Short Period Variables in Leo A

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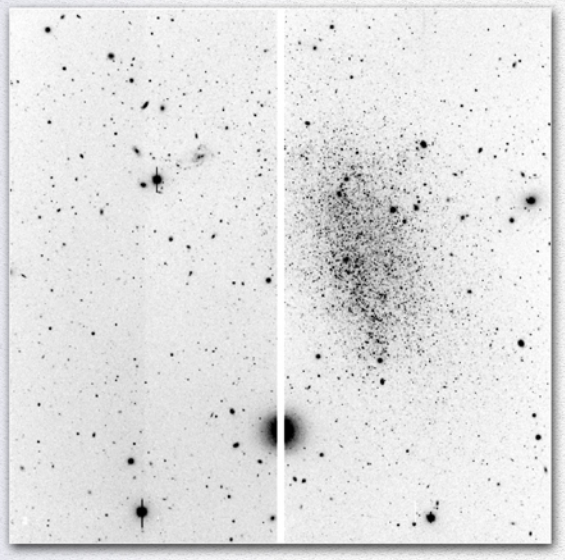
Leo A is a dwarf irregular galaxy in the Local Group, lying at a distance of slightly under 1 Mpc. Recent HST observations (Tolstoy et al. 1998, AJ, 116, 1244) have suggested that Leo A may have begun forming stars only within the past couple Gyr. Because of many young main sequence stars, determining the presence or lack of a horizontal branch from the CMD alone is impossible; we therefore set out to detect RR Lyraes based on their variability.

Observations of Leo A were obtained at the WIYN 3.5m telescope on the nights of 20-22 December 2000, using the MIMO (mini-mosaic) camera. We obtained 23 images in *V* and 5 in *R*, most having exposure times of 30 minutes and all with sub-arcsecond seeing. Using an adaptation of the HSTphot (Dolphin 2000, PASP, 112, 1383) package and variable star finding algorithms, we have identified 92 candidate variables. The variable star population was clearly divided into two populations: 8 RR Lyraes and 84 short-period Cepheids.



Deep V image of Leo A, created by co-adding 22 individual frames. The field of view is 9.6 x 9.6 arcmin. North is to the left and east is down.

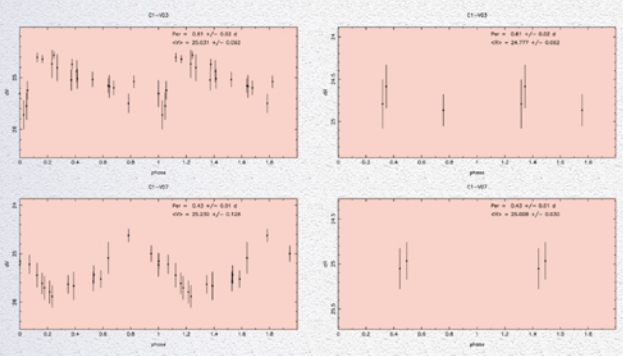
RR Lyraes: Because of severe crowding that prevented the photometry of RR Lyraes in the main body of the galaxy, we had only eight candidate RR Lyraes. Judging from the quality of the photometry and light curves, we conclude that two are definite RR Lyraes, two others are most likely RR Lyraes, and the remaining four are probably RR Lyraes. The discovery of RR Lyraes in Leo A establishes the presence of an ancient population of stars.

Taking the most conservative estimate (using only the two best), we measure an RR Lyrae mean magnitude of $\langle V \rangle = 25.10 \pm 0.09$. Adopting an extinction of Av = 0.06 and the absolute magnitude calibration of Carretta et al. (2000, ApJ, 533, 215), we calculate a true distance modulus for Leo A of

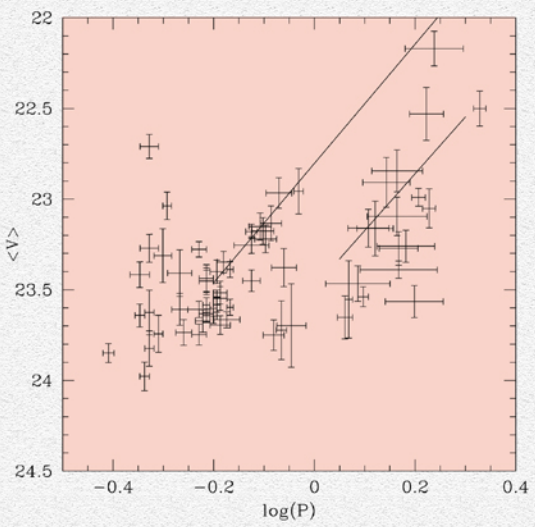
$$(m\text{-}M)_0 = 24.51 \pm 0.12,$$

which corresponds to a distance of 0.80 ± 0.04 Mpc.

