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UV(IUE) spectra of hot post-AGB candidates *

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Abstract. Analysis of the low resolution UV(IUE) spectra of 15 hot post-AGB candidates is presented. The UV(IUE) spectra of 10 stars suggest partial obscuration of the hot stars due to circumstellar dust. The reddened continua of these 10 stars were used to model and estimate the circumstellar extinction. The circumstellar extinction law was found to be linear in λ^{-1} in the case of IRAS13266-5551 (CPD-55 5588), IRAS14331-6435 (Hen3-1013), IRAS16206-5956 (SAO 243756), IRAS17074-1845 (Hen3-1347), IRAS17311-4924 (Hen3-1428), IRAS18023-3409 (LSS 4634), IRAS18062+2410 (SAO 85766), IRAS18371-3159 (LSE 63), IRAS22023+5249 (LSIII +5224) and IRAS22495+5134 (LSIII +5142). There seems to be no significant circumstellar extinction in the case of IRAS17203-1534, IRAS17460-3114 (SAO 209306) and IRAS18379-1707 (LSS 5112). The UV(IUE) spectrum of IRAS12584-4837 (Hen3-847) shows several emission lines including that of HeII. It may be a massive young OB-supergiant or a low mass star in the post-AGB phase of evolution. IRAS16206-5956 (SAO 243756) and IRAS 18062+2410 (SAO 85766) show variability in the UV which in addition to stellar pulsations may be attributed to a dusty torus in motion around the hot central stars. The UV spectrum of the bipolar PPN, IRAS17423-1755 (Hen3-1475) indicates that the central B-type star is obscured by a dusty disk. The stars were placed on the log g−log T_{eff} diagram showing the post-AGB evolutionary tracks of Schönberner. Terminal wind velocities of the stars were estimated from the CIV and NV stellar wind features. The presence of stellar wind in some of these stars indicates ongoing mass-loss.

Key words. Stars: AGB and post-AGB — Stars: early-type — Stars: evolution — Stars: circumstellar matter — Ultraviolet: stars

1. Introduction

Low and intermediate mass stars (M $\simeq$ 0.8 - 8 $M_{\odot}$) pass through the post-asymptotic giant branch (post-AGB) phase of evolution on their way to becoming planetary nebulae (PNe). From an analysis of the Infrared Astronomical Satellite Point Source Catalog (IRAS PSC) cooler post-AGB stars having G,F,A supergiant like character were first identified (Parthasarathy & Pottasch 1986, Lamers et al. 1986, Pottasch & Parthasarathy 1988a, Hrivnak et al. 1989). These stars were found to have circumstellar dust shells with far-IR colors and flux distributions similar to the dust shells of PNe. Later, from an analysis of IRAS data, Parthasarathy & Pottasch (1989) found a few hot (OB spectral types) post-AGB candidates. Their supergiant like character, the presence of cold detached dust shells, far-IR colors similar to PNe and high galactic latitudes suggested that they may be in a post-AGB phase of evolution. Thus, there seems to be an evolutionary sequence ranging from the cooler G,F,A supergiant-like stars to hotter O-B types, evolving from the tip of the AGB towards young PN stage (Parthasarathy, 1993c).

Pottasch et al. (1988b) and van der Veen & Habing (1988) identified a region of the IRAS color-color diagram (F(12μ)/F(25μ) < 0.35 and F(25μ)/F(60μ) > 0.3) which was mainly populated by stars in transition from the AGB to the PN phase. Based on their far-IR colors and low resolution optical spectra, several hot post-AGB candidates were identified (Parthasarathy & Pottasch 1989, Parthasarathy 1993a, 1993c, Parthasarathy et al., 2000a). The optical spectra of these objects show strong Balmer emission lines and in some cases low excitation nebular emission lines such as [NII] and [SII] superposed on the OB stellar continuum. The absence of [OIII] 5007Å line and the presence of low excitation nebular emission lines indicate that photoionisation has just started. It is important to study these stars in the UV to obtain better estimates of their temperatures and to look for signatures of circumstellar reddening, mass-loss and stellar winds. The UV(IUE) spectra of some hot post-AGB stars (eg. Hen3-1357, Parthasarathy et al. 1993b, 1995, Feibelman, 1995) have revealed violet shifted stellar wind P-Cygni profiles of CIV, SiIV and NV, indicating hot and fast stellar wind,

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* Based on observations obtained with the International Ultraviolet Explorer (IUE), retrieved from the Multimission Archive at STScI

post-AGB mass-loss and rapid evolution. In this paper we have analysed the UV(IUE) spectra of 15 hot post-AGB candidates.

