SPECTROPHOTOMETRY OF THE NEW COMMON-PROPER-MOTION PAIR ESO 440-55A/55B

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ABSTRACT

Spectrophotometry of the common-proper-motion pair ESO 440-55a/55b indicates that 440-55a ($m_V \approx 19.3$) is a DZ 7 showing lines of Ca II, Ca I, Mg I, and Fe I, with no He or H lines present, while 440-55b is an M5 red dwarf with $m_V \approx 20.2$. Its proper motion $\mu = 0.22 \pm 0.04''$/yr ($\theta = 273°$) at an estimated distance of 120 pc implies a tangential velocity $v_T = 125$ km s^{-1} and a separation between the stars of 9.4×10^{15} cm.

I. INTRODUCTION

Less than about 3% of all known white dwarfs (Sion *et al.* 1988) show lines of Ca, Mg, Fe, and other heavy elements. These stars are classified as DZ by Sion *et al.* (1983). Three hypotheses about the origin of metals in DZ stars have been discussed in the literature: (1) Metals are dredged up by convection (Greenstein 1976); (2) Rotation stops gravitational diffusion of heavy elements (Strittmatter and Wichramasinghe 1971); (3) Metals are accreted from the interstellar medium when the star encounters an interstellar cloud (Truran *et al.* 1977). The observational consequences of this last idea have been discussed by Wehrse and Liebert (1980). The first two explanations consider that the metals belong to the star and thus would require a certain pattern in the relative abundances, which is not observed (Zeidler *et al.* 1986); relative abundances and compositions vary strongly from star to star (Liebert *et al.* 1987). ESO 440-55a is a DZ 7 showing lines of Ca II, Ca I, Mg I, and Fe I whose study might help in deciding what mechanism provides metals to the atmospheres of these degenerates.

The pair was discovered during a search program for faint nearby stars (Ruiz *et al.* 1988). Figure 1 [Plate 119] is a finding chart for them; their 1979.2 coordinates for equinox 1950.0 are

440-55a, $\alpha = 12^h04^m03\overset{s}{.}2$, $\delta = -31°20'30''$,

440-55b, $\alpha = 12^h04^m03\overset{s}{.}3$, $\delta = -31°20'25''$.

II. OBSERVATIONS

Spectrophotometry of both stars was obtained in March 1988 at the European Southern Observatory (La Silla) with the 3.6 m telescope equipped with EFOSC (Faint Object Spectrograph and Camera), the B300 grism, and an RCA CCD (#3) as a detector. This setup gave a spectral coverage from 3800 Å up to 6900 Å. The slit was 2" wide, which gave a resolution of about 20 Å. During the night, three photometric standards and several He–Ar spectra were observed in order to flux and wavelength calibrate the spectra. The seeing during the night was $\sim 1.5''$ under photometric conditions. The flux and wavelength calibrations were performed at the CTIO La Serena computer facilities using IRAF. A proper motion $\mu = 0.22 \pm 0.04''$/yr in the direction $\theta = 273°$ was obtained using a pair of glass copies of the ESO *R* Survey with a time base of 5 yr.

III. RESULTS AND DISCUSSION

The spectrum of ESO 440-55b in Fig. 2 corresponds to that of a red dwarf. The strength of the TiO and CaOH bands indicates a spectral type of M5. The apparent visual magnitude obtained from the spectrum in Fig. 2 is $m_V \approx 20.2$. According to Wing and Dean (1983), an M5 dwarf has an absolute visual magnitude $M_V \simeq 14.8$, which would imply a distance of 120 pc. At that distance, the separation between the stars would be $\sim 9.4 \times 10^{15}$ cm, which rules out any possible interaction during their evolution, and the tangential velocity of the system would amount to 125 km s^{-1}, typical of the old halo population.

From the spectrum in Fig. 3, the apparent visual magnitude of ESO 440-55a is $m_V \approx 19.3$, implying an absolute visual magnitude $M_V \approx 13.9$ at a distance of 120 pc. The spectral distribution of 440-55a to the red of 4500 Å corresponds to a blackbody at $T_{BB} \approx 7000$ K. No traces of H lines are visible in the spectra, while strong Ca II, Mg I, and Fe I are present. In Table I, the equivalent widths of the strongest lines are given.

For accretion from the ISM to be responsible for the metals in the atmospheres of DZ stars, a selective mechanism that inhibits the accretion of hydrogen has to be invoked. Several such mechanisms have been proposed (Liebert *et al.* 1987; Fontaine and Michaud 1979; Wesemael and Truran 1982; Zeidler *et al.* 1986); however, an empirical lower-tem-

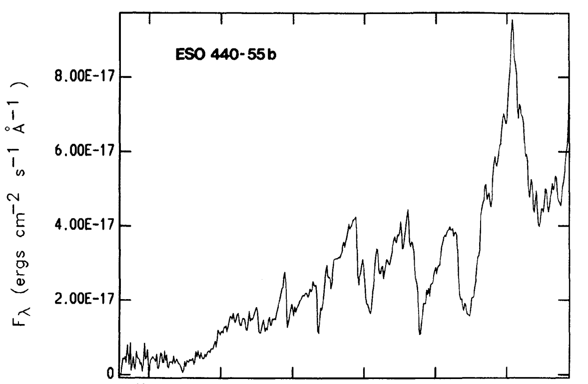

FIG. 2. Spectrum of ESO 440-55b obtained with the ESO 3.6 m telescope at La Silla equipped with EFOSC, the B300 grism, and an RCA CCD. The integration time was 2 hr.

