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A PHOTOMETRIC AND SPECTROSCOPIC SEARCH FOR WHITE DWARFS IN THE YOUNG OPEN CLUSTER IC 2602

BARBARA J. ANTHONY-TWAROG[1]
Yale University Observatory
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ABSTRACT

A *UBV* photographic survey of the young open cluster IC 2602 has been carried out with the aim of finding white dwarf remnants in the cluster. Approximately equal numbers of white dwarfs and blue subdwarfs have been detected and observed spectroscopically; none of the white dwarfs appears to have a common evolutionary origin with the 20-million-year-old cluster. The relatively high number of hot subdwarfs in the field and its implications for similar photometric surveys is discussed.

Subject headings: clusters: open — stars: subdwarfs — stars: white dwarfs

I. INTRODUCTION

Surveys for white dwarfs in open clusters have been part of a larger effort to determine the latest courses of evolution for intermediate mass stars, i.e., stars with initial masses in the range of 3–8 $\mathscr{M}_\odot$. In particular, the upper mass limit for white dwarf progenitors is not precisely known. The presence of white dwarfs in the Hyades cluster implies both that mass loss has affected the pre-white-dwarf evolution (Auer and Woolf 1965) and that the original masses of the progenitor stars probably exceeded the turnoff mass of the cluster, about 2 $\mathscr{M}_\odot$. Further comparison of the remnant population to that of the cluster implied that progenitor masses as high as 4 $\mathscr{M}_\odot$ were possible (van den Heuval 1975). Other open clusters have been searched with the presumption that association of a white dwarf with a cluster implies a probable progenitor mass greater than the turnoff mass of the cluster (Hartwick and Hesser 1978). A possible member of the Pleiades, white dwarf LB 1497 (Luyten and Herbig 1960) would indicate a progenitor mass of 5–8 $\mathscr{M}_\odot$, and most recently Romanishin and Angel (1980) have presented photometric evidence for a white dwarf in M35, implying a progenitor mass of 5–7 $\mathscr{M}_\odot$.

A variety of other techniques has been brought to bear upon the problem of an upper mass limit for white dwarf progenitors, including statistical comparisons of birthrates and deathrates of main-sequence stars, planetary nebulae, supernovae, and pulsars, with somewhat inconclusive results. Our general understanding of the late stages of stellar evolution, as well as the more specific understanding of the conditions leading to explosive stellar deaths, is dependent on the result.

This work represents part of a survey of open clusters ranging in ages from 20 million to several hundred million years. Candidates have been selected on the basis of *UBV* colors from photographic photometry. IC 2602 is one of the youngest clusters accessible to such a search. Although it is not a particularly rich cluster, at least one remnant star might be expected if the progenitor mass were originally 1–4 solar masses greater than the present turnoff mass. Thus, a white dwarf member in the cluster would imply a progenitor mass of 8–11 $\mathscr{M}_\odot$ if the turnoff mass is 7 $\mathscr{M}_\odot$, and 10–13 $\mathscr{M}_\odot$ if the present turnoff mass is 9 $\mathscr{M}_\odot$. The following sections will describe the observational material upon which this survey is based, and the last section will discuss the implications of the results.

[1] Visiting Astronomer, Cerro Tololo Inter-American Observatory, supported by the National Science Foundation.

II. IC 2602 (θ CARINAE CLUSTER)

IC 2602 is a loose, nearby cluster of approximately 2° in angular diameter, surrounding the member star θ Car. Earlier *UBV* photometric studies by Whiteoak (1961) and Braes (1962) suggested a distance of about 155 pc for the cluster. This conclusion has not been substantially altered by subsequent *UBV* and Strömgren studies by Hill and Perry (1969) and Eggen (1972). The latter investigations derive a reddening for the cluster of $E_{B-V} = 0.04$.

The cluster and its color-magnitude diagram are dominated by θ Car, which is fully two magnitudes brighter than the next brightest cluster members. As Hill and Perry pointed out, there is an inconsistency between the cluster age implied by the sequence of pre-main-sequence stars, about 20 million years, and the apparent evolutionary age of θ Car if it is a main-sequence star, about 7 million years.

This inconsistency has been resolved by a confirmation of Eggen's(1972) suggestion that θ Car is a blue straggler and not representative of the cluster turnoff. Walborn (1979) has demonstrated that θ Car is the brighter member of a binary system, and as such may be an evolved star or the product of a symbiotic system.

Inspection of the colors and spectra of the second and third brightest and bluest stars, as suggested by Taff and Littleton (1973) and Harris (1976), suggest an age of 25 million years, based on a similarity to the Harris age group III with a corresponding turnoff mass of 6–8 $\mathscr{M}_\odot$. These same stars, if representative of the turnoff, also imply an age of 20–30 million years and a turnoff mass of 7–9 $\mathscr{M}_{\odot}$ when compared to the evolutionary models of Becker (1980) for composition $Y = 0.28$ and $Z = 0.02$. This age and turnoff mass is in keeping with the general kinematic and spectroscopic similarity of IC 2602 to members of the Pleiades moving group, which has been pointed out by Eggen (1965, 1972) and Kraft (1967).

III. PHOTOELECTRIC PHOTOMETRY

Whiteoak (1961) published a *UBV* photoelectric sequence for the field of IC 2602, which extends to $V \sim 10.7$, approximately the faint end of the main sequence of the cluster. This sequence has been extended to $V \sim 15.5$ by observations on the 1 m and the 0.9 m telescopes at the Cerro Tololo Inter-American Observatory in Chile, using S-20 photocathode photometers with standard (blocked) *UBV* filter sets. The observations were reduced using Landolt's (1973) equatorial network of *UBV* standards. No differences of greater significance than the photometric errors were detected by a comparison of stars in common with Whiteoak's sequence. Finding charts for the new standards are in Figures 1 and 2.

Table 1 lists the magnitudes and colors for the photoelectric sequences used in the reduction of the photographic material. The sources of the photoelectric values are indicated by an AT for this survey, and a W for values taken from Whiteoak's published lists. For those standards based on CTIO photometry, the number of observations as well as standard deviations are given. Multiple observations were combined using as weights the rms deviations from the standard transformations for individual nights. Stars with numbers less than 147 in the table and in Figures 1 and 2 are on the numbering system of Braes (1962).