2. Target Selection and Observations

The hot post-AGB candidates in this paper (Table 1), were identified on the basis of their IRAS colors ($F(12\mu)/F(25\mu) < 0.35$ and $F(25\mu)/F(60\mu) > 0.3$), high galactic latitudes and OB-giant or supergiant spectra in the optical (Parthasarathy et al., 2000a) with Balmer lines in emission. Young massive OB supergiants are not expected at high galactic latitudes and also they are not expected to have detached cold circumstellar dust shells. High galactic latitude OB supergiants with detached dust shells and far-IR colors similar to PNe were found to be in the post-AGB phase of evolution (Parthasarathy, 1993c, Parthasarathy et al., 2000a).

Low resolution ($\sim 6-7$Å), large aperture, UV(IUE) spectra of the hot post-AGB candidates from 1150Å to 3200Å were extracted from the Multimission Archive at STScI (Table 2). The spectra obtained by centering the stars in the $10''$X $23''$aperture were processed using the IUE NEWSIPS (new spectral image processing system) pipeline which applies the signal weighted extraction technique (SWET) as well as the latest flux calibration and close-out camera sensitivity corrections. An increased signal-to-noise (S/N) ratio of 10% − 50% has been demonstrated for low dispersion IUE spectra reprocessed with the NEWSIPS software (Nichols & Linsky, 1996). Well exposed IUE NEWSIPS spectra have S/N of $\sim$ 50 while weak, high-background, under-exposed spectra have S/N of $\sim$ 20 (Nichols et al., 1994, Nichols & Linsky, 1996). From our sample, IRAS14331-6435 (Hen3-1013), IRAS17074-1845 (Hen3-1347), IRAS17203-1534, IRAS18023-3409 (LSS 4634), IRAS18379-1707 (LSS 5112) and IRAS22023+5249 (LSIII +5224) have S/N $\sim$ 20. IRAS12584-4837 (Hen3-847), IRAS17460-3114 (SAO 209306) and IRAS18371-3159 (LSE 63) have well exposed spectra with S/N $\sim$ 50. The spectra of the remaining hot post-AGB candidates are of intermediate quality with S/N $\sim$ 30. The LWP spectra 18412 and 27936 of IRAS12584-4837 and IRAS18371-3159 respectively, were saturated and have not been used in the analysis. Line-by-line images were inspected for spurious features.

3. Analysis

Tables 3, 4a and 4b list the V magnitudes and B−V values of the 15 hot post-AGB candidates from literature. The optical spectral types are mainly from Parthasarathy et al. (2000a). For the optical spectral types of the stars, the corresponding intrinsic B−V values, $(B-V)_o$, were taken from Schmidt-Kaler (1982). Using the observed and intrinsic B−V values we derived the total (interstellar plus circumstellar) extinction, $E(B-V)_{total}$ ($=(B-V)_{obs} - (B-V)_o$) towards these stars. These values were compared with interstellar extinction ($E(B-V)_{I.S.}$) at the galactic latitudes and longitudes of these stars, estimated using the Diffuse Infrared Background Experiment (DIRBE)/IRAS dust maps (Schlegel et al., 1998). The DIRBE/IRAS dust maps do not give reliable estimates of the interstellar extinction for $|b| < 5°$. The accuracy of the DIRBE/IRAS extinction estimates are 16%. Comparing $E(B-V)_{total}$ and $E(B-V)_{I.S.}$ we found considerable circumstellar extinction in most cases (Tables 4a and b).

The 2200Å feature in the UV gives an estimate of the interstellar extinction. The merged LWP and SWP spectra of the hot post-AGB candidates were dereddened (Tables 3, 4a and b) using the 2200Å feature in the UV. Using the UNRED routine in the IUE data analysis software package, we adopted the average extinction law by Seaton (1979) and tried different values of E(B−V) till the 2200Å bump in the UV disappeared and smooth continua from 1150Å to 3200Å were obtained for all the stars. In the absence of an LWP spectrum of IRAS17460-3114 (SAO 209306), the SWP spectrum of the star was dereddened using $E(B-V)_{total}$ ($(B-V)_{obs}-(B-V)_o$)=0.54. In the rest of this paper, "dereddened spectra" would always refer to the observed IUE spectra corrected for interstellar extinction as determined from the 2200Å feature in the UV.

