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Observations of recently recognized candidate Herbig Ae/Be stars*

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Abstract. The results of multicolor photometric and low-resolution spectroscopic observations of 9 Herbig Ae/Be candidate stars are reported. This sample includes two newly recognized objects, MQ Cas and BD$+11^\circ829$, which were found by means of cross-correlation of the *IRAS* Point Source Catalogue and the catalogue of the galactic early-type emission-line stars (Wackerling 1970). Near-IR excesses were detected in two stars (AS 116 and BD$+11^\circ829$) for the first time. Algol-type variability, which is not common in Herbig Ae/Be stars, was detected in MQ Cas and V1012 Ori. Spectral types are determined for MQ Cas, GSC 1811$-$0767, HDE 244604, BD$+11^\circ829$, V1012 Ori, AS116, AS117, and HDE 290380 from low-resolution spectroscopy. Analysis of our and previously published data suggests that 8 of the 9 objects are pre-main-sequence stars, while the last one, Hen 938, is more likely a B[e] supergiant.

Key words: techniques: photometric – techniques: spectroscopic – stars: emission-line, Be – stars: planetary systems – stars: pre-main sequence

1. Introduction

Herbig Ae/Be stars (HAEBEs) are pre-main-sequence (PMS) objects of intermediate masses ($2 \leq M/M_\odot \leq 10$). Herbig (1960) proposed the first list of 26 such objects with emission-line spectra and spectral types earlier than F0 associated with dark or reflection nebulosities. Infrared (IR) excesses discovered in HAEBEs in the early 1970's (e.g., Geisel 1970) prompted Finkenzeller & Mundt (1984) to extend this list to 57 stars, including those without visible nebulae and not closely connected to star formation regions. The latter objects are called isolated HAEBEs (e.g., Grinin et al. 1991). Based on a long-term photometric monitoring of a large sample of young stars, Shevchenko (1989) proposed a new list of HAEBEs containing 87 stars.

A number of new HAEBE candidates were found in the *IRAS* Point Source Catalogue (PSC) after the release of the *IRAS* mission results (e.g., Dong & Hu 1991, Oudmaijer et al. 1992). Summarizing these and other new results, Thé et al. (1994) published a catalog of 287 early-type stars which exhibit characteristics which suggest that they are possible PMS stars. The authors called this sample "The Herbig Ae/Be stellar group". From a study of the observational characteristics of HAEBEs and related objects they concluded that there was no unique set of observational characteristics which could help to unambiguously distinguish a PMS star of intermediate mass, and presented the sample in five separate tables. Table 1 of that paper contains a list of 108 HAEBE members and candidate members. This list does not include HAEBE candidates found during a photometric and spectroscopic survey of southern *IRAS* sources with T Tau star-like IR properties (Gregorio-Hetem et al. 1992). A number of new HAEBE candidates have been found after publication of the Thé et al. catalogue (Torres et al. 1995, van den Ancker, Thé, & de Winter 1996). Thus the list of HAEBEs continues to grow. At the same time, the PMS nature of some of the recent HAEBE candidates has been demonstrated in a number of the follow-up studies (e.g., Miroshnichenko et al. 1997; Meeus, Waelkens, & Malfait 1998). Nevertheless, other such objects still remain poorly-studied and their evolutionary states are undetermined.

In this paper we present the results of multicolour photometric and classification-resolution ($R \sim 1300$) spectroscopic observations of 7 recently recognized HAEBE candidates by Gregorio-Hetem et al. (1992) and Thé et al. (1994) and of 2 other stars, which we suggest, for the first time, to be pre-main-sequence candidates. The list of the observed objects is presented in Table 1.

2. New HAEBE candidates

Almost all HAEBEs known before the *IRAS* mission were identified as *IRAS* PSC sources (Thé et al. 1994) except for a few stars, which are located in crowded areas with a complicated background (Weaver & Jones 1992). Therefore, one can expect to find new HAEBE candidates among the sources detected by *IRAS*. Such a search was performed by Dong & Hu (1991), who positionally cross-correlated the *IRAS* PSC and the catalogue of galactic early-type emission-line stars by Wackerling

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* Based on observations collected at the Astrophysical National Laboratory (LNA – Brazil), the South–African Astronomical Observatory, the Dark Sky Observatory (USA), and the Tien–Shan Observatory (Kazakhstan)

Table 1. List of the observed objects

No.	Name	R.A.[a]	Dec.[a]	*IRAS*	Photometry			Spectroscopy	
					$UBVRI_J^{\rm b}$	$UBVRI_C^{\rm c}$	$JHKL$	Dark Sky	Brazil
1	MQ Cas	$0^h07^m0\overset{s}{.}2$	$+57°56'30''$	00070+5756	42	–	–	4	–
2	GSC 1811−0767	3 35 55.4	+29 32 00	03359+2932	16	–	–	1	–
3	V1012 Ori	5 09 03.8	−02 26 25	05090−0226	18	–	–	2	–
4	HDE 290380	5 20 57.8	−01 07 08	05209−0107	4	2	2	1	–
5	BD+11°829	5 27 32.3	+11 18 05	05275+1118	9	–	1	1	–
6	HDE 244604	5 29 10.3	+11 15 33	05291+1115	11	–	–	2	–
7	AS 116	5 59 52.7	−10 00 54	05598−1000	9	2	2	2	1
8	AS 117	6 01 21.9	−14 52 52	06013−1452	6	2	2	1	1
9	Hen 938	13 49 07.5	−63 18 01	13491−6318	–	–	–	–	1

[a] the source coordinates are given on epoch 1950.0,
[b] J denotes the Johnson photometric system,
[c] C denotes the Cousins photometric system.

(1970). Dong & Hu (1991) have found more than 100 essentially unstudied stars, which could potentially become members of different stellar groups with IR excesses. These objects are listed in Table 4b of Thé et al. (1994). A disadvantage of such a cross-correlation procedure is the low precision of the optical positions listed in the Wackerling (1970) catalogue. It may lead either to optical misidentification of an IR source or to complete loss of the optical counterpart due to the positional difference. The position of the IR source may also be incorrect because of the potential presence of several nearby radiation sources, which is not unusual in the large *IRAS* diaphragms. In order to emphasize these situations Thé et al. (1994) gave a separate list of stars with such offsets larger than 30″.

However, in some cases, inaccurate optical positions can be improved by identification of a source in catalogues with higher positional precision (such as the Guide Star Catalogue (GSC) or the AC 2000 Catalogue) and new stars with IR excesses can be found. For this reason we have completed a new cross-correlation analysis of the *IRAS* PSC and the Wackerling catalogue allowing the maximum offset between the optical and IR positions to be 60″. This search resulted in the identification of nearly 40 objects not listed by Dong & Hu (1991). They include a number of well-known bright stars (e.g., υ Sgr) and planetary nebulae (e.g., LS III +54°46) as well as nearly 20 mostly unstudied objects from the lists of Wray (1966) and Henize (1976). Properties of these objects, which may be considered as additions to early-type emission-line objects listed in Tables 4a and 4b by Thé et al. (1994), will be described in a forthcoming paper. Here we present a study of two stars from our list of newly found stars with IR excesses, MQ Cas and BD+11°829.

The optical position of MQ Cas listed in Wackerling (1970) has an offset of 58″ with respect to that of *IRAS* 00070+5756, which was found by us as its possible IR counterpart. In SIMBAD MQ Cas is listed as a counterpart of this *IRAS* source, however its optical position is given according to Wackerling (1970). Comparison of the finding chart given by Wenzel (1955) for MQ Cas and the same area in the GSC allowed us to identify the variable with the star GSC 3664−0126. The position of this star coincides with that of the IR source within the *IRAS* error box (15″). Thus we improved the optical position of MQ Cas, which turned out to be as follows (GSC): R.A. $0^h9^m37\overset{s}{.}587$, Dec. $+58°13'10\overset{''}{.}92$, (2000.0). This star is known as an irregular Orion variable (Wenzel 1956) with an amplitude of nearly 2^m ($11\overset{m}{.}7$ – $13\overset{m}{.}6$, pg). Dolidze (1975) detected a moderate Hα emission in its spectrum, although the spectral type has not yet been determined. The presence of the Hα line in emission along with the obvious IR excess leads us to suspect that MQ Cas is a PMS candidate.

The same suggestion can be made about BD+11°829, whose optical position is within the *IRAS* error box of the source *IRAS* 05275+1118. This star attracted no attention in the past. However, its location close to a number of PMS stars (HAEBEs HK Ori, HDE 244604, HDE 245185, and T Tau stars CO Ori and GW Ori) in addition to the IR excess pointed to its possible PMS nature. We identified BD+11°829 with the star GSC 0709−1217.

