

The measurement of the Hubble Constant: beyond the cosmic ladder

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A precisely determined Hubble's constant H_0 would have an overarching effect on any feature of cosmological theory: the age of the Universe, the critical density of the Universe, or in the formation of cosmic structure. Producing a conclusive value for H_0 is difficult as absolute distances on the cosmic scale are difficult to measure. Inhomogeneous gravitational acceleration generates motion which does not follow the simple expansion as described by Hubble's Law $v = H_0 d$. An uncertainty arises due to the discrepancy between the methods to connect local distances to the smooth large-scale Hubble flow (Fukugita et al. 1993).

Several approaches for cosmic distance measurement should therefore be used to reduce systematic errors. These measurements can form the “rungs” of a *cosmic distance ladder*, where large extragalactic distances (> 1000 Mpc) are informed and calibrated by techniques which have smaller ranges (Carroll and Ostlie 2007). Astronomers may employ a variety of methods in tandem, therefore the ladder could instead be expressed as several pathways (Figure 1).

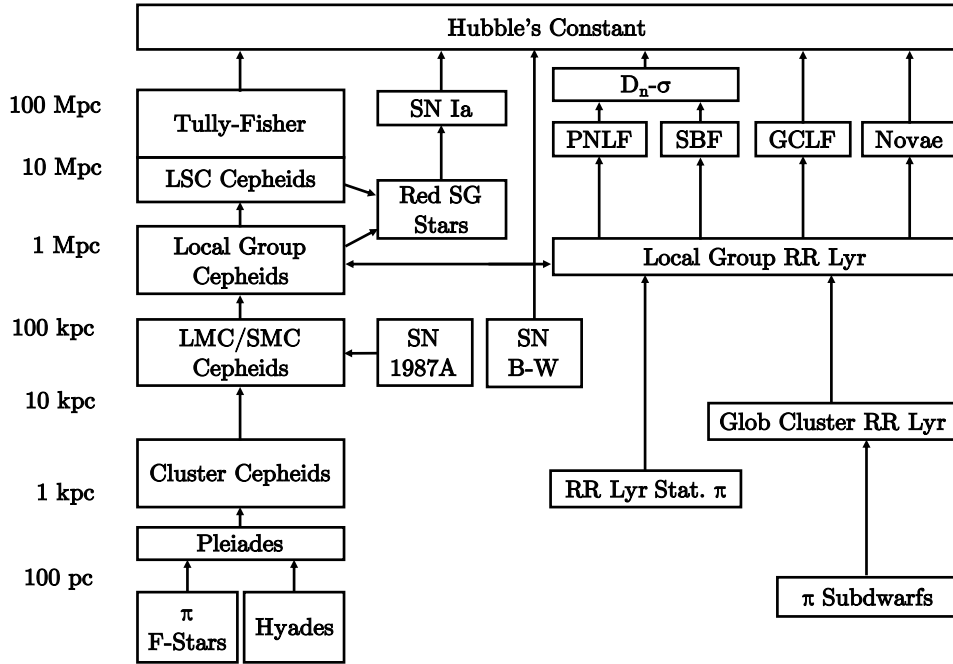


Figure 1: Adapted from Jacoby et al. (1992), this diagram illustrates the various approaches to calculate H_0 , each technique is roughly placed at the approximate range it operates at. One can see that there is not one strict “cosmic ladder”, rather multiple pathways. For reference, the acronyms used are: B-W - Baade-Wessenlink; GCLF - Globular-Cluster Luminosity Function; LSC - Local Super Cluster; PNLF - Planetary Nebula Luminosity Function; SBF - Surface-Brightness Fluctuations; SG - Super Giant; SN - Supernovae; π - parallax.

The Hubble Space Telescope H_0 Key Project was an effort to as described by Freedman et al. (2001)

References

- Carroll, B. W. and Ostlie, D. A. (2007), An Introduction to Modern Astrophysics, 2nd edn, Pearson.
- Freedman, W. L., Madore, B. F., Gibson, B. K., Ferrarese, L., Kelson, D. D., Sakai, S., Mould, J. R., Kennicutt, Robert C., J., Ford, H. C., Graham, J. A., Huchra, J. P., Hughes, S. M. G., Illingworth, G. D., Macri, L. M. and Stetson, P. B. (2001), ‘Final Results from the Hubble Space Telescope Key Project to Measure the Hubble Constant’, The Astrophysical Journal **553**, 47–72.
- Fukugita, M., Hogan, C. J. and E., P. P. J. (1993), ‘The cosmic distance scale and the Hubble constant’, Nature **366**.
- Jacoby, G. H., Branch, D., Ciardullo, R., Davies, R. L., Harris, W. E., Pierce, M. J., Pritchett, C. J., Tonry, J. L. and Welch, D. L. (1992), ‘A critical review of selected techniques for measuring extragalactic distances’, Astronomical Society of the Pacific **104**, 599–662.