TABLE 1

PHOTOELECTRIC SEQUENCES

Star	V	$B-V$	$U-B$	Source	N	$\sigma_{(V)}$	$\sigma_{(B-V)}$	$\sigma_{(U-B)}$
			Stars Used in Reduction of the W Plates					
6	9.55	0.52	...	W	...	...	...	...
6A[a]	11.70	1.26	0.94	AT	2	0.02	0.02	0.03
12	8.97	0.08	−0.33	AT	4	0.04	0.02	0.04
24	9.45	0.29	0.16	AT	5	0.04	0.02	0.04
77	10.37	0.19	0.06	AT	1	0.03	0.03	0.06
79	10.01	0.50	0.22	W	...	...	...	...
79A	10.99	1.10	0.79	AT	3	0.02	0.02	0.03
202	14.72	0.45	0.11	AT	5	0.04	0.03	0.04
203	15.01	1.29	...	AT	3	0.03	0.02	...
205	14.12	0.86	...	AT	4	0.04	0.03	...
221	14.37	1.68	...	AT	5	0.03	0.02	...
261	11.63	0.34	0.10	AT	7	0.04	0.02	0.04
262	12.12	1.33	1.10	AT	7	0.03	0.02	0.04
263	10.96	1.73	1.95	AT	2	0.02	0.02	0.03
			Stars Used in the Reduction of the E Plates					
42	9.41	0.32	0.25	W	...	...	...	...
55	8.51	1.16	1.04	W	...	...	...	...
59	8.99	0.50	0.06	W	...	...	...	...
60	9.31	0.17	−0.14	AT	9	0.03	0.02	0.04
60A[b]	13.80	0.78	0.26	AT	7	0.03	0.02	0.04
98	10.11	1.21	1.07	W	...	...	...	...
100	10.08	1.63	1.90	W	...	...	...	...
101	9.76	0.11	−0.26	W	...	...	...	...
131	10.06	0.49	0.03	W	...	...	...	...
133	8.97	1.16	0.77	AT	1	0.02	0.02	0.03
133A[c]	12.42	0.54	0.40	AT	9	0.03	0.02	0.04
304	11.23	0.43	0.28	AT	4	0.04	0.02	0.04
306	13.12	0.74	0.12	AT	2	0.03	0.02	0.04
308	12.63	0.63	0.23	AT	1	0.05	0.02	0.06
309	14.18	0.40	0.09	AT	1	0.04	0.02	0.03
310	13.67	0.29	0.13	AT	5	0.04	0.02	0.04
311	12.38	0.46	0.22	AT	1	0.05	0.02	0.06
312	14.67	1.31	...	AT	4	0.04	0.02	...
330	15.61	0.73	0.17	AT	3	0.04	0.02	0.05

[a] Star 6A is 3.′7 southeast of Braes 6.
[b] Star 60A is 0.′5 southwest of Braes 60.
[c] Star 133A is 2.′4 southeast of Braes 133.

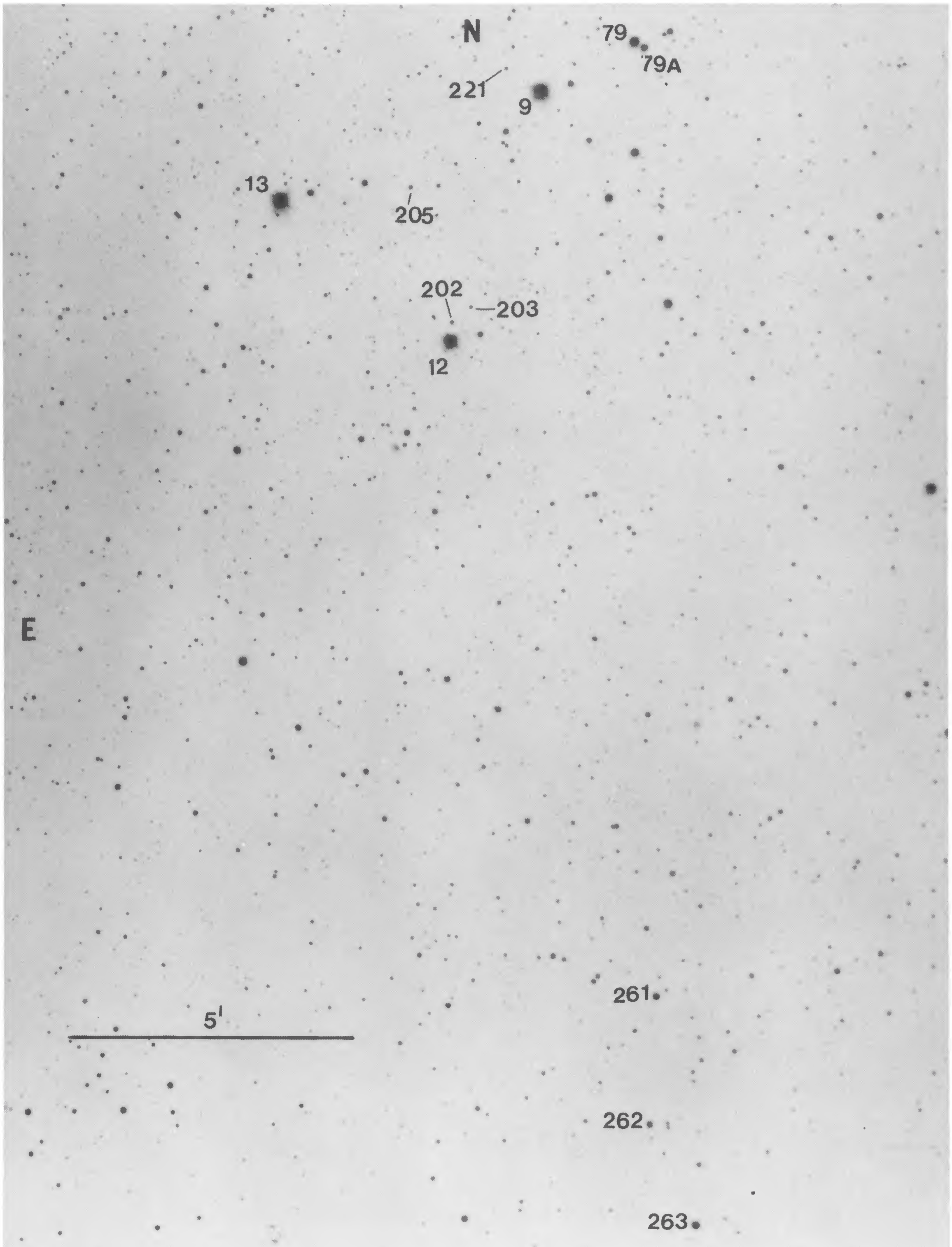

FIG. 1.—Identification chart for new photoelectric standards in the IC 2602 W field, from a *B* plate. Stars with numbers less than 147 are on the numbering system of Braes (1962). Secondary images produced by the sequence-extending wedge can be seen 2″ N and 32″ W of the primary images.

