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A STUDY ON THE UNIVERSALITY AND LINEARITY OF THE LEAVITT LAW IN THE LMC AND SMC GALAXIES

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The universality and linearity of the Leavitt law are hypotheses commonly adopted in studies of galaxy distances using Cepheid variables as standard candles. In order to test these hypotheses, we study the slope of the Leavitt law using linear regressions of fundamental-mode Cepheids observed by the OGLE project in the Magellanic Clouds.

Universality of the Leavitt law (LL) means that the slope of the LL is independent (or weakly dependent) on metallicity, implying that, in a photometric band, it is the same for all galaxies. Linearity means that there is a linear correlation between mean magnitudes and the logarithm of the pulsation periods of Cepheids.

To test these hypotheses we study the LL in optical bands without adopting the slope values reported by Udalski (2000). With this purpose, we apply two different approaches of linear fits: the ordinary least-squares (OLS) regression and the multiple least-squares (MLS) regression. With the MLS regression (García-Varela et al. 2013) we want to find the slope of the LL when the mathematical union of data sets of Cepheids from different galaxies is used, under the hypotheses that all data sets share the same slope (universality hypothesis), but each one has a different zero point.

We test the universality of the Leavitt law in the VI-bands and the Wesenheit index (W_I), by adopting the linearity hypothesis, through performing a mathematical union of the LMC and SMC Cepheids data (García-Varela et al. 2013). To do this we use the MLS without adopting the universal slope value reported by Udalski (2000). The slope obtained has a value in VI-bands that is consistent with that reported by Udalski (2000) for the LMC, but inconsistent in the W_I index, suggesting the universality of the Leavitt law in the VI-bands but not in the W_I index.

We also test the linearity of the LL through obtaining slopes in different ranges of periods, using the OLS for LMC and SMC samples, and using the MLS for the $LMC + SMC$ sample, in the

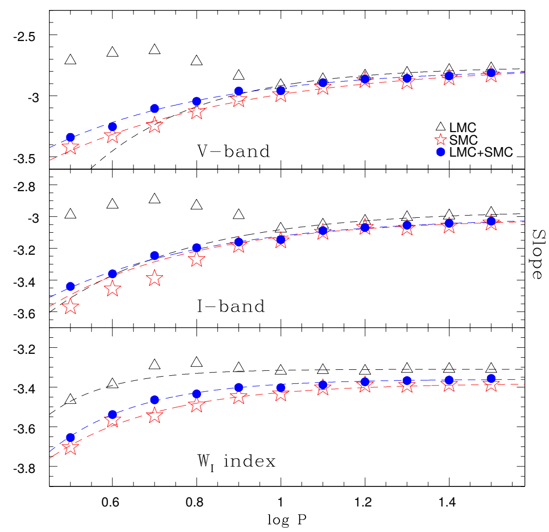

Fig. 1. Triangles and stars represent the slopes obtained through the OLS regression. Filled circles show the slope obtained with the MLS regression.

VI-bands and the W_I index. We take the ranges of periods starting at $logP = 0.5$, and varying the upper limit from $logP = 0.5$ up to $logP = 1.5$ with steps of 0.1. We find that, in the three cases, the slope values obtained are well fitted by exponential functions (Figure 1) given by following equation:

$$\eta = Ae^{-\beta \log P} + \mu, \qquad (1)$$

As a conclusion, we find that the slope of the LL for VIW_I-bands behaves exponentially with the logarithm of the pulsation period of Cepheids, suggesting that the Leavitt law is non-linear. We also find that the slope of the Leavitt law, obtained using long-period Cepheids can be considered as universal in the VI-bands, but not in the W_I index.

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