OBSERVATIONS OF COLD DEGENERATE STARS

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1 Abstract.

Spectrophotometry, BVRI CCD photometry and CCD trigonometric parallaxes of the southern DC stars vB3, ER8 and ESO 439-26 are presented. These stars should be considered among the lowest luminosity degenerates known, with absolute visual magnitudes of 15.4, 16.2 and 17.2 respectively.

2 Introduction.

Recently the study of cold DC type white dwarfs has received considerable attention. These old stars can provide crucial information about the star formation history of the Galaxy, the age of the galactic disk (Winget et al. 1987) and also give observational constraints necessary to the formulation of cooling theories of white dwarfs.

One of the controversial issues related to these very low luminosity degenerates is their number density, that is the trend of the White Dwarf's Luminosity Function at its faint end. There is also the question of their bolometric magnitudes, which provides information about sizes and masses of WDs. In both cases it is important to obtain their distances and apparent magnitudes with accuracy.

Motivated by the importance of cold DC stars, we included a few of them in a CCD parallax program of faint southern nearby stars presently under way at our institution (Anguita and Ruiz, 1988).

3 Observations.

Good signal-to-noise spectrophotometry of vB3, ER8 and ESO439-26 was obtained in March 1988 at La Silla (ESO) using the 3.6m telescope and EFOSC (ESO Faint Objects Spectrograph and Camera) with the B300 grism covering the spectral range between 3800 Å and 6900 Å with about 20 Å resolution. The spectra thus obtained are shown in Figures 1, 2 and 3.

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TABLE 1

	vB3	ER8	ESO439-26
V	16.59	17.05	20.34
B-V	+1.20	+1.40	+1.3
V-R	+0.63	+0.73	+0.37
R-I	+0.57	+0.60	+0.44
Parallax (")	0.0575±0.0031	0.0676±0.0033	0.0240±0.0090
Distance (pc)	17.4±1	14.8±0.8	41.7^{+25}_{-10}
M_V	15.4±0.1	16.2±0.1	$17.2^{+.7}_{-1}$
μ ("/year)	1.7015±0.0063	2.1812±0.0020	0.3972±0.0140
$\mu\alpha \cos\delta$ ("/year)	-0.2796	-2.1805	-0.3960
$\mu\delta$ ("/year)	+1.6784	-0.0542	+0.0307
v_t (km/s)	140±8	153±8	78^{+45}_{-25}

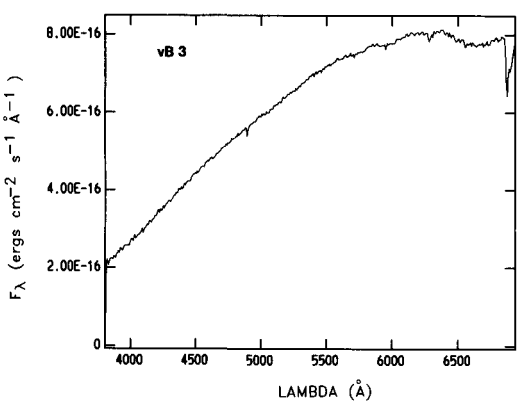

Figure 1. Spectrum of vB3 taken with the ESO 3.6m telescope. The integration time was 1 hour.

CCD photometry of vB3 has been published by Kunkel et al. (1984) their results together with our CCD photometry for ER8 and ESO439-26 obtained in March 1988 at Las Campanas 1m telescope equipped with a TI chip, is summarized in Table 1.

The CCD parallaxes and proper motions obtained by Anguita and Ruiz (1988) using the CTIO 1.5m telescope and an RCA chip are also given in Table 3.

Figure 4 is a finding chart for ESO439-26, its 1986.1 coordinates for the equinox 1950.0 are: $\alpha=11^h\ 36^m\ 33\overset{s}{.}4$ and $\delta=-28°\ 35'\ 39''$. This star was found during a search for faint nearby stars (Ruiz et al. 1988).