3. Observations

The photometric observations in the optical region (Johnson $UBVRI$ passbands) were obtained between January 1996 and December 1998 using the 1-meter telescope of the Tien-Shan Observatory (Kazakhstan) equipped with the two-channel photometer-polarimeter of the Pulkovo Observatory (Bergner et al. 1988). These observations are given in Tables 2 and 3. Typical errors of these observations, including those of the transformation from the instrumental to the standard photometric system, do not exceed $0\overset{m}{.}02$ for the stars brighter than 13^m and are somewhat larger for the fainter objects. The observations with errors exceeding $0\overset{m}{.}05$ are marked with colons. Quasi-simultaneous optical (Cousins $UBVRI$ passbands) and near-IR JHK photometry (and one observation of AS 116 in the L-band) of the southern objects from our sample was obtained at the SAAO using the 0.5-meter and 0.75-meter telescopes respectively during several observing runs in 1997. The errors of the optical

Table 2. Photometric observations of other HAEBE candidates at the Tien-Shan Observatory

Name JD 24...	V	$U-B$	$B-V$	$V-R$	$V-I$
GSC 1811−0767					
50427.19	10.82	0.22	0.32	0.31	0.57
50428.19	10.83	0.24	0.32	0.36	0.63
50429.22	10.86	0.20	0.37	0.36	0.62
50439.17	10.88	0.26	0.33	0.38	0.72
51039.43	10.77	0.24	0.33	0.33	0.68
51042.43	10.77	0.27	0.33	0.36	0.69
51043.45	10.74	0.20	0.36	0.31	0.57
51052.42	10.79	0.23	0.34	0.37	0.62
51053.47	10.78	0.20	0.34	0.38	0.64
51153.25	10.79	0.19	0.38	0.38	0.66
51154.22	10.78	0.20	0.29	0.35	0.59
51156.22	10.76	0.22	0.36	0.33	0.59
51157.21	10.78	0.24	0.30	0.33	0.60
51159.23	10.77	0.21	0.33	0.32	0.55
51160.25	10.75	0.21	0.33	0.33	0.59
51161.21	10.75	0.17	0.37	0.33	0.59
V 1012 Ori					
50107.20	12.32	−0.10	0.46	0.52	1.01
50352.51	13.00	0.14	0.66	0.63	1.10
50416.32	12.40	0.01	0.44	0.56	1.07
50417.32	12.31	0.25	0.41	0.57	1.04
50425.30	12.32	0.15	0.39	0.46	0.83
50427.28	12.27	0.14	0.43	0.45	0.78
50429.29	12.06	0.04	0.42	0.40	0.66
50433.26	12.04	0.10	0.41	0.41	0.65
50438.24	13.90	−0.22	0.41	0.56	0.88
50439.26	12.50	0.38	0.54	0.52	0.79
51153.33	12.44	0.33	0.49	0.54	0.96
51154.31	12.32	0.31	0.46	0.48	0.79
51156.30	12.38	0.20	0.45	0.47	0.81
51157.29	12.13	0.19	0.39	0.45	0.89
51160.29	12.04	0.16	0.42	0.43	0.79
51161.29	12.01	−0.03	0.47	0.50	0.95
51168.27	12.22	−0.14	0.72	0.49	0.92
51171.37	12.81	0.22	0.58	0.65	1.22
HDE 290380					
50424.25	10.38	0.06	0.50	0.36	0.67
50433.27	10.42	0.05	0.52	0.40	0.70
51154.33	10.50	0.02	0.50	0.48	0.75
51161.30	10.50	−0.02	0.50	0.48	0.76
BD+11°829					
50101.26	10.17	0.07	0.23	0.21	0.42
50107.24	10.23	0.07	0.22	0.22	0.43
50415.43	10.18	0.08	0.25	0.17	0.32
50416.36	10.19	0.13	0.16	0.21	0.35
50419.43	10.12	0.11	0.17	0.16	0.25
50423.42	10.17	0.02	0.30	0.20	0.34
51156.40	10.20	0.15	0.19	0.21	0.41
51157.39	10.24	0.06	0.23	0.25	0.45
51160.39	10.24	0.13	0.19	0.20	0.34
HDE 244604					
50101.27	9.50	0.09	0.21	0.13	0.27
50107.26	9.54	0.11	0.16	0.17	0.32
50415.45	9.51	0.16	0.18	0.16	0.27
50416.34	9.54	0.17	0.14	0.16	0.25
50416.44	9.54	0.15	0.14	0.16	0.28
50417.44	9.57	0.19	0.13	0.06:	0.53:
50419.42	9.54	0.19	0.13	0.12	0.20
50423.40	9.54	0.17	0.18	0.15	0.27
50425.40	9.53	0.08	0.20	0.15	0.30
51157.40	9.73	0.08	0.30	0.26	0.46
51168.38	9.48	0.14	0.19	0.15	0.27
AS 116					
49005.25	10.45	−0.44	0.27	0.35	0.50
50422.31	10.43	−0.43	0.25	0.33	0.63
50426.37	10.32	−0.39	0.24	0.36	0.58
51154.34	10.49	−0.51	0.29	0.38	0.62
51156.32	10.51	−0.37	0.27	0.38	0.69
51157.36	10.58	−0.41	0.22	0.43	0.77
51160.34	10.54	−0.39	0.21	0.40	0.71
51161.34	10.59	−0.50	0.26	0.45	0.83
51168.33	10.49	−0.48	0.32	0.40	0.68
AS 117					
50422.34	10.19	0.00	0.04	0.11	0.21
50426.35	10.17	0.00	0.08	0.09	0.15
51157.34	10.41	−0.02	0.07	-	-
51160.32	10.34	−0.01	0.10	0.11	0.24
51161.32	10.44	−0.02	0.21	0.24	0.40
51168.30	10.39	−0.03	0.13	0.12	0.15

The objects are numbered as in Table 1

photometry are nearly $0\overset{\text{m}}{.}01$ while those of the IR observations are different and are given in Table 4 along with the results of the SAAO observations.

Classification-resolution spectroscopy of the northern objects was obtained between January and November 1998 using the Gray/Miller spectrograph on the 0.8 meter telescope of the Dark Sky Observatory (DSO) of Appalachian State University. These spectra were obtained with a 600 lines mm^{-1} grating in the first order using a Tektronics 1024 × 1024 thinned, back-illuminated CCD, and have a spectral range of 380–560nm, and a resolving power R of about 1300 (0.36nm/2 pixels). The spectra, except for the two faintest stars (MQ Cas and V1012 Ori) have a signal to noise ratio ≥ 100. Reductions were carried out using standard IRAF routines. The log of these observations is given in Table 5.

The spectra of the southern objects were obtained on 1996 March 30 at the Laboratorio Nacional de Astrofísica at Pico dos Dias (Brazil) using the Cassegrain focus of the 1.6-meter telescope, with a 1024×1024 CCD and a 600 lines mm^{-1} grating with a spectral range of 479–690 nm. The spectra have

Table 3. Photometric observations of MQ Cas at the Tien-Shan Observatory

JD 245...	V	$U-B$	$B-V$	$V-R$	$V-I$	JD 245...	V	$U-B$	$B-V$	$V-R$	$V-I$
0096.05	12.61	0.07	0.52	0.75	1.34	0439.15	11.41	0.50	0.33	0.47	0.83
0097.09	12.76	0.07	0.59	0.74	1.38	1037.49	13.78	0.1:	0.28	0.40	0.73
0101.09	12.66	0.15	0.42	0.77	1.37	1042.40	13.82	−0.1:	0.33	0.40	0.69
0107.09	12.88	0.21	0.49	0.69	1.33	1043.41	13.72	−0.6:	0.66	0.39	0.75
0340.39	12.51	0.55	0.37	0.62	0.87:	1047.39	13.54	0.1:	0.34	0.66	1.26
0342.35	11.98	0.40	0.51	0.54	1.16	1051.37	13.76	0.1:	0.36	0.56	1.17
0348.39	12.15	0.21	0.51	0.62	1.02	1052.39	13.77	0.19	0.36	0.49	0.94
0349.29	12.47	0.25	0.47	0.56	1.09	1053.40	13.73	0.0:	0.39	0.49	0.83
0353.38	12.31	0.46	0.55	0.68	1.16	1083.26	13.38	0.29	0.45	0.56	1.20
0415.19	12.08	0.44	0.43	0.55	1.05	1100.29	13.29	0.23	0.35	0.50	0.87
0417.18	12.38	0.41	0.52	0.56	1.08	1102.36	13.05	0.16	0.41	0.59	1.13
0420.16	12.37	0.43	0.46	0.68	1.33	1103.35	12.96	0.3:	0.44	0.60	1.08
0422.17	12.67	0.46	0.40	0.51	0.87:	1104.38	12.91	0.16	0.41	0.62	1.06
0423.11	12.49	0.33	0.60	0.63	1.16	1153.16	13.46	−0.2:	0.26	0.47	0.80
0424.12	13.60	0.00	0.25	0.69	1.18	1154.15	13.44	-	0.37	0.52	0.96
0425.12	13.39	0.14	0.47	0.52	0.93	1155.15	13.63	0.1:	0.20	0.57	0.86
0426.18	12.82	0.30	0.58	0.70	1.19	1156.08	13.49	0.01	0.46	0.50	0.91
0427.11	12.97	0.27	0.56	0.71	1.24	1157.18	13.48	-	0.45	0.48	1.02
0428.10	13.39	0.30	0.53	0.64	1.21	1161.10	13.54	-	0.38	0.49	1.01
0429.14	13.24	0.82	0.49	0.76	1.33	1168.07	13.11	−0.1:	0.44	-	-
0433.18	12.72	0.67	0.60	0.59	1.00	1171.22	13.15	-	0.41	0.58	1.03

