SF2A 2019
P. Di Matteo, O. Creevey, A. Crida, G. Kordopatis, J. Malzac, J.-B. Marquette, M. N'Diaye, O. Venot (eds)

CEPHEID DISTANCE MEASUREMENTS OF SNIA HOST GALAXIES

B. Javanmardi[1] and P. Kervella[1]

Abstract. One of the most fundamental cosmological parameters is the current expansion rate of the Universe, i.e. the Hubble Constant (H_0). Recent studies revealed a significant tension between the local measurements of H_0 using Cepheids plus Type Ia Supernovae (SNIa) and the measurements from the cosmic microwave background (CMB) observations. This tension calls for thorough investigations and it is extremely important to understand its source which could be new physics beyond the standard model of cosmology, or systematic issues in the measurements. In this project, we aim to perform an independent accurate Cepheid distance measurement to the SNIa host galaxies in the local Universe, a crucial step for the determination of H_0.

Keywords: Stars: variables: Cepheids, Galaxies: distances and redshifts, Cosmology: distance scale

1 The Local and Cosmic Measurements of H_0 are in Tension

Before the CMB observations by the Planck satellite, the local (empirical) measurements of H_0 have been in agreement with the predictions from the CMB analyses. However, the results from Planck Collaboration et al. (2014, 2016) revealed a tension between these two sets of measurements. This tension became more significant with the reportedly precise direct measurements by Riess et al. (2016, 2018). Figure 1 shows the local and cosmic measurements of H_0 since 2001 to present.

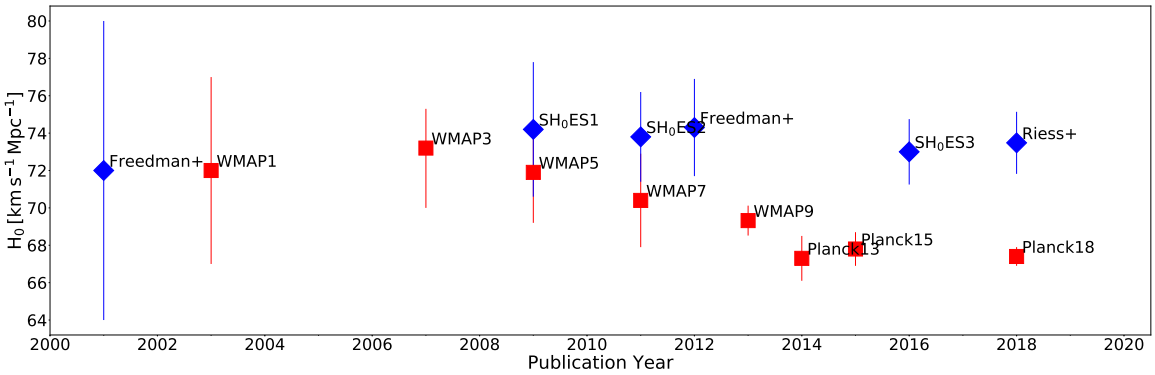

Fig. 1. Local (blue diamonds) and CMB (red squares) measurements of H_0 vs. their publication years.

2 Accurate distance measurements to SNIa hosts using Cepheids

Obtaining an accurate local value of H_0 involves a series of crucial steps each of which should be performed with utmost care. To use cepheids in distant galaxies to calibrate SNIa magnitudes, it is very important to have an accurate period-luminosity (PL) relation for Cepheids in the Milky Way (e.g. by using Gaia parallaxes, Breuval & et al. 2019) and the Large Magellanic Cloud (using independent and precise distance measurements,

[1] LESIA, Observatoire de Paris, PSL Research University, CNRS, UPMC, Univ. Paris Diderot, 5 place Jules Janssen, 92195 Meudon, France