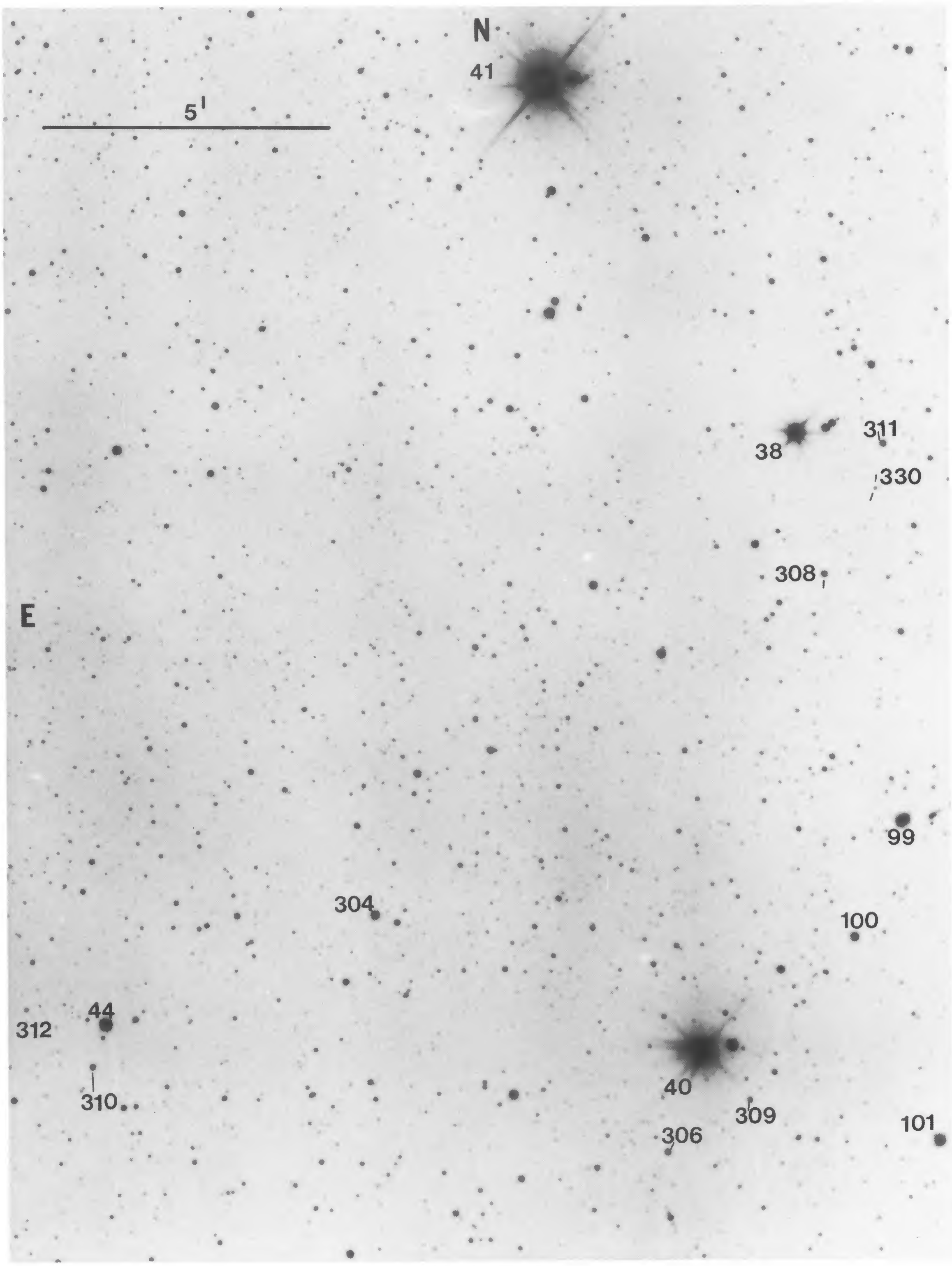

FIG. 2.—Identification chart for new photoelectric standards in the IC 2602 E field, also from a *B* plate.

IV. PHOTOGRAPHIC MATERIAL

UBV plates of IC 2602 were obtained at the Cassegrain focus of the CTIO 1.5 m telescope in 1978 May. Two plate fields, centered at $(\alpha_{78}, \delta_{78}) = 10^h44^m.7, -64° 16'.9$ and $10^h35^m.5, -64° 17'.6$, nearly cover the cluster and are denoted E and W, respectively. The plate material is described more fully in Table 2. All plates were exposed with the 16 cm sequence extending wedge.

The plates were measured on the Cuffey iris photometer at Yale University. The iris data were fit to the photoelectric standards by a maximum likelihood fit to a third-order polynomial function of the iris readings. The difference in magnitude between the primary and secondary images was solved as a free parameter in the solution. Derived values from each plate for Δm are included in Table 2; the mean Δm for the E plates is 4.39 ± 0.04, and 4.54 ± 0.18 for the W plates. The discrepancies for the two fields largely reflect the independence of the photoelectric standard sets used and the relative paucity of standards in the W field. In the final reduction of the photographic material, Δm was set at 4.39 for both cluster fields. Color terms were applied in the reduction of all plates in the sense $m_{pg} = m_{pe} +$ (color term) × (color), with values for the *V*, *B*, and *U* plates equal to −0.16, 0.07, and 0.10, respectively.

Candidates for iris measurement were selected by a comparison of *U* and *V* plate pairs on the blink comparator at Yale. As a control test, 65 stars on the IC 2602 E plates that were judged to be slightly bluer than average were measured as well as the strikingly blue stars. Reduction showed that none of these 65 stars had $(U-B)$ colors bluer than 0.00.