Table 4. Optical and near-IR photometry at SAAO

Name	JD 2450...	V	$U-B$	$B-V$	$(V-R)_c$	$(V-I)_c$	J	H	K
HDE290380	506.31	10.420	0.047	0.523	0.316	0.644	9.27±0.01	8.58±0.01	7.93±0.01
	510.30	10.423	0.050	0.528	0.310	0.641	9.26±0.01	8.59±0.01	7.93±0.01
AS116	506.33	10.427	−0.360	0.267	0.247	0.504	9.21±0.03	8.37±0.01	7.53±0.01
	510.31	10.349	−0.393	0.296	0.257	0.528	9.20±0.02	8.41±0.01	7.60±0.01
AS117	506.35	10.215	0.014	0.119	0.078	0.170	9.92±0.02	9.77±0.03	9.39±0.04
	510.33	10.220	0.028	0.128	0.074	0.162	9.95±0.03	9.79±0.04	9.38±0.03
BD+11°829	809.41	–	–	–	–	–	9.33±0.02	8.64±0.01	7.92±0.01

a signal–to-noise ratio of $\sim$ 100, and a resolving power R of about 1 000. The data reduction was performed using the IRAF package, in which the standard CCD reduction tasks were used to remove cosmic rays, perform bias subtraction and flat-field the images. Spectral extraction was carried out using the optimal extraction algorithm in the IRAF task *apsum*, in which pixel values across an order of the spectrum are weighted according to the calculated signal to noise ratio. The spectra were wavelength calibrated using a Thorium/Argon calibration lamp.

4. Results and discussion

Our photometric observations confirmed the data from the General Catalogue of Variable Stars (Kholopov et al. 1985–1990) that MQ Cas and V1012 Ori show strong brightness variations in the optical region. The other stars have not displayed any variability exceeding $0\overset{m}{.}3$ in all the passbands used. However, the small number of observations does not allow us to draw more definite conclusions on this subject. The spectroscopic observations revealed an emission component in the Hβ line of BD+11°829, which suggests that the star should have a signifi-

Table 5. Log of the Classification-resolution Spectroscopic Observations obtained at the Dark Sky Observatory

Name	JD 24500000+[a]	Exp.[b]
HDE 244604	818.59	25
	839.69	20
BD+11°829	839.71	40
MQ Cas	1016.87	30
	1046.85	55
	1048.91	30
	1070.83	60
GSC 1811−0767	1066.81	40
V1012 Ori	1100.84	60
	1111.83	60
AS116	1111.87	20
	1135.83	30
AS117	1111.89	20
HDE 290380	1135.79	40

[a] Central moments of the exposures
[b] Exposure times in minutes

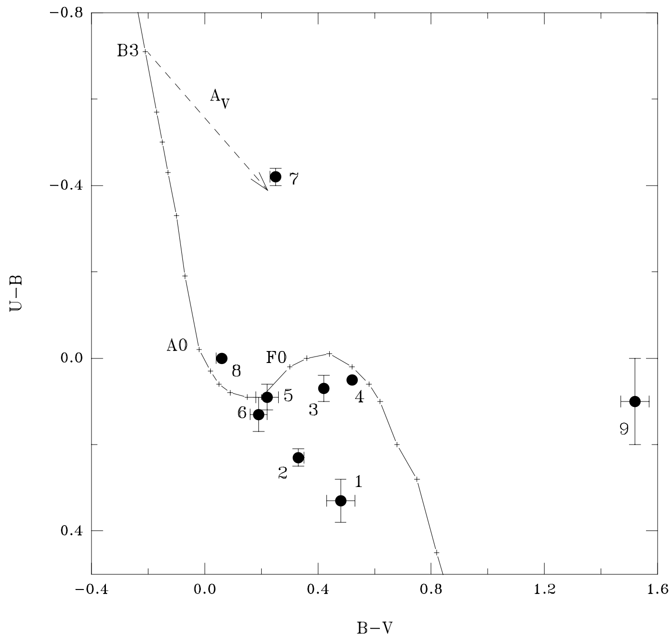

Fig. 1. Color-color diagram containing the studied objects labeled as follows: 1 – MQ Cas, 2 – GSC 1811−0767, 3 – V1012 Ori, 4 – HDE 290380, 5 – BD$+11°829$, 6 – HDE 244604, 7 – AS 116, 8 – AS 117, 9 – Hen 938. Solid line represents intrinsic color-indices for luminosiuty type V from Strajzhys (1977). Dashed line shows the mean reddening vector.

cant emission in the Hα line. The spectra of the three southern objects (AS 116, AS 117, and Hen 938) were obtained in a larger spectral region than in the previous study by Gregorio-Hetem et al. (1992) and with a sufficient resolution to study them in detail.

No reliable estimates of the spectral types of any of our objects have been published before (Thé et al. 1994). We can use the results of our and previously published UBV observations to predict the spectral types of these stars. The averaged $U-B$ and $B-V$ color-indices can be used for the objects with small brightness variations, while for those with Algol-type minima (Grinin et al. 1991) one should use the data in the brightest state. This method works rather well for HAEBEs without a strong emission-line spectrum. The objects with strong emission in the Balmer lines may display additional free-bound radiation shortward of the Balmer jump, which makes their $U-B$ color-indices more negative suggesting an earlier spectral type (e.g., Doazan 1982). Furthermore, circumstellar matter, which is present around the objects, may affect the color-indices making the predicted spectral types uncertain. Below we will compare our photometric estimates with those derived from the spectroscopic observations.

The $U-B \sim B-V$ diagram containing our objects is presented in Fig. 1. It is seen that all of the objects except Hen 938 and possibly AS 116 are located not far from the line of the intrinsic colors for dwarfs (Strajzhys 1977). To predict the spectral types we used the mean color excess ratio E_{U-B}/E_{B-V} = 0.75. The resulting spectral type predictions for our objects along with their averaged color-indices are given in Table 6. The color-indices for MQ Cas and V1012 Ori were averaged in their brightest states. Only the position of V1012 Ori in the color-color diagram is ambiguous and could correspond to any spectral type between B8 and F0. The colors of Hen 938 point to an early-B spectral type. However its high reddening, strong Balmer line emission, and the fact that we used only one UBV observation make this prediction uncertain. Below we discuss the results we obtain for each object separately.

4.1. Comments on individual objects

4.1.1. MQ Cas

The largest number of photometric observations were obtained for MQ Cas. Our results (see Table 3) for the amplitude of its brightness variations ($\sim 2^{m}.5$) are in general agreement with the photographic data reported in the literature, although the information about its color-indices is reported for the first time. Analysis of the color-magnitude diagrams (see Fig. 2) shows that the star becomes bluer when it is fainter.

This behaviour can be compared to that of HAEBEs with Algol-type minima, which become redder until they fade by $\Delta V \sim 1^{m}.0$–$2^{m}.0$ and bluer in deeper minima due to variable circumstellar extinction during obscurations by dust clouds orbiting around the star (Voschinnikov 1989). The "blueing" effect in deep minima is explained by the fact that the contribution of scattered radiation from the circumstellar envelope becomes larger than that of the direct stellar radiation attenuated by the dusty cloud (Grinin et al. 1991). The difference between this general behavior and what we have observed for MQ Cas can be explained if our photometric observations do not include the brightest state of MQ Cas. This is clearly seen in Fig. 2 especially in the behaviour of the $U-B$ color-index.

It might imply that the object's circumstellar envelope is rather dense and scattering on dust plays an important role even if the star is outside a minimum. Therefore, a small additional obscuration of the stellar light is enough to make the optical color-indices bluer. In other words, we observe only the lower part of the whole color-magnitude track. There are some examples of HAEBEs which display a similar behaviour on timescales comparable with that of our observations of MQ Cas (e.g., UX Ori, Grinin et al. 1994).