3. Results.

The spectra in Figures 1, 2 and 3 look very similar with a smooth continuum showing a broad shallow absorption near 6600 Å, this feature

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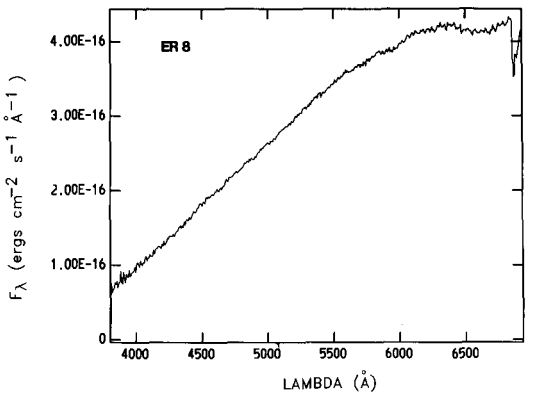

Figure 2. Spectrum of ER8 taken with 1 hour of integration.

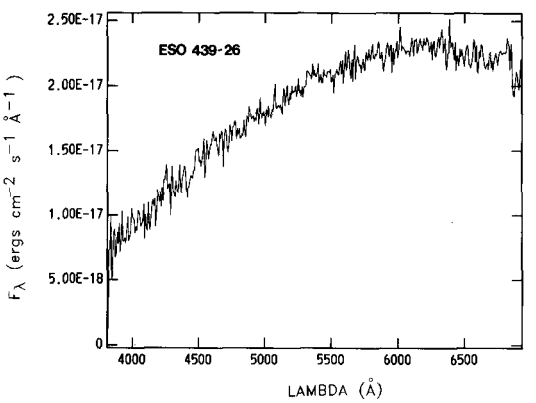

Figure 3. Spectrum of ESO439-26 taken witn 3 hours of integration.

was also observed in the DC star ESO439-163 (see Ruiz and Maza this volume). Other faint non DC stars observed during the same run did not show the broad shallow feature, suggesting that it might be real and not an artifact of the observing or reduction procedures. The identification of the 6600 Å feature with Hα is tempting; however a definite ID should await the fitting of an appropriate model atmosphere to the observed spectra.

The CCD photometry given in Table 1 show that the spectral distribution of these cold degenerates differ from one another. It is clear that even when their B-V colors are similar (like ESO439-26 and ER8) their V-R and R-I colors are different and so are their bolometric corrections, which do not correspond to that of a black body at a given temperature. The bolometric corrections for these stars are probably close to 0.0 (Liebert et al. 1988), therefore an estimate of their luminosities can be obtained from the visual absolute magnitudes in Table 1, taking BC=0.0. They turn out to be:

$$L\ (vB3) = 5.5 * 10^{-5}\ L_{\odot}$$

$$L\ (ER8) = 2.6 * 10^{-5}\ L_{\odot}$$

$$L\ (439\text{-}26) = 1.0 * 10^{-5}\ L_{\odot}$$

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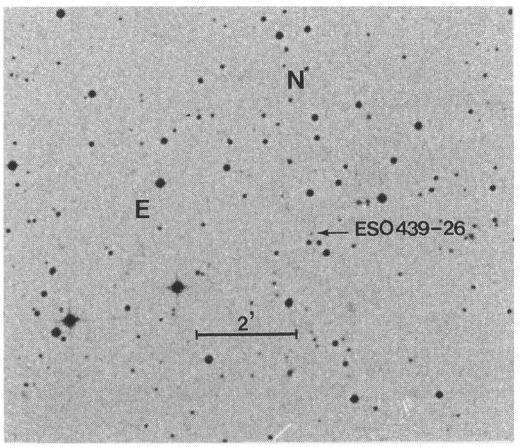

Figure 4. Finding chart for the star ESO439-26.

The large differences observed in the luminosities are partly due to differences in their BC and partly the consequence of a different evolutionary history suggesting that isolated white dwarfs like ER8 and ESO439-26 are more massive than those members of a binary like vB3, giving some weight to the bi-modal star formation hypothesis (Larson, 1986).

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