Thirty-four candidates were judged to be considerably brighter in the ultraviolet than in the visual. Of these, eight were found to have *V* magnitudes between 16 and 19 and colors near the blackbody relation. The color-magnitude and color-color diagrams for the candidates are shown in Figures 3 and 4, with the photoelectric cluster sequence of Whiteoak shown in Figure 3 for comparison. The eight candidate stars are further described in Table 3, and their positions are indicated on finding charts in Figures 5 and 6. The color-color diagram of Figure 4 shows the dwarf sequence of FitzGerald (1970) and the blackbody color-color line of Arp (1961). Some of the rest of the 34 blink candidates are also plotted in the color-color diagram. Of the twelve remaining blink candidates, four were determined to be "tertiary" images of the

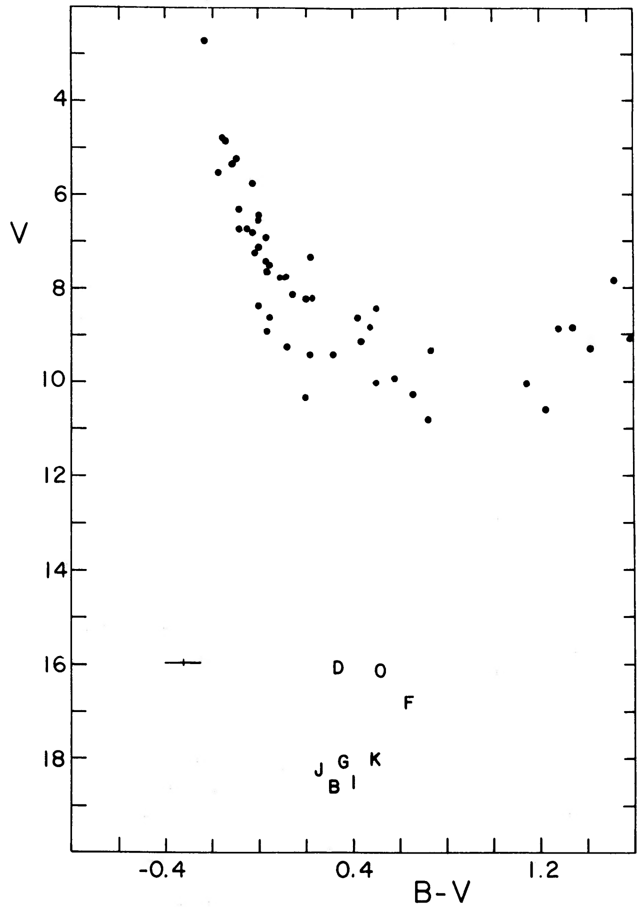

FIG. 3.—Color-magnitude diagram for IC 2602. Cluster stars with photoelectric values from Whiteoak (1961) are noted by filled circles. Letters denote photometric white dwarf candidates in the field. One sigma error bars are shown.

TABLE 2

PLATES OF IC 2602

Plate Number	Emulsion	Filter	Exposure (minutes)	Derived Δm
2852 E	103aD	GG 14	60	4.36
2853 E	103aO	GG 385	45	4.41
2854 E	103aO	GG 385	45	4.40
2858 E	103aD	GG 14	60	4.32
2859 E	103aO	UG 2	120	4.46
2860 E	103aO	UG 2	120	4.41
2866 W	103aO	UG 2	120	4.74
2867 W	103aO	GG 385	40	4.88
2872 W	103aD	GG 14	60	4.63
2873 W	103aO	UG 2	120	4.80
2874 W	103aO	GG 385	40	4.52

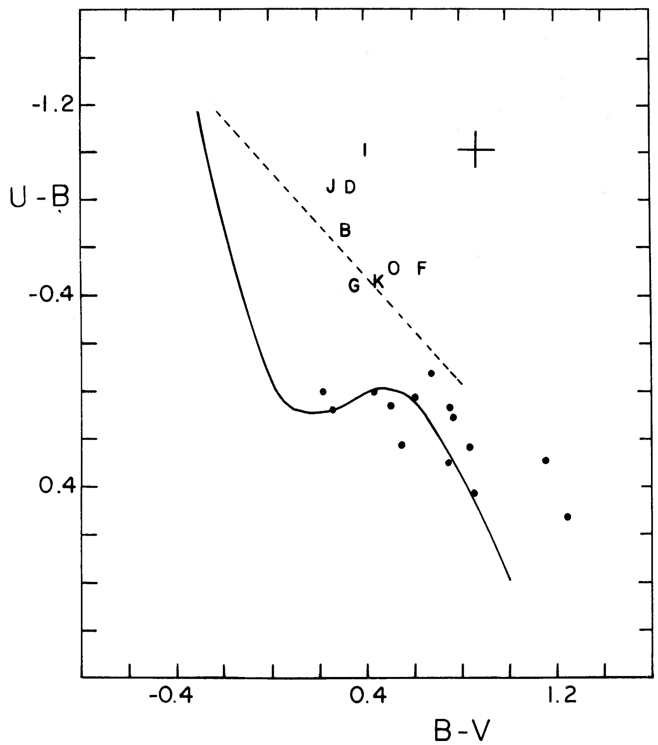

FIG. 4.—Color-color diagram of IC 2602 white dwarf candidates with main sequence and blackbody sequences shown for comparison. Filled circles mark the positions of other stars selected in a blink survey of U and V plates.

brightest, bluest stars in the field produced by a combination of refraction and reflection off the sequence extending wedge, and the remaining eight were too red to be included as candidates. Estimated 1 σ errors in the magnitudes and colors are indicated by error bars in both figures.

An estimate can be made of the number of blue objects one might expect to find in the field of the cluster. If the local space density $\varphi(M_v)$ of blue $(B-V < 0.4)$ stars is known, then the number of stars in a magnitude interval $V \pm \frac{1}{2}$ is:

$$N(V) = \omega(1000/3)10^{0.6V} \int \varphi(M_v)10^{-0.6M_v}dM_v \,,$$

TABLE 3

PHOTOGRAPHIC PHOTOMETRY OF CANDIDATES

White Dwarf Candidate	V	$B-V$	$U-B$	Plate field
D	16.04	0.33	−0.85	W
O	16.10	0.51	−0.52	W
F	16.74	0.63	−0.52	W
K	17.97	0.44	−0.46	E
G	18.06	0.35	−0.45	E
J	18.22	0.25	−0.85	E
I	18.53	0.39	−1.01	E
B	18.58	0.31	−0.68	E

where ω is the area of the field in steradians. Using the luminosity function of Green (1980), which tabulates contributions from white dwarfs with absolute magnitudes of 10–13, the estimated numbers of stars in various apparent magnitude intervals can be calculated for a field of 1.8 square degrees and are shown in Table 4. These estimates do not reflect the probable influence of interstellar absorption, which would further reduce the expected numbers. The eight detected objects can be seen to represent a significant excess of blue stars over the expected number.

In spite of this apparently significant number of blue stars, it must be noted that none of the eight candidates has $(B-V)$ color less than 0.00 which one would expect for a young, hot white dwarf. LB 1497, the suspected white dwarf member of the Pleiades cluster has a $(B-V)$ color of −0.20. While all eight photometric candidates are near the blackbody relation, none are as bright or blue as would be expected for white dwarfs evolving from the cluster population of IC 2602.