During our last observing runs in Kazakhstan in August and December 1998 the star was caught in the faintest state ($V \sim 13^{m}.7$ and $13^{m}.5$ respectively). It displayed an almost constant brightness during nearly 2 weeks. In the framework of the hypothesis about the variable circumstellar extinction described above this brightness level is mainly due to the star's radiation being scattered by circumstellar dust, while the contribution of the direct stellar light is much smaller. In such a situation the real amount of the star's obscuration by the dusty cloud may be larger than $2^{m}.5$ (e.g., Grinin et al. 1991). Therefore, $V \sim 13^{m}.7$ is probably the absolute minimum state, which can be observed provided the star does not change its luminosity. Since the duration and amplitude of the photometric minima in HAEBEs

Table 6. Basic information about the objects

Name	$\overline{U-B}$	$\overline{B-V}$	E^{a}_{B-V}	Sp[b]	Sp[c]	JD 24500000+
MQ Cas	0.33±0.05	0.48±0.05	0.50	A0	A0 Vae [Fe II]e	[d]
1811−0767	0.23±0.02	0.33±0.02	0.35	A0	A1 Va^{-}(er)	1066.81
V1012 Ori	0.07±0.03	0.42±0.02	?	?	A3 II shell?	[e]
HDE 290380	0.05±0.01	0.52±0.01	0.05	F6	keF6 IVeb	1135.79
BD+11°829	0.09±0.03	0.22±0.04	0.27	B9	kA1 hA3 mA3 Vaer Bd< Npc2	839.71
HDE 244604	0.13±0.04	0.19±0.03	0.21	A0	A3 Va^{+} (eb) Nem1	818.59
					kA4 hA3 mA3 Va^{+}	839.69
AS 116	−0.42±0.02	0.25±0.02	0.50	B3	B7 Ve	1111.87
AS 117	0.00±0.01	0.06±0.02	0.11	B9	A0 Va^{-}e Bd≤ Ne2	1111.89
Hen 938[f]	0.1:	1.52	1.8:	B0:		

[a] intrinsic color-indices are taken from Strajzhys (1977)
[b] spectral type predicted from the photometry
[c] spectral type determined from the spectroscopy (see Gray & Corbally 1998 for an explanation of the spectral-type notation)
[d] spectral type determined from a co-added spectrum made up of spectra obtained between JD 24501016.87 and JD 24501070.83
[e] spectral type determined from a co-added spectrum made from two spectra obtained on JD24501100.84 and JD24501111.83
[f] photometric data are taken from Torres et al. (1995)

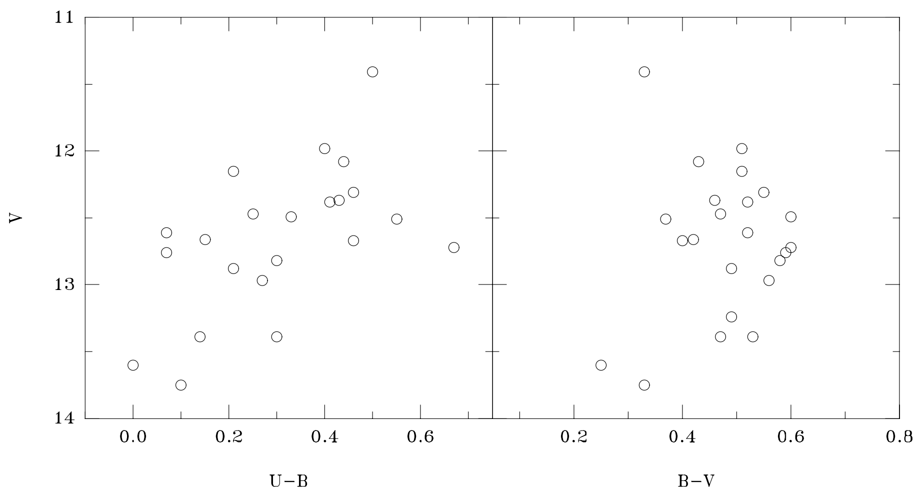

Fig. 2. Color-magnitude diagrams for MQ Cas.

decrease as the star evolves toward the main sequence, one can assume that MQ Cas is closer to the birthline (Palla & Stahler 1993) than to the zero-age main sequence (ZAMS). At the same time, we should note that this suggestion may not prove to be true because of the rather short period of our observations. For example, an Algol-type HAEBE, UX Ori, which is frequently seen in its brightest state and is thought to be nearly halfway to the ZAMS, recently showed a long-term minimum of nearly the same duration as we detected in MQ Cas (Grinin et al. 1994). Thus, further photometric observations are needed to constrain the brightest level of MQ Cas. Polarimetric data are important to prove its pre-main-sequence nature, as the Algol-type stars show a significant increase of polarization in the minima (Grinin et al. 1991).

All the spectra obtained of MQ Cas have a rather low signal-to-noise ratio because the star was close to its minimum state. In order to derive a reliable spectral classification we studied both single spectra and spectra co-added in various combinations. The resulting spectral type is A0 Vae with an uncertainty of 2 temperature subtypes. The star shows a considerable variation in the Hβ line, which is seen in emission in all our spectra (Fig. 3). Its emission core was found to be essentially centered on the absorption line on 1998 July 22 (JD 2451016), clearly shifted to the red on August 21 (JD 2451046), slightly to the blue on August 23 (JD 2451048), and considerably weaker and slightly shifted to the blue on September 14 (JD 2451070). Such profile variations may be due to an interplay between accretion and the stellar wind, which are both observed in HAEBEs (e.g., Grady et al. 1996). The Balmer decrement appears "normal" in that while Hβ was in emission, Hγ showed only a slight emission core, and Hδ was normal (see Fig. 4d). Within the limits of the noise, no emission in the Fe II series was visible, but weak absorption lines at 4233 Å (Mult. 27) and 5169 Å (Mult. 42) were detected instead. All the spectra show a number of [Fe II] lines in emission, the strongest of which, λ 5158 Å [Fe II] (18F), is shown in Fig. 4d. Other possible forbidden emission lines are as follows: λ 4244 Å [Fe II] (21F), λ 4814 Å [Fe II] (20F), λ 5108 Å [Fe II] (18F), λ 5262 Å [Fe II] (19F), λ 5273 Å [Fe II] (18F), λ 5334 Å [Fe II] (19F), λ 5376 Å [Fe II] (19F).

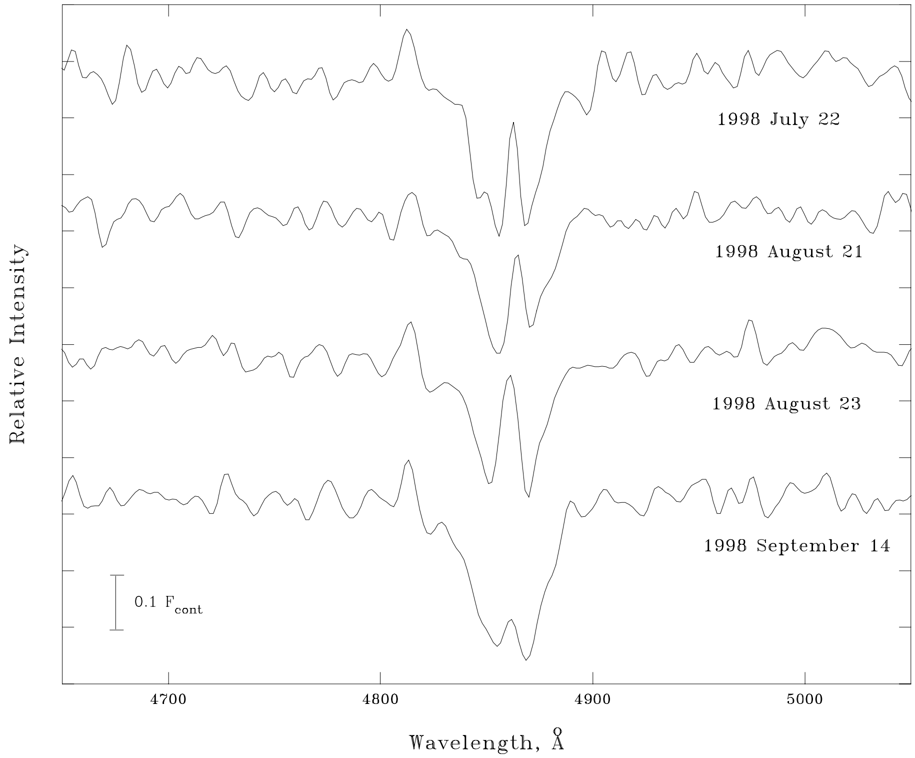

Fig. 3. Variations in the Hβ line of MQ Cas.

Our estimate of the spectral type for MQ Cas, A0 Vae, is in agreement with its large-amplitude variability, which is usually displayed only by late-B – A-type HAEBEs (c.f., Bibo & Thé 1991). Thus, the observed properties of the star strongly favor its PMS nature.

4.1.2. GSC 1811−0767

This star is located close to a pair of HAEBE stars, IP Per and XY Per. Its spectral type, as determined by us, A1 Va$^-$(er), is in agreement with weak emission at Hα, which was detected by Gregorio-Hetem et al. (1992). Its visual magnitude observed by these authors is $\sim 0\overset{m}{.}2$ brighter than we found. During our observations the star showed small and slow variations with an amplitude of about $0\overset{m}{.}1$ in all 5 photometric bands. In general, the color-indices observed by us agree well with those by Gregorio-Hetem et al. (1992), taking into account the difference between the photometric systems (Johnson and Cousins respectively).