For stars with multiple LWP and SWP spectra, we overplotted the observed LWP (and SWP) spectra of each star to check for variability. The LWP and SWP spectra of IRAS16206-5956 (SAO 243756) and IRAS18062+2410 (SAO 85766) were found to show variation (Fig.1). Coadded LWP and SWP spectra of IRAS17311-4924 and IRAS22023+5249 were used in the analysis.

The dereddened merged spectra of the hot post-AGB candidates were compared with the dereddened spectra of standard stars from the atlas by Heck et al. (1984) The spectral types of the standard stars chosen for comparison were as close as possible to the optical spectral types of the hot post-AGB candidates. Tables 3, 4a and 4b list the standard stars used for comparison, their spectral types and E(B−V) values. For comparison, the flux of the standard stars were scaled in accordance with the difference between the V magnitudes (after correcting for interstellar exintinction as determined from the 2200Å feature) of the standard star and the corresponding hot post-AGB candidate.

3.1. Spectral features in the UV

The spectra from 1150Å to 3200Å dereddened with E(B−V) determined from the 2200Å feature are shown in Figs. 2, 3, 5a and 6a. Lines of NV(1240Å), CII(1335Å), SiIV(1394, 1403Å), CIV(1550Å), NIV(1718Å), FeII(2586-2631Å) and MgII(2800Å) typical of hot stars (Heck et al., 1984) and central stars of PNe were identified in the spectra of these stars. The UV line strengths in the hot post-AGB candidates were compared with the line strengths in the standard stars. The absence of CIV in the B3-supergiant star, IRAS14331-6435 (Hen3-1013)

Table 1. Hot post-AGB candidates

Star No.	IRAS	Name	l	b	IRAS Fluxes (Jy.)			
					12μ	25μ	60μ	100μ
1.	12584-4837	Hen3-847	304.60	+13.95	36.07	48.75	13.04	3.31
2.	13266-5551	CPD-55 5588	308.30	+6.36	0.76	35.90	35.43	11.66
3.	14331-6435	Hen3-1013	313.89	-4.20	4.04	108.70	70.71	20.61
4.	16206-5956	SAO 243756	326.77	-7.49	0.36L	11.04	12.30	4.83
5.	17074-1845	Hen3-1347	4.10	+12.26	0.50	12.20	5.66	3.47:
6.	17203-1534		8.55	+11.49	0.32	10.70	6.88	3.37
7.	17311-4924	Hen3-1428	341.41	-9.04	18.34	150.70	58.74	17.78
8.	17423-1755	Hen3-1475	9.36	+5.78	7.05	28.31	63.68	33.43
9.	17460-3114	SAO 209306	358.42	-1.88	6.26	20.82	12.20	220.40L
10.	18023-3409	LSS 4634	357.61	-6.31	0.26L	2.94	1.82	25.64L
11.	18062+2410	SAO 85766	50.67	+19.79	3.98	19.62	2.90	1.00L
12.	18371-3159	LSE 63	2.92	-11.82	0.25L	6.31	5.16	1.95
13.	18379-1707	LSS 5112	16.50	-5.42	1.67	23.76	7.12	3.66L
14.	22023+5249	LSIII +5224	99.30	-1.96	1.02	24.69	14.52	3.93L
15.	22495+5134	LSIII +5142	104.84	-6.77	0.54	12.37	7.18	3.12

A colon **:** indicates moderate quality IRAS flux, **L** is for an upper limit

alongwith near normal line strengths of SiIV and NIV suggests the underabundance of carbon in this star. From the SiIV and CIV features it appears that IRAS17074-1845 (Hen3-1347) and IRAS17460-3114 (SAO 209306) may be slightly metal deficient. Based on its optical spectra, IRAS18062+2410 (SAO 85766) was found to be metal poor and underabundant in carbon (Parthasarathy et al. 2000b, Mooney et al., 2002). In the UV also the line strengths appear to be weaker compared to a standard B1-supergiant. Metal deficiency has been observed in some high latitude hot post-AGB stars (see eg. McCausland et al. 1992, Napiwotzki et al. 1994).

3.2. Stars with negligible circumstellar extinction

The UV continua and spectral features of IRAS17203-1534, IRAS17460-3114 (SAO 209306) and IRAS18379-1707 (LSS 5112) were in good agreement with the dereddened UV(IUE) spectra of standard stars (Table 3) of similar optical spectral types (Fig. 2). The E(B−V) values of these stars determined from the 2200Å feature are nearly the same as $E(B-V)_{total}$ (Table 3) suggesting negligible extinction of starlight due to circumstellar dust in these three cases. Emission lines of SiII(1533, 1808, 1817Å), HeII(1640Å), NI(1743Å) and FeII(1785, 2746Å) in the spectrum of IRAS12584-4837 (Hen3-847) indicate the presence of hot plasma or a nebula.