V. SPECTROSCOPY

The eight candidates chosen from the UBV photographic color-color relation were selected for further investigation. A program of spectral classification was carried out on the CTIO 4 m Cassegrain vidicon spectrograph. Spectra of approximately 200 Å mm^{-1} inverse dispersion, with ~ 7 Å resolution were obtained on five nights of 1980 March. All eight photometric candidates, plus a selection of objects whose UBV colors resemble those of the candidates, were observed.

The exposure times, positions, and airmasses of the eight candidates are contained in Table 5, as well as similar information for several white dwarfs and B stars which will be illustrated for comparison. The classifications for the standard white dwarfs are from McCook and Sion (1977), and from Greenstein (1966) and Greenstein and Sargent (1974) for the Feige stars. Star IC 2602 J's spectrum was too contaminated by a nearby star to form any conclusions about its nature. Three white dwarf standards of Oke (1974)—W485 A, LDS235 B, and L75-46 A—formed the basis of the flux calibration. The flux-calibrated spectra are shown in Figures 7 through 11 with the range of 3500 Å to 5500 Å illustrated.

Predictably for such faint objects, the spectra for the candidates are much noisier than those of the comparison standards. No smoothing has been applied to the spectra. Low signals shortward of 3900 Å caused the region of the Balmer jump to be fairly unreliable as a luminosity indicator. Low signal level for the flux standards beyond 5100 Å produced unreliable flux calibrations for the redder regions of the spectra. A particular feature of apparent emission at 5200 Å is seen in all of the long exposures and is most likely an artifact of imprecise flux calibration and sky subtraction of faint signals in that spectral region.

The spectra were classified by comparison to known white dwarfs selected from the catalogue of McCook and Sion (1977) and more luminous O and B stars from the lists of Greenstein and Sargent (1974). The classification

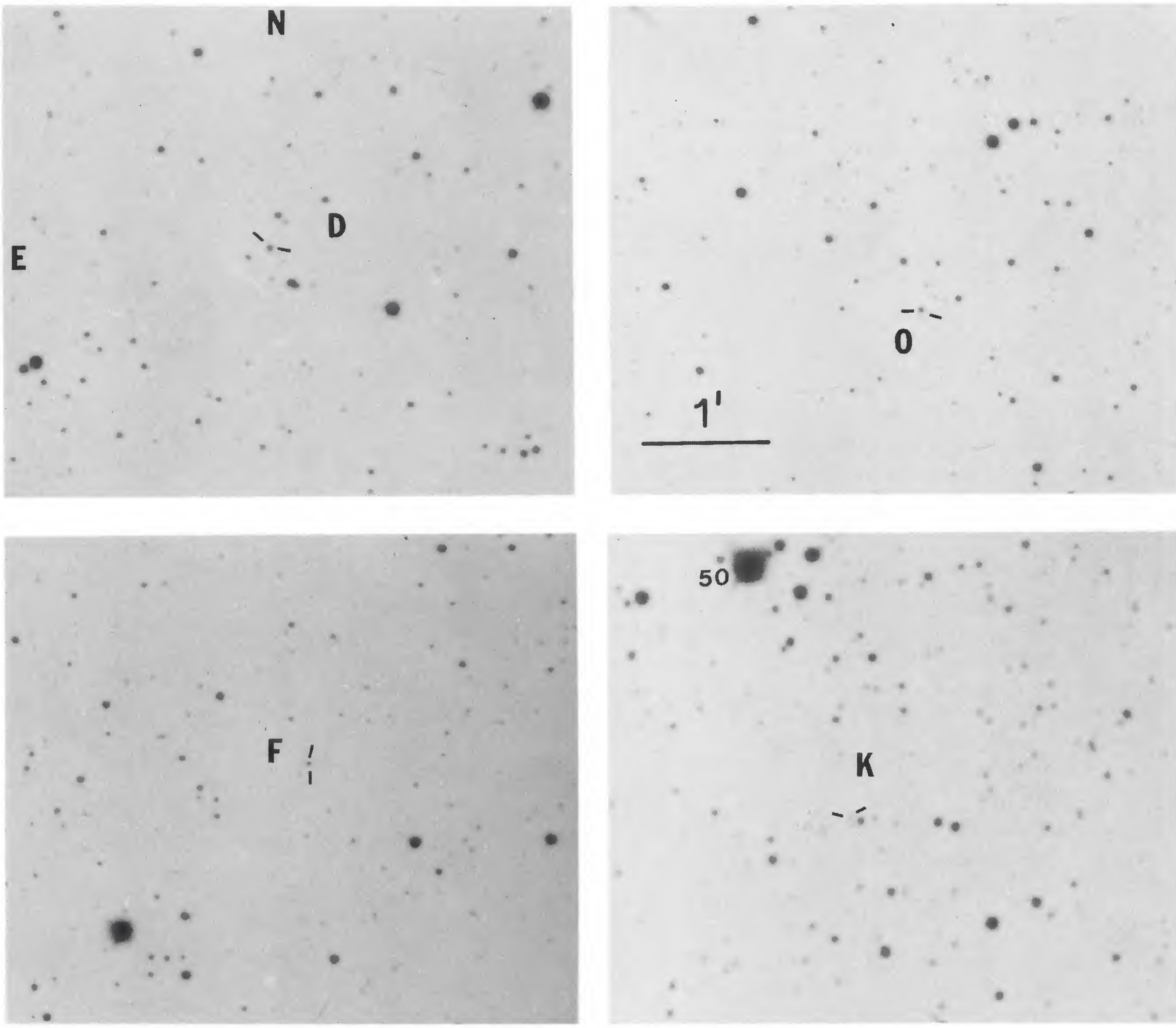

FIG. 5.—Finding charts for photometric white dwarf candidates in IC 2602. Numbered stars are on the numbering system of Braes (1962).

guidelines of Greenstein (1960) have been followed. Recognition of white dwarfs' spectra is primarily based on inspection of the hydrogen Balmer lines. The high pressures of degenerate stars produce extremely wide Balmer lines, the salient feature of the most common type of white dwarf, DA. DB stars exhibit equally broad lines but of the neutral helium series. No hydrogen lines are evident in DB white dwarfs. Hotter and brighter white dwarfs may be found in the DO class with He II lines prominent and He I and/or H lines also present. Other classes are typically cooler—DC: no lines to the 10% level; DAF: weaker Balmer lines and weak Ca II lines; DF: no hydrogen lines but Ca II lines. Some white dwarfs exhibit molecular carbon lines in the region of 4670 Å. By contrast, higher luminosity class B stars exhibit progressively sharper and more numerous Balmer lines and more pronounced Balmer discontinuities.