Our spectroscopic observations indicate that the hydrogen lines of GSC 1811−0767 are slightly broader than those of the A1 Va standard star, implying that it is quite close to the ZAMS. There is a slight infilling of the Hβ line, and this emission is shifted slightly to the red. The Balmer decrement is normal, i.e. Hγ is also very slightly filled in, but Hδ is normal. No emission in the Fe II (42) series is visible (see Fig 4b). Thus, the spectroscopic determination of the spectral type is in good agreement with the photometric estimate.

Near-IR observations are strongly desirable for GSC 1811−0767 to check whether it has excess radiation in this spectral region, which would be strong evidence of its youth. Nevertheless, at the moment there is no contradiction with the suggestion that this star is a HAEBE candidate.

4.1.3. V1012 Ori

V1012 Ori is known as a large-amplitude variable star (m$_{pg}$ = 12^m – 16^m, Kholopov et al. 1985–1990). However, its first photoelectric observations were published only recently (Cieslinski et al. 1997). Three $UBV(RI)_c$ observations obtained by these authors in October 1989 and March 1991 caught the star near its brightest state ($V \sim 12\overset{m}{.}1$–$12\overset{m}{.}3$). Our more extended data set shows that the star spends most of its time near the brightest state. The color-indices obtained by Cieslinski et al. (1997) and us are in good agreement. However, we detected a short-term (on the order of a few days) deep minimum in November 1996 (see Table 2), which is similar to those of the Algol-type HAEBEs. JHK observations of Nakano (1998) showed that V1012 Ori has a noticeable near-IR excess ($J = 10\overset{m}{.}65$, $H = 9\overset{m}{.}71$, $K = 8\overset{m}{.}73$). These facts make the suggestion by Thé et al. (1994) that it is a PMS star more likely.

The photometry we have obtained for V1012 Ori is consistent with any spectral type between B8 and F0, depending upon its reddening. We were able to obtain two classification-resolution spectra of V1012 Ori. These spectra, which are essentially identical, were co-added to increase the signal-to-noise ratio (see Fig. 5). The resulting spectral type is A3 II shell?, with no indication of emission, either in the hydrogen lines or in lines of the Fe II (42) multiplet. However, slightly peculiar hydrogen-line profiles may indicate the presence of a shell.

The luminosity type suggests that this star is still quite far from the ZAMS. A straight-forward calculation of the distance

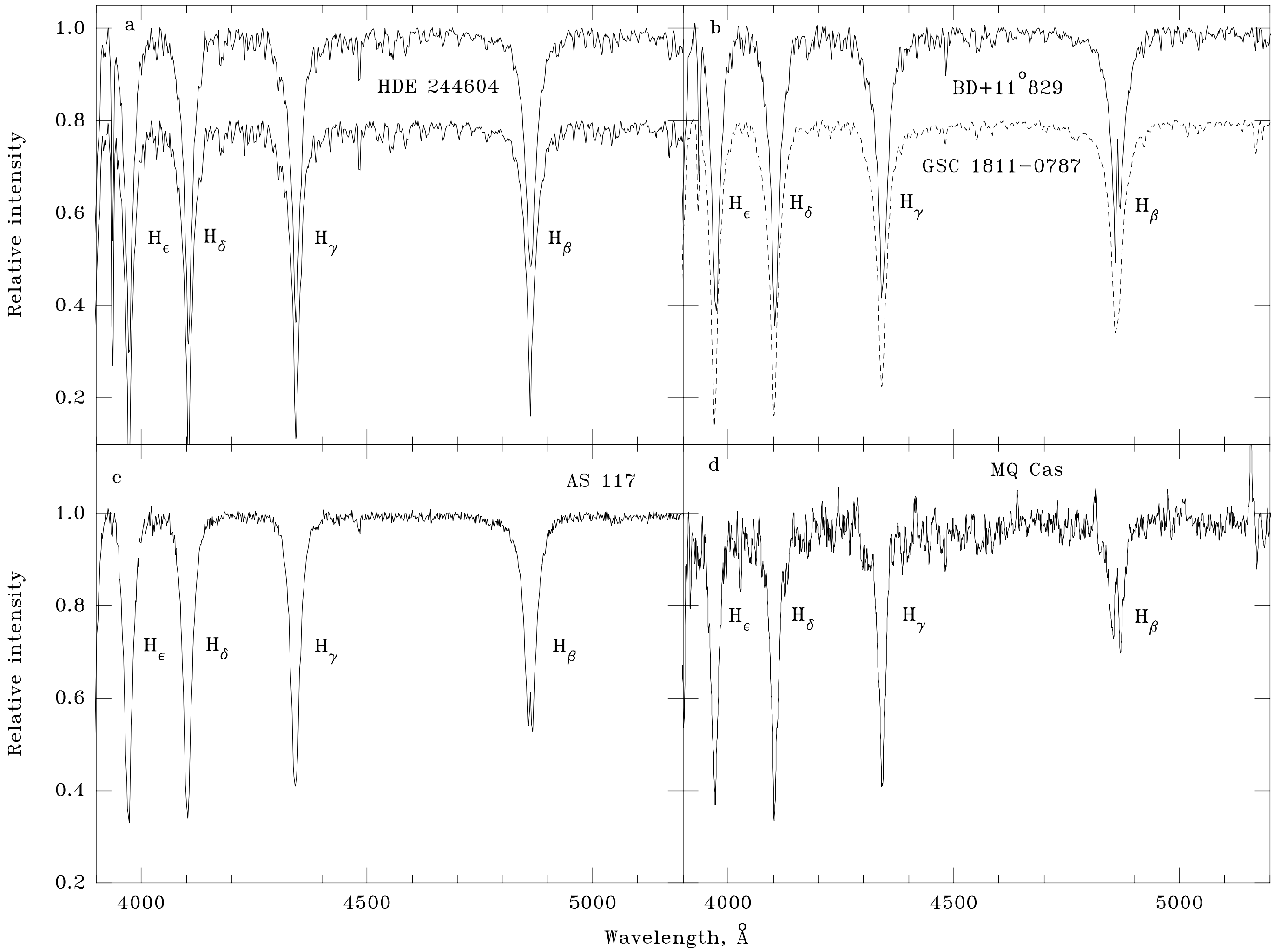

Fig. 4a–d. Portions of the classification-resolution spectra obtained with the 0.8-meter telescope of the Dark Sky Observatory. **a** HDE 244604: the upper spectrum was obtained on JD 2450818, the lower on JD 2450839. The spectra are shifted by 0.2 I_{cont} with respect to each other; **b** BD+11°829 (solid line) and GSC 1181−0767 (dashed line); **c** AS 117; **d** MQ Cas: the spectrum shown is the result of co-addition of all four spectra.

based on the reddening and absolute magnitude ($M_V \sim -2\overset{m}{.}3$) derived from the spectral type implies a distance of nearly 6 kpc, which is highly unlikely considering the moderate reddening and the fact that this star is in the galactic anticenter direction. However, the presence of a shell has probably caused us to overestimate the luminosity of this star.

4.1.4. HDE 290380

The presence of emission lines in the spectrum of HDE 290380 was noted by MacConnell (1982). Later it was considered to be a transition object between AGB and Planetary Nebulae on the basis of its *IRAS* and near-IR color-indices (Garciá-Lario et al. 1997). Torres et al. (1995) obtained a low-resolution spectrum and $UBVR_CI_C$ photometry and suggested that it is a Herbig Ae/Be star with an F0 spectral type. These authors detected moderate emission in the Hα line with equivalent width (EW) = 7 Å, showing a single-peaked profile and a weak indication of a P Cygni-type blueshifted absorption. Recently Garciá-Lario et al. (1997) agreed with the PMS nature of HDE 290380.

Our photometry is in excellent agreement with the published data except for the K-band. Our K-magnitude is $0\overset{m}{.}15$ brighter than that of Garciá-Lario et al. (1997); this can be explained by the difference in the photometric systems used. The object exhibits a significant near-IR excess which is more likely due to radiation from circumstellar dust rather than free-free emission, because the emission-line spectrum is weak. Its optical color-indices are close to the intrinsic ones for mid-F type stars.

The spectrum is very similar to that of the F6 IV standard. However, it shows emission in the Ca II H and K lines: both lines are at only about 70% of normal depth and the K line has a clear reversal in the core. The Hβ line clearly has blueshifted emission in the core, while the core of Hγ is slightly shallow. There are no signs of emission in the Fe II (42) lines.

