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Distance and Geometry of the Magellanic Clouds using the Period Wesenheit Relations of Classical Cepheids

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Classical Cepheids play a key role in constraining the astronomic distances. They are very bright variable stars, so they can be observed at great distances, and they obey to a well known Period Luminosity Relation (PL), so we can use the measured pulsation period and the observed magnitude to estimate the absolute magnitude.
According to theoretical models the PL relation is expected to depend on metallicity of Cepheids. This dependence seems to be negligible for Period-Wesenheit (PW) relations.
In order to delineate these relations, we collected the largest sample of Cepheids observed in the Magellanic Clouds, thanks to the OGLE - III project, which includes ~ 3000 Cepheids in the LMC and ~ 4000 in the SMC. The data set includes accurate optical (V and I bands) from the optical catalog OGLE- III CVS and NIR data (J H Ks bands) from the IRSF/SIRIUS Catalog.
Our results show that the PW relations are an excellent standard candle being metallicity insensitive in both slope and zero-point and at the same time being reddening insensitive and showing the least internal dispersion.Classical Cepheids play a key role in constraining the astronomic distances and are tightly connected with the Hubble constant determination. They are very bright variable stars, so they can be observed at great distances, and they obey to a well known Period Luminosity Relation (PL), so we can use the measured pulsation period and the observed magnitude to estimate the absolute magnitude.
Cepheids are intermediate-mass stars in the evolutionary stage of central Helium (He) and Hydrogen (H) shell burning. The evolutionary tracks of intermediate-mass stars follow a blue loop in the HR diagram. These loops are extended enough to cross the instability strip, a region in the HR diagram where the H and He ionization zones, being in specific layers of the stellar envelope, are able to induce stable radial pulsation in the star.
The finite width (in temperature) of the Instability strip introduces a scatter in the statistical PL relation for the Cepheids in the same galaxy, but this scatter is reduced if we use a PeriodLuminosity-Color (PLC) relation, that take into account the temperature effect. If we use the near infrared (NIR) bands J H Ks the scatter in the PL relation is lower, since the width of the Instability Strip is reduced. Moreover, according to theoretical models the PLC relation is expected to depend on metallicity of Cepheids [Bono et al. 2010]. This dependence seems to be negligible for Period-Wesenheit (PW) relations. The Wesenheit parameters are reddening-free magnitude that can be defined from multiband photometric data, assuming a reddening law [Cardelli, Clayton, and Mathis 1989]. The slope of the PW relations seems to be independent of the Cepheid metallicity and chemical composition, according to theoretical models and empirical results. We can then calibrate the PW relation with the HST parallaxes measurements of Galactic Cepheids and use them as standard candle.
Data.We collected the largest sample of Cepheids observed in these galaxies, thanks to the OGLE - III project, which includes ~ 3000 Cepheids in the LMC and ~ 4000 in the SMC. The data set includes accurate optical (V and I bands) from the optical catalog OGLE- III CVS and NIR data (J H Ks bands) from the IRSF/SIRIUS Catalog. We also adopt the position of each Cepheid, the luminosity amplitude and the phase of maximum from the optical catalog OGLE- III CVS .

Results. We conclude that there are evidence for an universal PW relation and we give the zero point and slope for optical and NIR bands. We found the LMC distance modulus (1) μ0 = 18.46 ± 0.003 (random error only) and LMC-SMC relative distance modulus (2) Δμ0 = 0.437 ± 0.003 (random error only), that implies dLMC = 49.2 ± 0.2kpc and dSMC = 60.3 ± 0.3kpc.. If the PW adopted can be used as a universal standard candle, we can estimate the individual distances of Cepheids in the MCs. From the

study of the three-dimensional distributions of the Cepheid we can infer the thickness of the LMC disc: hdisk = 7 ± 1kpc and the length of the SMC bar: lbar = 14 ± 1kpc, that is is longer than previous estimates.The LMC has a complex vertical structure along the line of sight, with evidence of a non-planar matter distribution. The SMC is more homogeneous than the LMC, with a line-of-sight depth that increases moving away from us, like a comet tail. In order to obtain more detailed informations

we plan to produce the mass distribution and the age distribution of Cepheids. We plan also to study the kinematics of the Cepheids in the sample. Moreover, with the GAIA mission, it will became possible to perform an independent calibration with geometric methods in order to reduce the systematic errors affecting the Cepheids distance scale.

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