Classification of the candidate stars has been attempted by visual inspection alone. Quantitative classification based on the Balmer line widths requires a fairly accurate estimate of the effective temperature. The *UBV* colors from the photographic photometry are not of sufficiently high accuracy to provide a good enough effective temperature.

A typical DA white dwarf, W485 A, is illustrated in Figure 7. The extremely broad Balmer lines are easily recognizable. Candidate star G is shown with W485 A and resembles it in the width of its Hβ and Hγ lines, although the higher lines of the series are sharper than one might expect for a white dwarf. This star has been

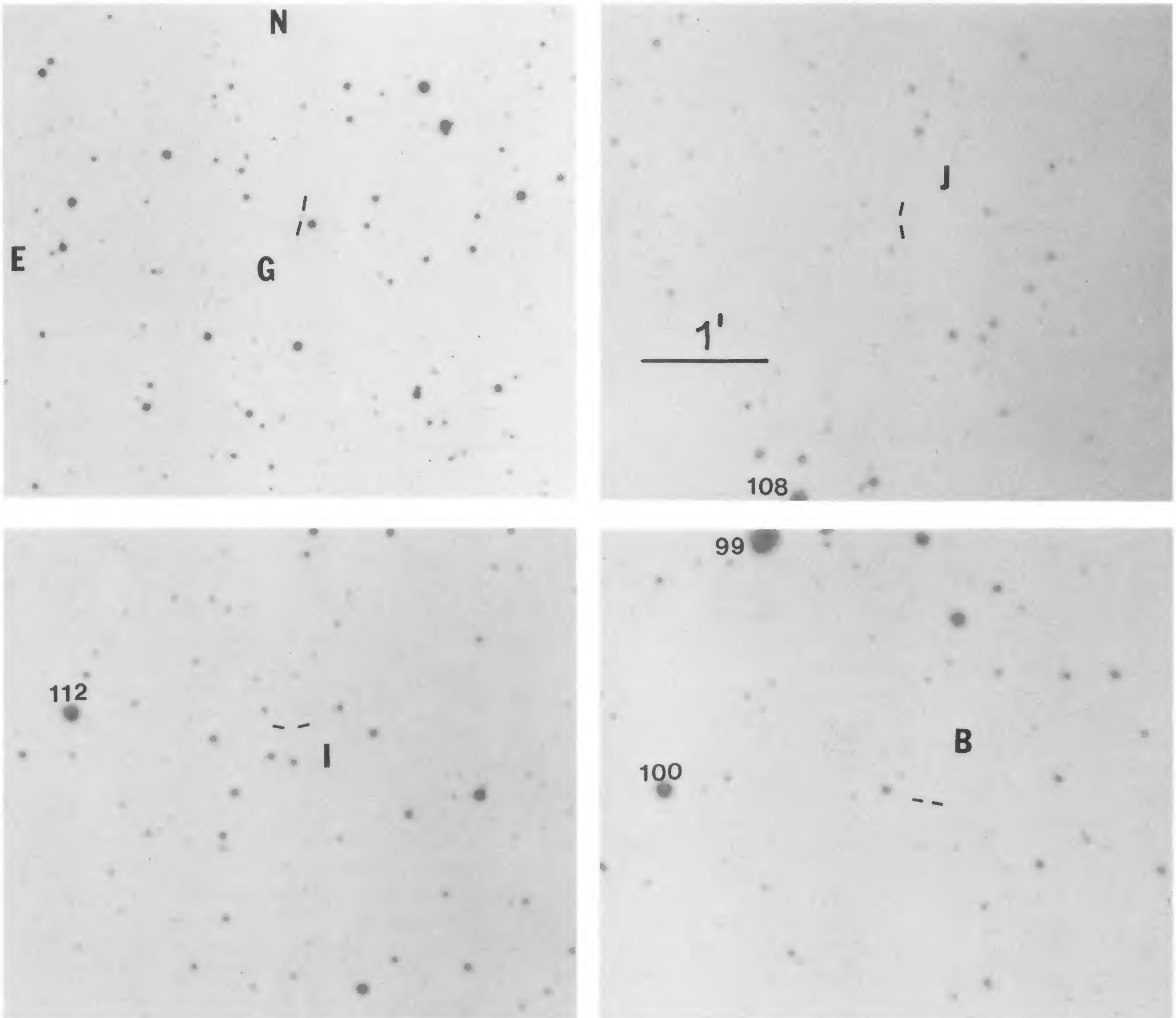

FIG. 6.—Finding charts for photometric white dwarf candidates in IC 2602.

TABLE 4

ESTIMATED NUMBERS OF BLUE STARS IN V MAGNITUDE INTERVALS

V	$N(V)$
16	<1
17	<1
18	1
19	5
20	20

identified as a DA white dwarf, or a B subdwarf. Star O appears to be of higher luminosity class because of the detectable Balmer jump and sharp Hδ and Hε lines, and in spite of the apparently broad Hβ line.

Candidate stars D and F are shown in Figure 8 along with a B subdwarf star, Feige 75. Both D and F have fairly weak Balmer lines with widths indicative of dwarf or subdwarf gravities, unless the temperatures are very much different than indicated by the unreddened *UBV* colors, based on comparison with models compiled by Greenstein and Sargent (1974). Neither can reliably be identified as a white dwarf. The weak lines redward of Hγ in F resemble early B V stars or somewhat later B giants.

In Figure 9, an O subdwarf, Feige 46, is illustrated in comparison to candidate K. K has apparently broad Hβ and Hγ lines as well as some helium lines. K is probably an O subdwarf or DO white dwarf, but highly reddened in either case. The other star in Figure 9 is a blue star in the field of NGC 6067, identified by its blue colors ($B-V=$

TABLE 5

SPECTRA OF WHITE DWARF CANDIDATES AND STANDARDS

Star	α_{1950}	δ_{1950}	Night	Exposure (minutes)	Mean Air Mass	Spectral Class
D	$10^h32^m51^s.3$	−63°56′19″	2	20.6	1.22	sdB
			4	29	1.33	...
O	10 37 15.9	−63 54 24	3	30	1.25	sdB
F	10 32 23.1	−64 4 38	5	60	1.29	sdB
K	10 44 46.5	−64 23 30	3	59	1.24	DO/sdO
G	10 45 18.5	−63 40 1	4	95	1.29	DA/(sdB)
J	10 41 22.0	−64 20 51	2	45	1.34	contaminated
			5	75	1.22	...
I	10 42 37.8	−64 17 43	1	60	1.35	DB
			4	140	1.24	...
B	10 41 18.7	−64 57 37	2	108	1.22	DA
			5	180	1.31	...
GD 190	15 42 4.0	+18 16 6	4	6	1.51	DB std
GD 268	13 4 56.0	+15 0 30	2	11	1.48	DB std
Feige 101	14 38 24.0	+18 7 0	3	0.16	1.51	HBB std
Feige 56	12 4 6.0	+11 57 0	5	0.10	1.74	B5 V std
Feige 46	11 34 54.0	+14 27 0	2	0.50	1.42	sdO std
Feige 75	13 13 30.0	+13 14 0	3	1.5	1.48	sdB std
W485 A	13 27 40.0	−8 18 48	4	0.20	1.11	DA std

NOTE.—Nights 1 through 5 denote UT dates 1980 March 7–11, inclusive.