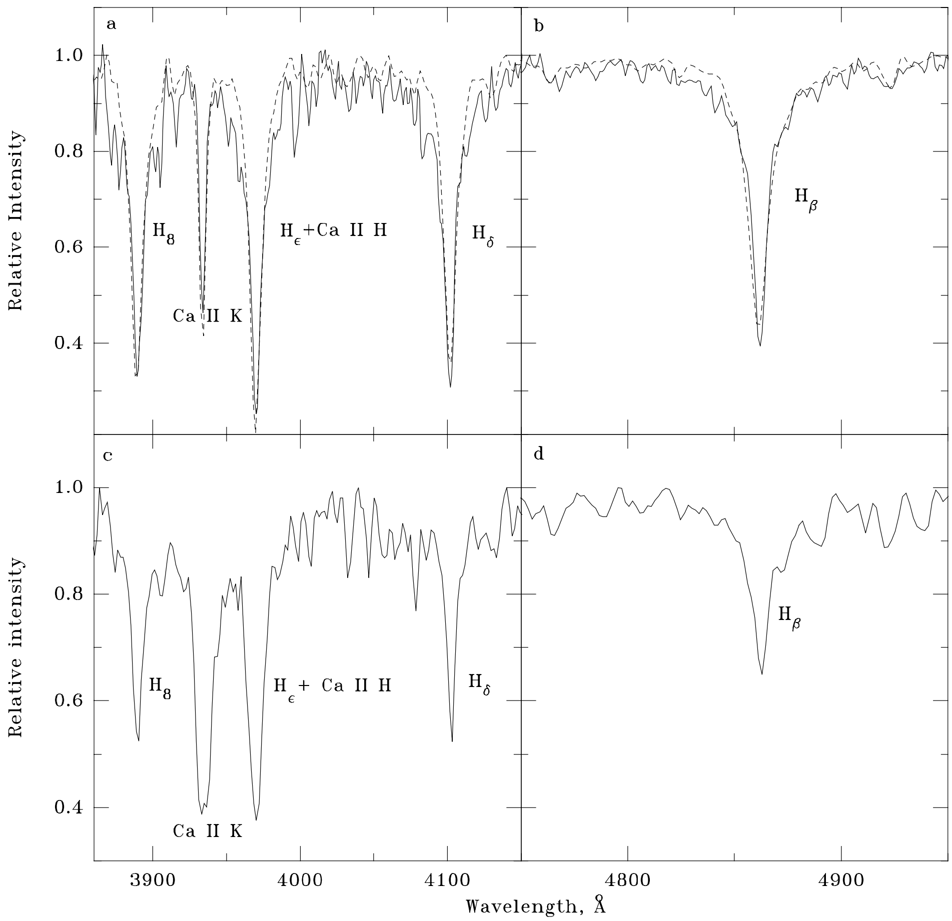

Fig. 5a–d. Portions of the classification-resolution spectra obtained at Dark Sky Observatory. **a**, **b** V1012 Ori (solid line) in comparison with HR 146 (A3 II, dashed line); **c**, **d** HDE 290380.

4.1.5. AS 116

AS 116 was discovered to have an *IRAS* counterpart by Dong & Hu (1991). Gregorio-Hetem et al. (1992) detected strong emission in the Hα line (EW = 102 Å). The optical photometry obtained by these authors suggests that AS 116 is a reddened early B-type star. The SAAO near-IR photometry shows that the star has a near-IR excess, which is likely due to hot circumstellar dust. Its brightness in the L-band ($6\overset{m}{.}5 \pm 0\overset{m}{.}4$), which was measured on JD 2450506.34, gives additional support to this suggestion.

We have obtained spectra of AS 116 both from Brazil and DSO in the United States. The Brazilian low-resolution spectrum (see Fig. 6ab) shows a number of emission lines including a bright Hα and Hβ, weak Fe II lines of the multiplets 42 and 49, and a forbidden line of O I at 6300 Å. The He I lines at 5876 and 6678 Å appear in absorption, however a weak emission component is seen in the second line. Several weak interstellar features (Na I $D_{1,2}$ lines, diffuse interstellar bands at 5780, 6278, and 6283 Å) are consistent with a moderate reddening of the star. The widths of the Balmer lines are about 400 km s^{-1}, indicating a low terminal velocity of the stellar wind. Absence of a P Cygni-type absorption in the Hα profile might imply a non-spherical circumstellar envelope. However this must be supported by more high-resolution observations.

The two classification-resolution spectra from DSO agree well with the Brazilian spectrum in the region of overlap. These spectra also show that emission is present in the cores of the hydrogen lines up to H8, the Ca II K-line appears to be in emission, as well as many Fe II lines (see Fig. 7). All the emission lines are slightly stronger in the second spectrum, while the He I absorption lines appear the same in both spectra. The hydrogen-line profiles and the He I line strengths both indicate a spectral type of B7 Ve, taking into account the distortion by the shell emission. A spectrum of HR 1029 (B7 V) obtained at DSO is shown in Fig. 7 for comparison.

Both sets of our photometric observations (Tien-Shan Observatory and SAAO) show that AS 116 is variable. In December 1998 it faded by $\Delta V \sim 0\overset{m}{.}2$ in comparison with the earlier data. This process was accompanied by an increase in the $V-R$ and $V-I$ color-indices and a decrease of the $U-B$. While the increases in $V-R$ and $V-I$ are consistent with the variable circumstellar extinction, the decrease in $U-B$ is probably due to a brightening in the Balmer continuum which, in turn, might be caused by an increase in the emission-line activity, such as was observed at DSO.

The discrepancy between the spectral type derived from photometry and that from spectroscopy may be due to such effects as a contribution of the Hα emission line to the V-band flux and an inverse Balmer jump from free-bound radiation of

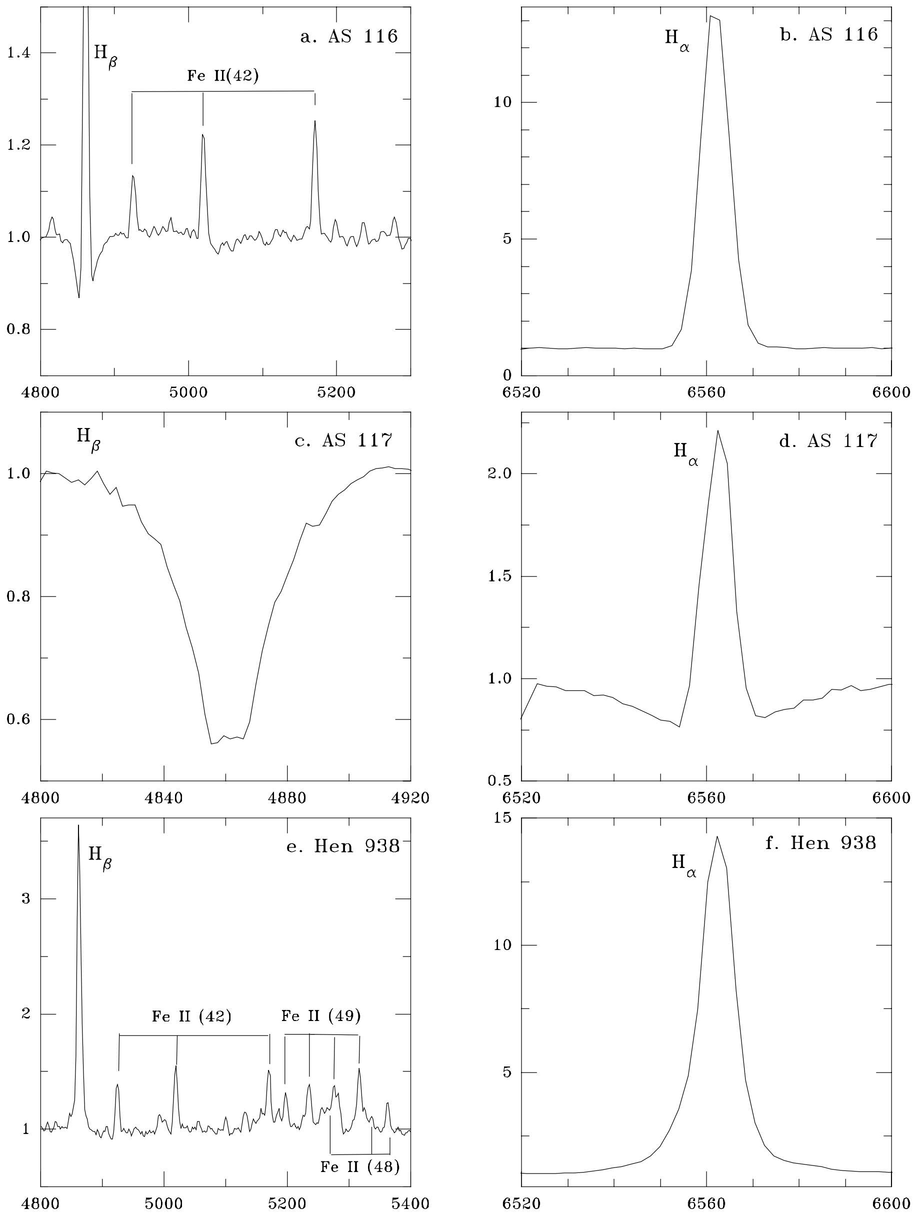

Fig. 6a–f. Portions of the low-resolution spectra obtained with the 1.6-meter telescope of the Laboratorio Nacional de Astrofísica at Pico dos Dias. **a,b** AS 116, **c,d** AS 117, **e,f** Hen 938.

the circumstellar envelope. The latter is frequently observed in the spectra of classical Be stars which normally have weaker line emission than that of AS 116. It has been shown that the excess, which is introduced by a circumstellar envelope producing the Hα emission line with EW $\sim$ 100 Å, can be as large as $0\overset{m}{.}25$ (cf. Doazan 1982). This is actually the shift in the position of AS 116 in the color-color diagram (Fig. 1) in $U-B$ from that of a normal reddened star with a B7 spectral type. Furthermore, the Balmer decrement in AS 116 is much steeper than seen in emission-line stars with an Hα line of comparable strength such as HD 200775 (B3, Beskrovnaya et al. 1994) and HD 45677 (B2, Israelian et al. 1996). This points to a later spectral type for AS 116. On the other hand, the star may have a spectral type earlier than B7 and a larger rotational velocity than that of HR 1029 (100 km s^{-1}, Abt & Morrell 1995). Additionally, its helium lines may be partly filled in with emission. Summarizing all the above, one can conclude that the true effective temperature of AS 116 lies between B3 and B7. A more definite answer to this question would come from high-resolution spectroscopy and modeling of the line profiles.