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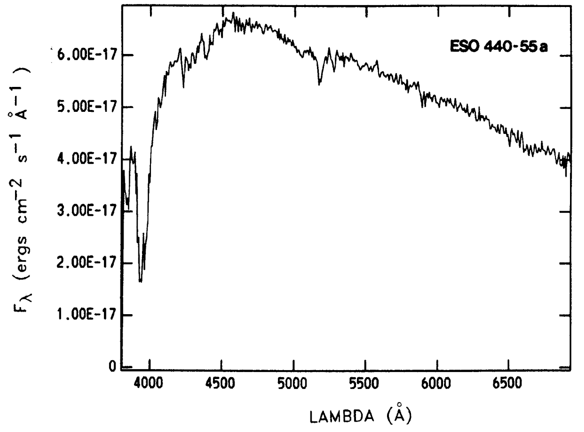

FIG. 3. Spectrum of ESO 440-55a obtained with the same equipment and integration time as in Fig. 2.

perature limit at $T = 11\,000 \pm 1000$ K has been found necessary for the hydrogen screening mechanisms to work efficiently (Liebert *et al.* 1987). ESO 440-55a, with a temperature of ~ 7000 K and no traces of hydrogen lines in its spectrum, does not fit into the proposed schemes of selective accretion, and thus might provide valuable information regarding the origin of metals in DZ stars.

TABLE I. Absorption lines in the spectrum of ESO 440-55a.

λ (Å)	Equivalent width (Å)	Identification
3839 (blend)	5.69	Mg I (3)
3933 + 3969	46.55	Ca II (*H* + *K*) (1)
4227	1.99	Ca I (2)
4384	2.48	Fe I (41)
5046	2.80	?
5173 + 5184	5.61	Mg I (2)
5270	1.47	Fe I (15)
5456	0.96	Fe I (15)

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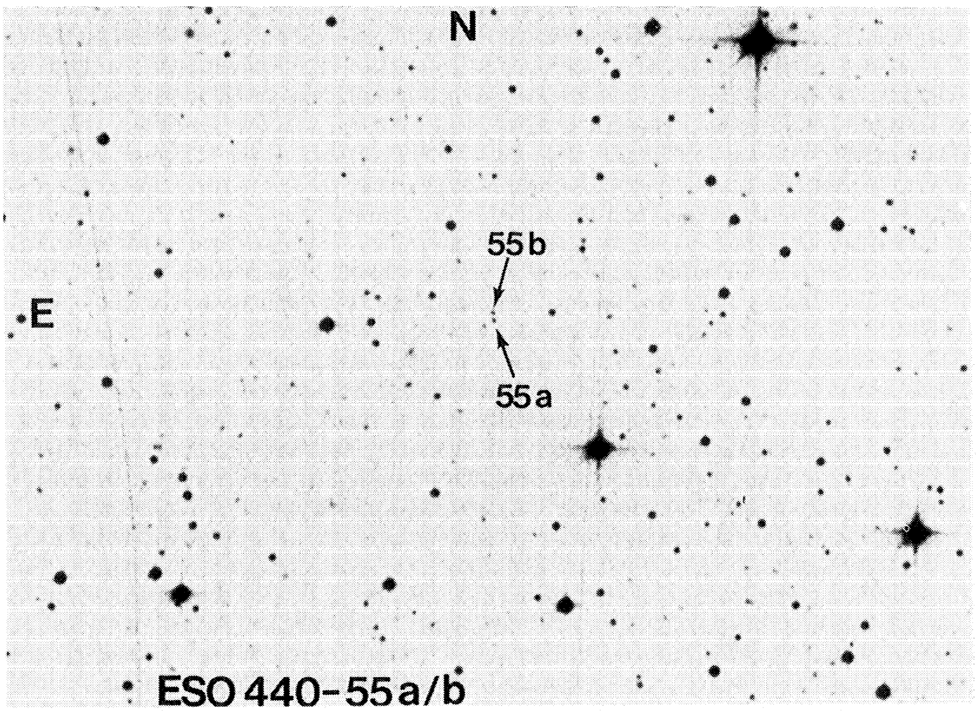

FIG. 1. The position of ESO 440-55a and 55b is indicated in a reproduction of the ESO *R* sky survey. The distance between the stars is 5."4.

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