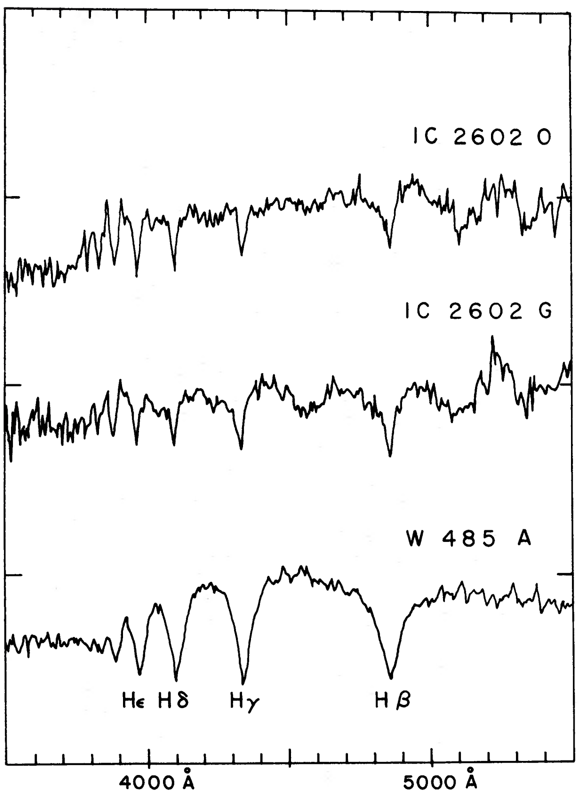

FIG. 7

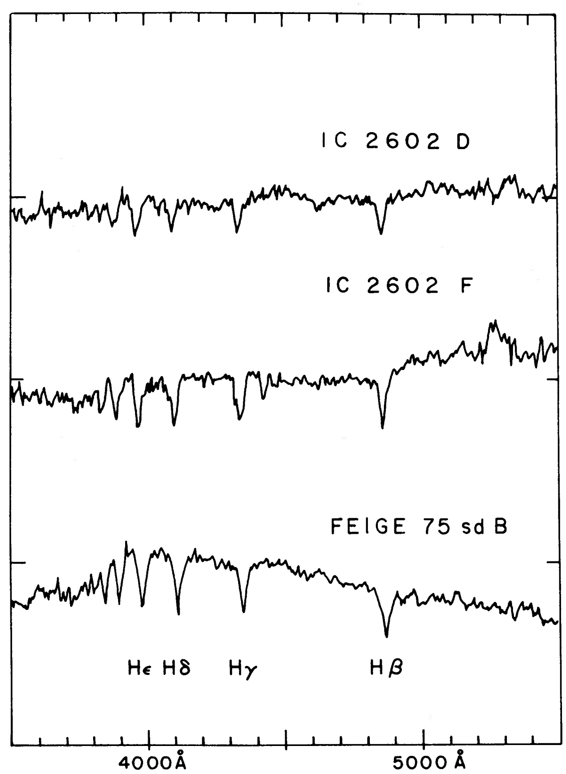

FIG. 8

FIGS. 7–11.—Flux-calibrated spectra. The ordinate is $F(\nu)$ normalized to $F(\nu)$ at 4500 Å. On this normalized scale, a value of 1 is indicated by vertical tick marks, with zero placed at the tick mark for the next lower spectrum in the illustration.