The above mentioned spectral features are common to three types of stars with near-IR excesses: HAEBEs, B[e] supergiants, and LBVs. The latter two have high luminosities (M$_V \leq -6^m$), which would place AS 116 at a distance of at least 10 kpc from the Sun. This seems unlikely, because the star is located towards the galactic anticenter. In addition, such a high luminosity is inconsistent with the spectral type. On the other hand, its rather weak near- and far-IR excess, lack of evidence for accretion and its spectral type suggest that it is a pre-main-sequence star close to the ZAMS. In this case its luminosity would be about M$_V \sim -1^m$ (cf. Strajzhys & Kurilene 1981) giving a distance on the order of 1 kpc. The emission-line spectrum of AS 116

Table 7. Spectral lines in the Brazilian spectrum of AS 116

Transition	λ_{obs}, Å	I/I$_{cont}$	EW, Å
Fe II (42)	4923.1	1.14	1.2[a]
Fe II (42)	5017.7	1.22	1.7[b]
Fe II (42)	5170.0	1.25	2.0
Fe II (49)	5198.8	1.03	0.2
Fe II (49)	5235.8	1.03	0.2
Fe II ()	5318.1	1.09	0.7
Fe II ()	5427.6	1.26	1.4
DIB	5781.0	0.96	0.3
He I (11)	5874.0	0.96	0.2
Na I (1)	5888.0	0.95	0.3
Na I (1)	5896.0	0.96	0.3
DIB	6280.0	0.90	1.3[c]
[O I] (1F)	6298.7	1.05	0.2
He I (46)	6678.0	0.94	0.4
Fe I ()	6822.1	0.95	0.3

[a] blend with λ 4929.2 Å
[b] blend with λ 5023.9 Å
[c] blend of λ 6278 and 6283 Å

favors this hypothesis, because B[e] supergiants and LBVs of a similar temperature usually display a large number of strong metallic emission lines. For example, Lopes et al. (1992) in their spectroscopic study of luminous peculiar B-type stars pointed out that the strength of the emission lines (namely Hβ and Fe II (42) λ 4924 Å) is possibly luminosity dependent. Our data for these lines in AS 116 suggest that its luminosity is rather low.

4.1.6. AS 117

AS 117 was selected by Dong & Hu (1991) in the same way as AS 116. Gregorio-Hetem et al. (1992) obtained one photometric $UBVR_cI_c$ observation and a spectrum showing weak emission at Hα (EW = 7 Å). This star is less reddened than AS 116 and has a lower effective temperature. Our JHK photometry shows that its near-IR excess is weak. Again, we have two spectra for this star, one from Brazil, the other from DSO. The Brazilian spectrum shows only Hα in emission, while the Hβ line is essentially photospheric (Fig. 6cd). On the other hand, the DSO spectrum shows emission in the core of Hβ, and slight emission in the cores of all the hydrogen lines up to H8 (Fig. 4c). The Fe II (42) lines are filled with emission. The wings of the Balmer lines are slightly broader than the A0 Va standard. Thus, we assign this star a spectral type of A0 Va$^-$e, suggesting that it lies near to the ZAMS. The low reddening suggests that AS 117 is located not far from the Sun and, hence, has a low luminosity. Recently Yudin & Evans (1998) reported that the star shows a polarization of about 0.5% in the V-band. This fact is consistent with the star being relatively nearby.

The weakness of its emission at Hα points to a weak stellar wind, which, along with the small IR excess, also implies that the star is very close to the ZAMS (e.g., Miroshnichenko et al. 1996). Its observed properties are similar to those of such HAEBEs as HD 37411 (Hu et al. 1989) and V351 Ori (van den Ancker et al. 1996). At the same time, one can not exclude the possibility that the dusty envelope of AS 117 may be clumpy (like those in HAEBEs with Algol-type minima). In December 1998 we observed a slight decrease of its visual brightness which might be an evidence of such a structure. This event coincided with a similar fading of AS 116, which was observed with the same comparison star, HD 40745. The brightness difference of HD 40745 and the check star, HD 45629, was constant within the observational errors in all five photometric bands used. Thus, the observed variations are real. However, more frequent photometric observations are needed to study these two stars in more detail.

Table 8. Spectral lines in AS 117

Transition	λ_{obs}, Å	I/I$_{cont}$	EW, Å
Na I (1)	5892.0	0.93	0.5
Na I (1)	5896.1	0.93	0.5
DIB	6280.0	0.84	1.1[a]
[O I] (1F)	6299.5	1.05	0.2
Fe II (40)	6516.6	0.92	0.7

[a] blend of λ 6278 and 6283 Å

4.1.7. Hen 938

Hen 938 was selected by Allen & Swings (1976) as a peculiar Be (or B[e]) type star because it displayed forbidden emission lines in the optical spectrum and a noticeable near-IR excess. In its spectrum, which was obtained with an image tube at a resolution of 140 Å mm^{-1}, these authors found 5 Balmer lines, 7 Fe II lines, and weak [O I] lines in emission and the Ca I H and K lines in absorption. They also reported the presence of Ti O absorption bands, which would imply the presence of a late-type companion.

As shown in Figs. 6e and 6f, our spectrum of Hen 938 is enriched with metallic emission lines. We found 37 lines of Fe II, 2 of Ti II, 2 of Si II, and 1 of [Fe II]. There is also a weak line of [O I] at 6300 Å. No signs of the TiO absorption bands or other features of late-type stars were found. The He I lines at 5876 and 6678 Å have P Cygni profiles indicating a strong stellar wind and a high temperature ($\geq$ 20000 K). The Balmer lines (Hα and Hβ) are strongly in emission (see Table 10), and Hα has an almost symmetric profile without any absorption components, which may be evidence of a non-spherical outflow. Its equivalent width, 150 Å, is almost twice as strong as that in the spectrum taken by Gregorio-Hetem et al. (1992), 77 Å.

All these facts show that the emission lines in the spectrum of Hen 938 change on short time scales. At the same time, the object did not display any significant brightness changes between the early 1970's (m$_V$ = $13\overset{\mathrm{m}}{.}3$, Allen & Swings 1976) and the mid 1990's (V = $13\overset{\mathrm{m}}{.}52$, Torres et al. 1995). The described spectral features suggest that Hen 938 has greater similarities to B[e] supergiants than to HAEBEs. Indeed, there are only a few early B-type HAEBE candidates with such a large number of metallic lines in emission (e.g., MWC 137, MWC 300). How-

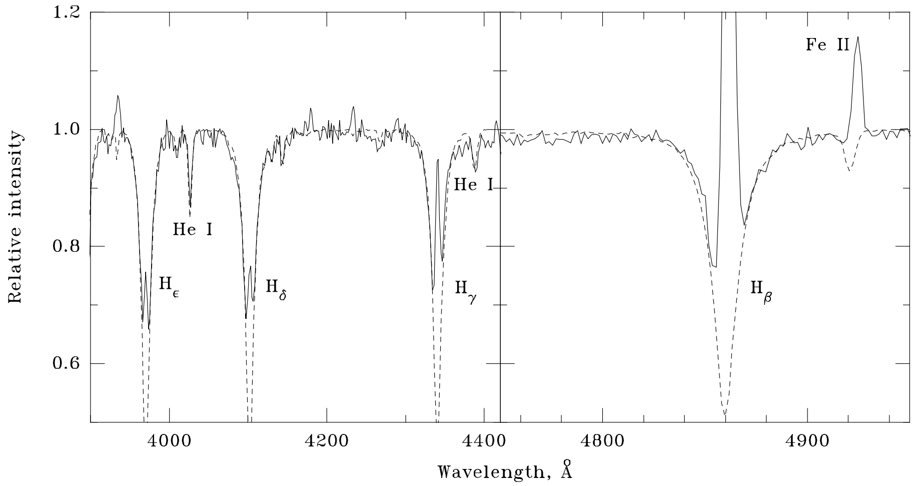

Fig. 7. Portions of the classification-resolution spectra obtained at Dark Sky Observatory. AS 116 (solid line) and HR 1029 (dashed line)