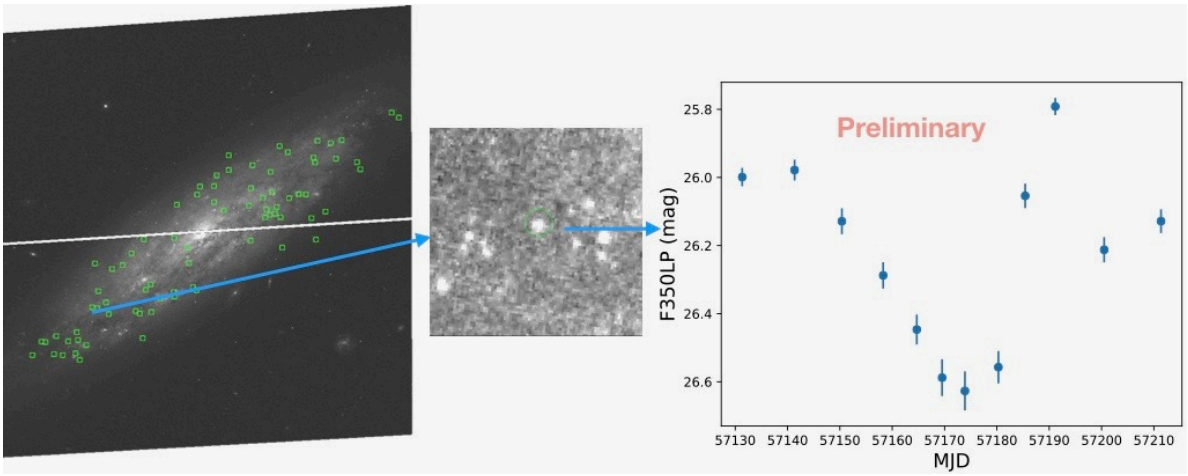

Fig. 2. Left: HST image of NGC 3972, Cepheids positions are shown with green squares. **Center**: A cutout region centered on one of the Cepheids in NGC 3972. **Right**: A preliminary photometry result of that Cepheid in F350LP band vs. Modified Julian Date (MJD).

Pietrzyński et al. 2019). In addition, to understand and control various possible systematics, it is necessary to perform detailed studies of the physics of these fascinating variable stars (see e.g. Kervella et al. 2019a,b; Borgniet et al. 2019; Hocde & et al. 2019). And last but not least, an accurate photometry of Cepheids in SNIa host galaxies by taking into account the various sources of systematic uncertainties is needed to robustly constrain the value of H_0. The latter is the main aim of this project.

Riess et al. (2016) have used the Hubble Space Telescope (HST) observations of 19 supernovae host galaxies in the local Universe. In this ongoing work, we have started with the photometry of more than 70 identified Cepheids (Hoffmann et al. 2016) in the galaxy NGC 3972 (shown in the left panel of Figure 2). This galaxy has been observed in 12 epochs in 2015 using the F350LP filter on the WFC3/UVIS camera. A representative cepheid in this galaxy and its preliminary light curve are shown in the center and the right panels of Figure 2, respectively.

3 Next Steps

We are currently working on accurate PSF photometry of the Cepheids in SNIa galaxies. The next steps involve corrections for crowding and metallicity effects, and accurate modeling of the light curves to measure periods and mean luminosities. Our independent distance measurements to these SNIa host galaxies would either reveal or rule out systematic issues as a possible source of the tensions in the H_0 measurements.

We thank Fateme Kamali for kindly providing us with the H_0 vs. publication years plot (Fig. 1). This study has made use of Astroconda, AstroDrizzle, and Matplotlib packages, and the MAST data Archive.

References

Borgniet, S., Kervella, P., Nardetto, N., et al. 2019, A&A, 631, A37
Breuval, L. & et al. 2019, A&A, submitted
Hocde, V. & et al. 2019, A&A, submitted
Hoffmann, S. L., Macri, L. M., Riess, A. G., et al. 2016, ApJ, 830, 10
Kervella, P., Gallenne, A., Evans, N. R., et al. 2019a, A&A, 623, A117
Kervella, P., Gallenne, A., Remage Evans, N., et al. 2019b, A&A, 623, A116
Pietrzyński, G., Graczyk, D., Gallenne, A., et al. 2019, Nature, 567, 200
Planck Collaboration, Adam, R., Ade, P. A. R., et al. 2016, A&A, 594, A1
Planck Collaboration, Ade, P. A. R., Aghanim, N., et al. 2014, A&A, 571, A1
Riess, A. G., Casertano, S., Yuan, W., et al. 2018, ApJ, 855, 136
Riess, A. G., Macri, L. M., Hoffmann, S. L., et al. 2016, ApJ, 826, 56