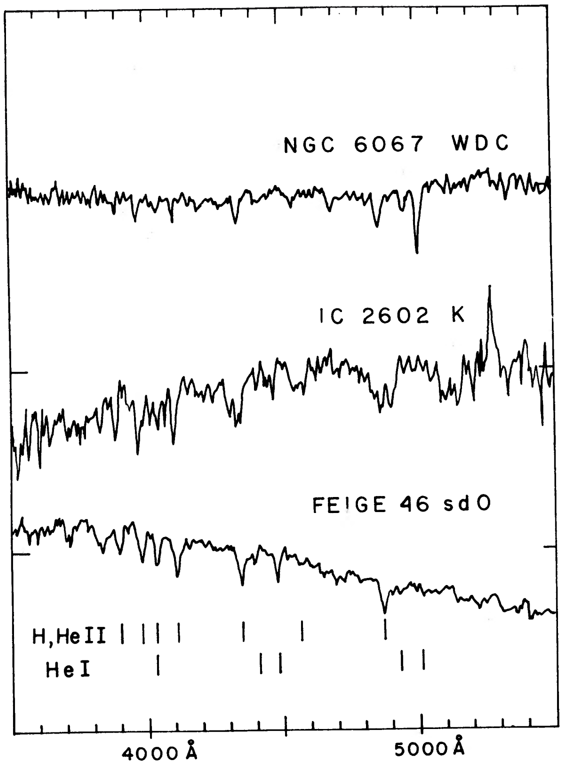

FIG. 9

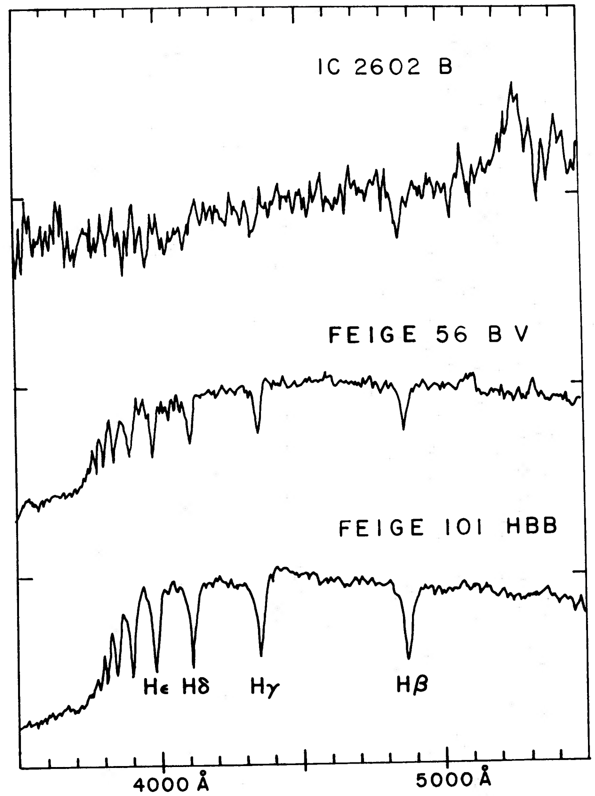

FIG. 11

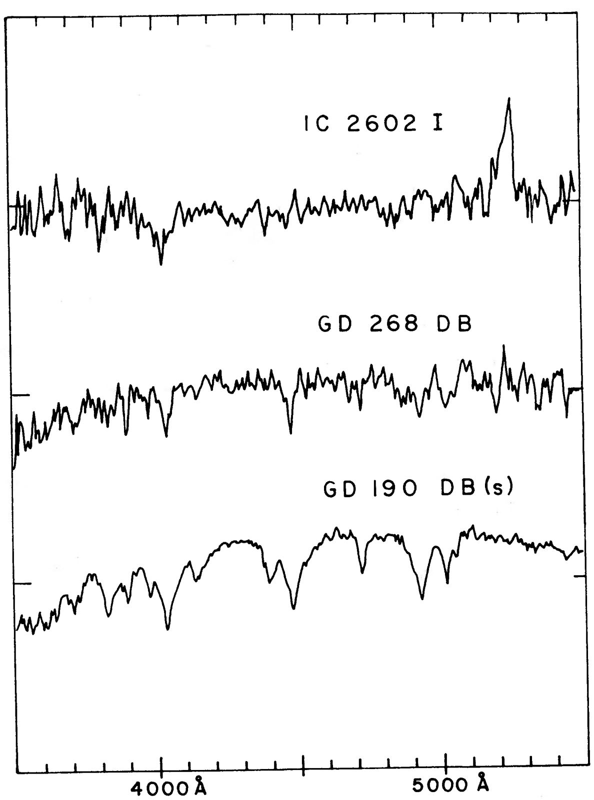

FIG. 10

0.00, $U-B = -0.50$) as a photometric white dwarf candidate by Engver (1965). The spectrum of this star exhibits He I lines (including a particularly strong line of He I at 5015 Å) as well as weak, narrow Balmer lines, indicating classification as an O subdwarf.

Two helium-line (DB) white dwarfs are shown in Figure 10, as well as the rather noisy spectrum of candidate I. The spectrum shown is a superposition of flux-calibrated spectra from two nights, in an effort to minimize the noise level. The most prominent line is identified as He I at 4026 Å, and I is classed as a DB white dwarf. Candidate B is similarly illustrated in Figure 11. In spite of the noise, Hβ appears fairly wide, and this star is also identified as a white dwarf. Two higher luminosity B stars are also shown for comparison.

While the fairly noisy spectra cannot rule out lower gravities for these candidate objects, arguments can be made on photometric grounds against intrinsic luminosities greater than those for subdwarf stars. The program objects are all bluer than $(B-V) \sim 0.5$, and estimates of visual absorption based on maximum possible reddening and a ratio of total to selective absorption of 3, are 1.5–3 mag. For stars with $M_v = -1$ (B5 V) this implies distance moduli ranging from 13 to 17, rather excessive distances for such blue stars, particularly for stars so near the plane of the Galaxy. Furthermore, several of the spectra indicate higher temperatures than typical for a B5 star, and this would further increase the distance estimate for a main-sequence star.

VI. CONCLUSIONS

Of the seven candidate stars in the field of IC 2602 observed spectroscopically, four, at most, appear to be white dwarfs. Of these white dwarfs, none is both bright enough and blue enough to suggest an evolutionary connection with the cluster. The cluster is approximately 20 million years old, and the cooling times of Sweeney (1976) indicate that white dwarfs of comparable age should have absolute magnitudes of around +10 and $(B-V)$ colors less than zero.

The presence of three or four field white dwarfs in a field of nearly 2 square degrees is not implausible nor is the apparent absence of cluster white dwarfs. Although not precluded by the present theories of mass loss and stellar evolution, a progenitor mass of $> 7\ \mathscr{M}_{\odot}$ would require extreme amounts of mass loss. It is also true that IC 2602 is not an exceptionally rich cluster; an extrapolation of the luminosity function of IC 2602 in comparison to the cluster luminosity function of Taff (1974) shows that the cluster may have originally contained at least one star 15–20 $\mathscr{M}_{\odot}$. This estimate, however, is subject to uncertainties due to the small numbers of stars at the bright end of the luminosity function, and it may be that the binary system θ Car represents most or all of the evolved stellar population of the cluster.

One is left, however, with somewhat of an embarrassment of blue subdwarfs in the field of IC 2602 with nearly equal numbers of white dwarfs and subdwarfs detected. The subdwarfs are quite difficult to distinguish spectroscopically from the white dwarfs, and, if reddened, may be photometrically indistinguishable as well. A recent study by Carrasco *et al.* (1979) of space motions of O and B stars from the catalogues of Cruz-Gonzales *et al.* (1974) and Rubin *et al.* (1967) suggests a bimodal distribution of velocities characteristic of old disk as well as extreme Population I stars. Carrasco *et al.* propose the possibility of considerable contamination of O and B star counts by subdwarfs which are nearly indistinguishable from their higher luminosity class counterparts; the estimated space density for this disk population of UV-bright stars is about 10^{-6} pc^{-3}. Although this space density is three orders of magnitude lower than that of the white dwarf space density in the solar neighborhood, a mean absolute magnitude for hot subdwarfs five mag brighter than the mean magnitude for white dwarfs would lead to nearly equal numbers of observed white dwarfs and subdwarfs. Without better space densities and absolute magnitudes for hot subdwarfs, the observed surface density of subdwarfs in the field of IC 2602 may be judged to be consistent with Carrasco *et al.*'s estimated space density for disk blue subdwarfs.

The contaminating effects of such a population on low galactic latitude searches for blue objects may be considerable. Estimates of the upper mass limit for white dwarf progenitors based only on photometric evidence should be interpreted with caution; a spectroscopic confirmation of the photometric white dwarf candidate in M35 (Romanishin and Angel 1980) would be of tremendous value.

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BARBARA J. ANTHONY-TWAROG: University of Texas at Austin, Department of Astronomy, Austin, TX 78712