Thesis summary:

Precise distance measurements to selected Local Group galaxies.

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Distance determinations are one of the most important and difficult measurements in astronomy. They allow us to set the structure of the Universe, energy scale of astrophysical phenomena, and value of the physical constants – in particular Hubble'a constant.

Comparison of measurement results for numerous galaxies shows discrepancy between different methods. Distance determinations are dominated by different systematic errors, of which the most important are reddening, population effects and zero point calibration.

In my thesis I investigate the impact of systematic errors on three distance indicators: the brightness of Cepheids, brightness of the Tip of the Red Giant Branch, and the mean magnitude of the Red Clump.

In first part of my thesis I present distance measurement to the M33 galaxy, for which the discrepancy of the distance measurements is up to 30 %. Based on infrared and optical photometry of 26 Cepheid I have obtained the distance moduli of 24.62 $\pm$ 0.03 (rand.) $\pm$ 0.06 (syst.) mag. The value is consistent with contemporary designations based on optical measurements of the brightness of Cepheids, but is smaller by about 0.2-0.3 mag in relation to such methods as FGLR or eclipsing binaries. By using optical and infrared bands, I have obtained accurate value of reddening ($E_{BV} = 0.19 \pm 0.02$ mag). The resulting distance is slightly dependent on the value of the extinction law, reddening, metallicity and population effects.

In the following part of the thesis I investigate the impact of systematic errors on the brightness of the Tip of the Red Giant Branch in the optical and infrared bands. On the basis of TRGB brightness I have obtained distance to four Local Group galaxies: LMC, SMC, WLM and IC 1613.

The distance to the Large Magellanic Cloud determined in the K-band TRGB brightness is higher by 0.2 mag compared to the "classic distance" (18.50 mag). However, in the I band it is smaller by 0.2 mag. Those differences are much larger than the statistical measurement uncertainty (0.04 mag), which proves the existence of a systematic error predicted by the synthetic stellar population models. This effect is associated with the presence of relatively young stars on the red giant branch.

Distances derived for other three galaxies confirm the existence of this population effect. The relative distance between the LMC and the individual galaxies have the same value in the bands J, K and in the bolometric brightness, they are also consistent with the relative distances derived with other methods – infrared brightness of Cepheid variable stars and eclipsing binaries.

Determination of the distance based on the TRGB bolometric luminosity and color of red giant branch leads to a result which is consistent with Cepheides and eclipsing binaries and hardly depends on the population effects described above.

In the last part of the thesis I analyze impact of the population effects on the brightness of the Red Clump stars. Based on the photometry of the Hubble Space Telescope I have measured the average brightness of RC stars in the 15 nearby galaxies. I compared mean RC brightness with the bolometric brightness of the tip of the red giant branch (TRGB) in those galaxies, which is a very small dependent on the metallicity and other population effects. RC absolute magnitude of stars is different for different galaxies and in extreme cases can be up to 0.4 mag in comparison to the average RC brightness in the Milky Way. This effect is consistent with expectations based on synthetic stellar population models.