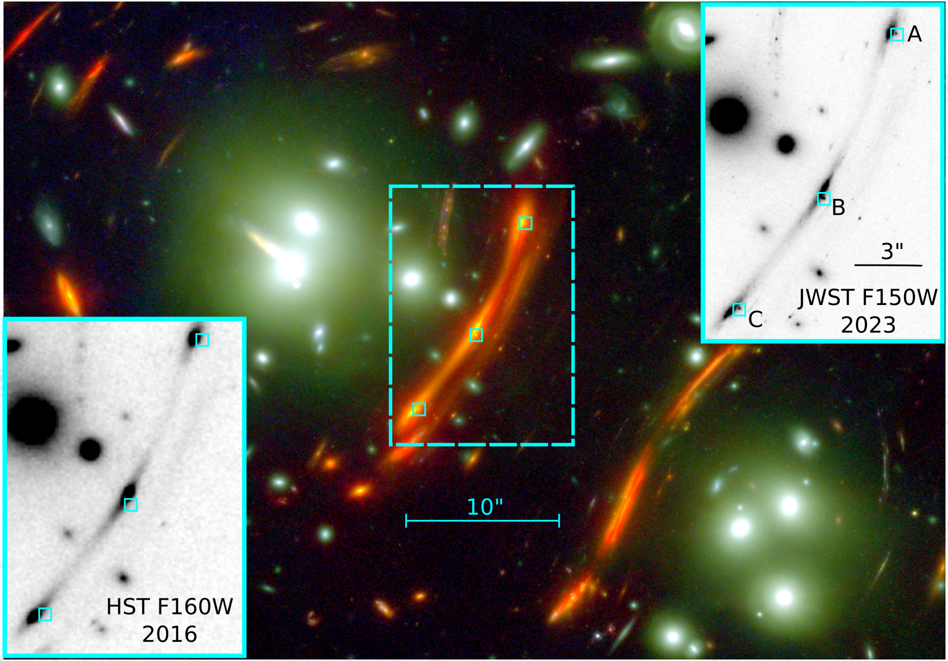
[Submitted on 27 Mar 2024]

SN H0pe: The First Measurement of H_0 from a Multiply-Imaged Type Ia Supernova, Discovered by JWST

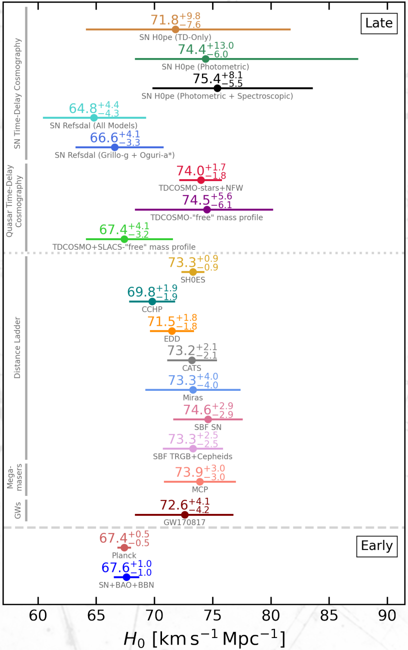
Massimo Pascale, Brenda L. Frye, Justin D.R. Pierel, Wenlei Chen, Patrick L. Kelly, Seth H. Cohen, Rogier A. Windhorst, Adam G. Riess, Patrick S. Kamieneski, Jose M. Diego, Ashish K. Meena, Sangjun Cha, Masamune Oguri, Adi Zitrin, M. James Jee, Nicholas Foo, Reagen Leimbach, Anton M. Koekemoer, C. J. Conselice, Liang Dai, Ariel Goobar, Matthew R. Siebert, Lou Strolger, S. P. Willner

The first James Webb Space Telescope ({\it JWST}) Near InfraRed Camera (NIRCam) imaging in the field of the galaxy cluster PLCK G165.7+67.0 ($z=0.35$) uncovered a Type Ia supernova (SN~Ia) at $z=1.78$, called ``SN H0pe." Three different images of this one SN were detected as a result of strong gravitational lensing, each one traversing a different path in spacetime, thereby inducing a relative delay in the arrival of each image. Follow-up {\it JWST} observations of all three SN images enabled photometric and rare spectroscopic measurements of the two relative time delays. Following strict blinding protocols which oversaw a live unblinding and regulated post-unblinding changes, these two measured time delays were compared to the predictions of seven independently constructed cluster lens models to measure a value for the Hubble constant, $H_0=71.8^{+9.8}_{-7.6}$~km~s^{-1}~Mpc^{-1}. The range of admissible H_0 values predicted across the lens models limits further precision, reflecting the well-known degeneracies between lens model constraints and time delays. It has long been theorized that a way forward is to leverage a standard candle, however this has not been realized until now. For the first time, the lens models are evaluated by their agreement with the SN absolute magnification, breaking these degeneracies and producing our best estimate, $H_0=75.4^{+8.1}_{-5.5}$~km~s^{-1}~Mpc^{-1}. This is the first precision measurement of H_0 from a multiply-imaged SN~Ia, and provides a measurement in a rarely utilized redshift regime. This result agrees with other local universe measurements, yet exceeds the value of H_0 derived from the early Universe with $\gtrsim 90\%$ confidence, increasing evidence of the Hubble tension. With the precision provided by only four more events, this approach could solidify this disagreement to $>3\sigma$.

Comments: Submitted to ApJ. 22 pages, 7 Figures
Subjects: **Cosmology and Nongalactic Astrophysics (astro-ph.CO)**; Astrophysics of Galaxies (astro-ph.GA)
Cite as: arXiv:2403.18902 **[astro-ph.CO]**
(or arXiv:2403.18902v1 **[astro-ph.CO]** for this version)
https://doi.org/10.48550/arXiv.2403.18902



A
B
3"
C
JWST F150W
2023
10"
HST F160W
2016



Late
71.8 +9.8 −7.6
SN H0pe (TD-Only)
74.4 +13.0 −6.0
SN H0pe (Photometric)
75.4 +8.1 −5.5
SN H0pe (Photometric + Spectroscopic)
64.8 +4.4 −4.3
SN Refsdal (All Models)
66.6 +4.1 −3.3
SN Refsdal (Grillo-g + Oguri-a*)
SN Time-Delay Cosmography
74.0 +1.7 −1.8
TDCOSMO-stars+NFW
74.5 +5.6 −6.1
TDCOSMO-"free" mass profile
67.4 +4.1 −3.2
TDCOSMO+SLACS-"free" mass profile
Quasar Time-Delay Cosmography
73.3 +0.9 −0.9
SH0ES
69.8 +1.9 −1.9
CCHP
71.5 +1.8 −1.8
EDD
73.2 +2.1 −2.1
CATS
73.3 +4.0 −4.0
Miras
74.6 +2.9 −2.9
SBF SN
73.3 +2.5 −2.5
SBF TRGB+Cepheids
Distance Ladder
73.9 +3.0 −3.0
MCP
Mega-masers
72.6 +4.1 −4.2
GW170817
GWs
Early
67.4 +0.5 −0.5
Planck
67.6 +1.0 −1.0
SN+BAO+BBN
60
65
70
75
80
85
90
H_0 [km s^{-1} Mpc^{-1}]

This 1949 photo shows American astronomer Edwin Hubble, who discovered cosmic expansion, looking through the Schmidt telescope at the Palomar Observatory, which is located close to San Diego.