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ORIGINAL ARTICLE

Distances to galaxies from the brightest stars in the Universe

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Abstract Blue Supergiants (BSGs) are the brightest stars in the universe at visual light with absolute magnitudes up to $M_V = -10$ mag. They are ideal stellar objects for the determination of extragalactic distances, in particular, because the perennial uncertainties troubling most of the other stellar distance indicators, interstellar extinction and metallicity, do not affect them. The quantitative spectral analysis of low resolution spectra of individual BSGs provides accurate stellar parameters and chemical composition, which are then used to determine accurate reddening and extinction from photometry for each individual object. Accurate distances can be determined from stellar gravities and effective temperatures using the "Flux Weighted Gravity–Luminosity Relationship (FGLR)".

Most recent results of the quantitative spectral analysis of BSGs in galaxies within and beyond the Local Group based on medium and low resolution spectra obtained with the ESO VLT and the Keck telescopes on Mauna Kea are presented and distances obtained with the FGLR-method are discussed together with the effects of patchy extinction and abundance gradients in galaxies. BSG metallicities and metallicity gradients are compared with results from strong-line H II region studies and the consequences for the empirical calibration of the metallicity dependence of the Cepheid period–luminosity relationship are pointed out. The perspectives of future work are discussed, the use of the giant ground-based telescopes of the next generation such as the TMT on Mauna Kea and the E-ELT and the tremendous value of the GAIA mission to allow for the ultimate calibration of the FGLR using galactic BSGs.

Keywords Galaxies: distances and redshifts · Galaxies: individual (M81, M33, NGC 300, WLM) · Stars: abundances · Stars: early-type · Supergiants

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1 Introduction

After the detection of the accelerated expansion of the universe the physical explanation of dark energy has become the major challenge of astronomy and physics. One way to constrain the physics behind dark energy is to measure the equation-of-state parameter $w = p/(\rho c^2)$. This requires an extremely accurate determination of the extragalactic distance scale and the Hubble Constant H_0. As is well known (Macri et al. 2006), the determination of cosmological parameters from the cosmic microwave background is affected by degeneracies in parameter space and cannot provide strong constraints on the value of H_0 (Spergel 2006; Tegmark et al. 2004). Only if additional assumptions are made, for instance that the universe is flat, H_0 can be predicted with high precision (i.e. 2%) from the observations of the cosmic microwave background, baryonic acoustic oscillations and type I high redshift supernovae. If these assumptions are relaxed, then much larger uncertainties are introduced (Spergel et al. 2007; Komatsu et al. 2009). The uncertainty of the determination of w is related to the uncertainty of H_0 through $\Delta w/w \approx 2\Delta H_0/H_0$. Thus, an independent