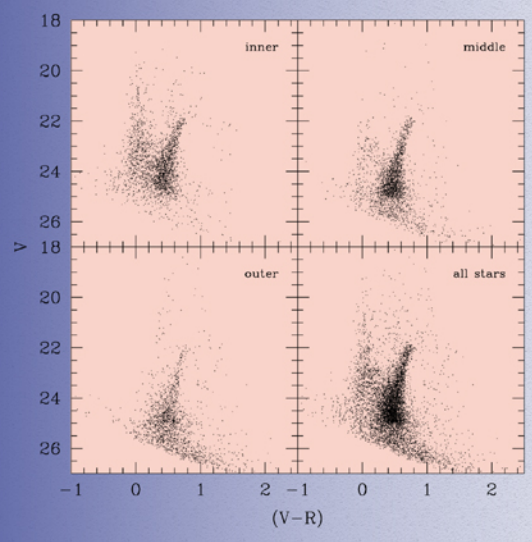
Stellar Populations: Comparing color-magnitude diagrams of different regions in the galaxy, one sees that, while red giants are distributed throughout the image, blue stars (main sequence and helium burners) are highly concentrated in the visible portion of the galaxy. We interpret this as evidence of a halo of old stars.



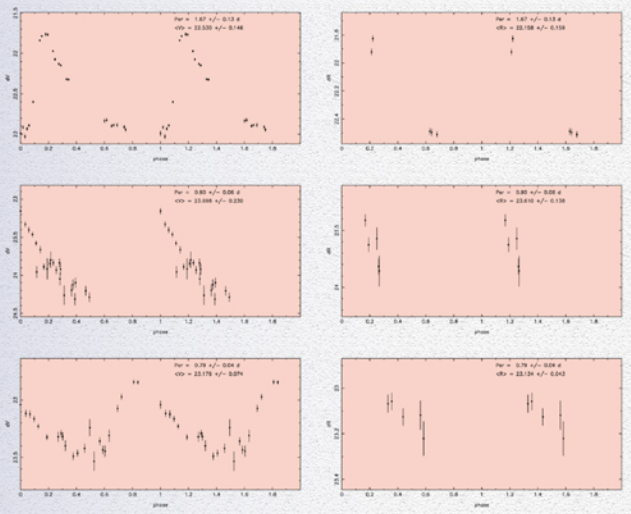
Light curves of our two best RR Lyraes.



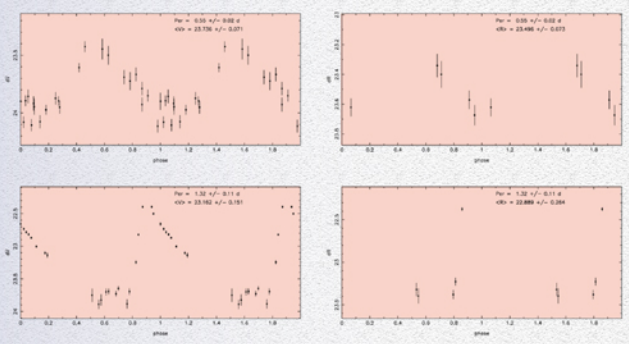
Period-luminosity diagram of Leo A Cepheids. The two lines are the mean relations of short-peroid SMC Cepheids (Udalski et al. 1999, AcA, 49, 437).



Color-magnitude diagrams of Leo A, divided by region. The inner CMD includes the main body of the galaxy, the middle CMD contains the outskirts of the visible extent of the galaxy, and the outer CMD contains the remainder of the field.



Above are light curves of three fundamental-mode Cepheids. Below are light curves of two first-overtone Cepheids.



Cepheids: Although our observing strategy was designed to detect RR Lyraes, we found that most of the detected variable stars are short-period Cepheids. This was something of a surprise, given the relatively unsuccessful Cepheid search of Hoessel et al. (1994, AJ, 108, 645), which had been optimized to find variables with periods of roughly 10 days or more. A period-luminosity relation calculated using short-period the SMC Cepheids observed by Udalski et al. (1999, AcA, 49, 437) shows that Leo A's Cepheid population follows the expected relations for fundamental-mode and first-overtone pulsators.

We find that Leo A's Cepheids have shorter periods (or fainter magnitudes) and are more numerous (compared with the host galaxy's luminosity) than those of any other galaxy. We interpret both differences as metallicity effects, since the blue loops intersect the instability strip at fainter magnitudes for populations with lower metallicities. Though previously unseen in significant numbers, short-period Cepheids should be common in all metal-poor galaxies with ongoing or very recent star formation and thus should not be termed ``anomalous.''

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