Table 9. Spectral lines in Hen 938

Transition	λ_{obs}, Å	I/I$_{cont}$	EW, Å	Transition	λ_{obs}, Å	I/I$_{cont}$	EW, Å
FeII(42)	4925.0	1.39	2.7	FeII(57)	5656.1	1.08	0.5
FeII(36)	4993.4	1.13	0.9	DIB	5777.6	0.83	1.6
FeII(42)	5019.7	1.55	4.1	HeI(11)	5875.0	1.15	0.7[a]
FeII(35)	5100.4	1.10	0.5	FeII(46)	5988.3	1.23	1.4
FeII(35)	5132.1	1.15	1.3	FeII(46)	6081.1	1.17	1.4
FeII(35)	5146.3	1.09	0.5	FeII(46)	6111.3	1.08	0.8+f
[FeII](18)	5157.8			FeII(46)	6115.4		
FeII(35)	5170.2	1.52	5.9+p	FeII(74)	6146.6	1.37	3.0
TiII(70)	5186.7			DIB	6199.2	0.92	0.7
FeII(49)	5197.0	1.32	4.1+p	FeII(74)	6236.9	1.29	4.0+f
TiII(70)	5225.8			FeII(74)	6245.1		
FeII(49)	5236.1	1.39	4.4+p	DIB	6279.3	0.74	3.0
FeII(49)	5256.7			[O I](1F)	6298.9	1.09	0.3
FeII(48)	5264.9			FeIIJ	6314.7	1.18	1.1[b]
FeII(49)	5277.3	1.37	8.1+2p+f	SiII(2)	6345.5	1.08	0.3
FeII(41)	5283.5			SiII(2)	6367.5	1.14	0.9[c]
FeII(48)	5316.4	1.53	6.8+2f	FeIIJ	6381.3	1.23	1.3[b]
FeII(49)	5324.6			FeII(74)	6416.6	1.11	0.6
FeII(48)	5337.0			FeII(40)	6430.3	1.32	1.8
FeII(48)	5363.8	1.23	1.6	FeII()	6444.9		
FeII(48)	5411.0	1.08	0.3	FeII(74)	6455.2	1.34	2.8+p
FeII(49)	5423.5	1.16	1.6+f	FeII()	6489.5	1.09	0.6
FeII(55)	5431.7			FeII(40)	6513.6	1.36	2.6
FeII(55)	5531.7	1.27	2.7	HeI(46)	6682.3	1.08	0.4[a]

[a] EW of the emission part of P Cyg profile
[b] from Johansson (1978)
[c] blend with Fe II (40) 6368 Å
"p" refers to the preceding line, "f" to the following line which are blended.

ever, both these stars still have a controversial evolutionary state (e.g., Wolf & Stahl 1985 and Esteban & Fernández 1998).

Another suggestion about the nature of Hen 938 is that it might be a star evolving towards the planetary nebula stage. Its photometric and spectroscopic variations as well as its spectral appearance are similar to those of OY Gem = HD 51585, which is thought to be a post-AGB star (e.g., Arkhipova & Ikonnikova 1992). In this case Hen 938 seems to be less evolved than OY Gem, because it displays only a few weak forbidden emission lines, while OY Gem shows a large number including some of high-excitation (e.g. [O III]). This implies that we can expect a further increase in the emission line strength in Hen 938.

At the same time, other methods may be applied in order to investigate whether Hen 938 is a young or an evolved star. For example, radial velocity measurements may help to constrain the distance towards the star, while mid- and far-IR spectroscopy

Table 10. Characteristics of the Balmer lines from the Brazilian spectra

Name	Hα		Hβ	
	I/I_{cont}	EW, Å	I/I_{cont}	EW, Å
AS 116	13.20	98.2	1.92	4.9
AS 117[a]	2.21	10.5	0.56	15.5
Hen 938	14.28	150.2	3.64	23.9

[a] Hβ is in absorption

may give information about the composition of the circumstellar dust. The low-resolution mid-IR spectrum obtained by *IRAS* (Olnon et al. 1986) is essentially featureless; this may imply the absence of crystalline structures. Recent results obtained by *ISO* show that amorphous circumstellar dust is common in both young stars and evolved objects, where it was formed a long time ago (Voors 1998).

4.1.8. HDE 244604 and BD$+11°829$

As we pointed out above, these two stars are located in a star formation region in upper Orion and are situated within a few degrees of each other. HDE 244604 was identified with an *IRAS* source by Oudmaijer et al. (1992). Recently Malfait et al. (1998) showed that it also has a near-IR excess. According to our photometric data, the star is rather stable ($\Delta V \sim 0\overset{\text{m}}{.}1$) except for one observation of 1998 December 9. Its brightness level is close to that indicated by Malfait et al. (1998), $V = 9\overset{\text{m}}{.}41$.

We obtained two spectra of the star in the blue-yellow region on two different nights. In the first spectrum (JD 2450818), HDE 244604 showed a slight filling-in of the Hβ core due to emission. This core emission was slightly shifted to the blue with respect to the absorption line (Fig 4a). A close comparison of this spectrum with that of the A3 V standard shows a slight infilling of the three Fe II (42) lines at 4923, 5018 and 5169 Å which is not readily apparent in the figure. The spectral type was determined to be A3 Va$^+$ (eb) Nem1 for this date. In the second spectrum (JD 2450839), emission in the Hβ line had disappeared, as well as the weak emission in the Fe II (42) lines. The strength of the Ca II K-line became stronger indicating a K-line type of A4, while the general metallic spectrum and the hydrogen lines gave an A3 type. In both spectra, the hydrogen lines were slightly more narrow than the A3 Va standard, β Leo. Thus, on JD 2450839, the spectral type was kA4 hA3 mA3 Va$^+$.

BD$+11°829$ is $0\overset{\text{m}}{.}7$ fainter and slightly more reddened than HDE 244604. Its near-IR excess is comparable with that of HDE 244604 ($V-K = 2\overset{\text{m}}{.}3$ and $2\overset{\text{m}}{.}2$ respectively). The photometric temperature type is B9, but the variations in the color-indices make this estimate uncertain. The Hβ line in the spectrum of BD$+11°829$ shows a fairly strong emission component (Fig. 4b). The emission core is shifted slightly to the red with respect to the absorption line. The Balmer decrement is very weak, meaning that emission is seen up to quite high Balmer lines (indeed, the cores are shallow all the way up to H9 - the highest Balmer line in our spectrum). The K-line is weak, and this is probably due to an emission component, as the core of Hϵ (which is blended with the Ca II H-line) also shows an asymmetry (with strongest emission to the blue side), probably due to Ca II H-line emission. The Fe II (42) lines show a noticeable P-Cygni profile. This star has a temperature type of A3.

Both stars show signs of photometric and spectroscopic activity. However, if we assume the same distance to the stars and equal temperatures, then HDE 244604 would be more luminous than BD$+11°829$, farther from the ZAMS, and more massive. At the same time, the difference in temperature derived from the color-indices and the spectrum, which were obtained at different times, might imply that the temperature of BD$+11°829$ is not well constrained. For instance, low-resolution spectra of an HAEBE, AB Aur, obtained with the same equipment on different nights, resulted in different spectral types, A0 and A3 (Gray & Corbally 1998). Thus, if BD$+11°829$ has an earlier spectral type than HDE 244604, the stars may have almost the same luminosity (given the same distance), because their brightness difference may be due to the difference in the circumstellar extinctions. As a result, BD$+11°829$ may have a larger mass than HDE 244604, but still be closer to the ZAMS.

5. Conclusions

A new search for *IRAS* counterparts of the galactic early-type emission-line stars (Wackerling 1970) resulted in the discovery of two HAEBE candidates, BD$+11°829$ and MQ Cas. The follow-up photometric and spectroscopic observations of these stars and 6 other recently suggested HAEBE candidates revealed the presence of a near-IR excess in 3 of them (AS 116, AS 117, and BD$+11°829$). The objects' spectral types were predicted from the UBV photometry and, in 8 cases, determined from classification-resolution spectra. Six were found to be late B-type – early A-type stars, one, Hen 938, is most likely an early B-type star, and one, HDE 290380, is an F6-type star. V1012 Ori was classified as A3 II shell?, however, it might have a lower luminosity if one takes into account the possible presence of the shell emission in the Balmer lines.

All objects except Hen 938 are most likely pre-main-sequence stars, while the observed characteristics of Hen 938 are more consistent with those of B[e] supergiants or post-AGB stars. Photometric variations, similar to those of HAEBEs, were found for MQ Cas and V1012 Ori. GSC 1811$-$0767, BD$+11°829$, and HDE 244604 are located in regions which contain other young stars, making the suggestion about their youth more reliable.

Nevertheless, additional observations are needed to extend our knowledge about these objects. In particular, higher resolution spectroscopy will provide us with quantitative information about their circumstellar envelopes and help to refine their distances. Long-term photometric monitoring will be capable of revealing brightness variations, which are expected for low-temperature HAEBEs. IR spectroscopy may place constraints on the chemical composition of the circumstellar dust.

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