3.3. Stars with circumstellar extinction

The UV(IUE) spectra of 10 stars (IRAS13266-5551 (CPD-55 5588), IRAS14331-6435 (Hen3-1013), IRAS16202-5956 (SAO 243756), IRAS17074-1845 (Hen3-1347), IRAS17311-4924 (Hen3-1428), IRAS18023-3409 (LSS 4634), IRAS18062+2410 (SAO 85766), IRAS18371-3159 (LSE 63), IRAS22023+5249 (LSIII +5224), IRAS22495+5134 (LSIII +5142)), dereddened using the 2200Å feature in the UV, showed considerably reddened continua in comparison with the dereddened spectra of standard stars of similar optical spectral types (Figs. 3, 5 and 6). Comparing the interstellar extinction estimates from the 2200Å feature with the total extinction ($E(B-V)_{total}$) towards these stars, we find that these stars have considerable UV deficiency and circumstellar extinction. The hot central star of the bipolar proto-planetary nebula (PPN), IRAS17423-1755 (Hen3-1475) was not detected in a 35 minute exposure with the SWP camera. This may be due to obscuration of the central star by a dusty disk. HST WFPC2 images of the object showed the presence of a dusty torus with a spatial extent of 2″ (Borkowski et al., 1997).

3.3.1. Modelling the circumstellar extinction

To account for the observed UV deficiency in the 10 hot post-AGB candidates mentioned in Sec. 3.3 and to understand the shape of the UV continuum in these stars, we investigated the circumstellar extinction law in these cases. Waters et al. (1989) modelled the circumstellar extinction in the case of the post-AGB star, HR4049. We followed the same procedure here.

We plotted the logarithmic difference between the dereddened UV flux of a hot post-AGB candidate (normalised to its V-band flux) and the dereddened UV flux of the corresponding standard star (normalised to its V-band flux), i.e.
$\Delta = \log(f_\lambda/f_v)_{star} - \log(f_\lambda/f_v)_{standard}$ Vs. λ^{-1}.
Fig. 4 shows the plot of the logarithmic flux deficiency due to circumstellar dust from 3.2 to 8 μ^{-1} for the 10 stars. Best fit lines were obtained by minimising the chi-square error statistic. Eg., in the case of IRAS17311-4924 (Hen3-1428), we obtained, $\Delta = 0.07 - 0.10\lambda^{-1}$. To derive

Table 2. Log of observations

IRAS	Camera	Image	Aperture	DateObs	Exposure Time(s)
12584-4837	SWP	39271	LARGE	21 July 1990	2999.781
= Hen3-847	LWP	18412	LARGE	21 July 1990	1799.659
	LWP	19726	LARGE	10 Feb 1991	299.704
13266-5551	SWP	39270	LARGE	20 July 1990	1799.652
= CPD-55 5588	LWP	18411	LARGE	20 July 1990	1199.595
14331-6435	SWP	33601	LARGE	22 May 1988	2399.717
= Hen3-1013	LWP	13295	LARGE	22 May 1988	1199.595
16206-5956	SWP	33953	LARGE	21 July 1988	2399.717
= SAO 243756	SWP	50195	LARGE	12 March 1994	2399.716
	SWP	50640	LARGE	28 April 1994	3599.844
	LWP	13714	LARGE	21 July 1988	1199.595
	LWP	26175	LARGE	19 August 1993	1019.781
	LWP	27667	LARGE	12 March 1994	599.531
17074-1845	SWP	39276	LARGE	21 July 1990	1799.652
= Hen3-1347	LWP	18418	LARGE	21 July 1990	599.531
17203-1534	SWP	50657	LARGE	30 April 1994	2399.716
	LWP	28020	LARGE	30 April 1994	1199.595
17311-4924	SWP	33600	LARGE	21 May 1988	2099.480
= Hen3-1428	SWP	48127	LARGE	17 July 1993	3599.844
	LWP	13294	LARGE	22 May 1988	959.570
	LWP	25934	LARGE	17 July 1993	899.768
17423-1755	SWP	35860	LARGE	26 March 1989	2099.480
= Hen3-1475					
17460-3114	SWP	54660	LARGE	12 May 1995	89.572
= SAO 209306					
18023-3409	SWP	55458	LARGE	9 August 1995	4199.499
= LSS 4634	LWP	31272	LARGE	9 August 1995	1559.634
18062+2410	SWP	44446	LARGE	21 April 1992	1200
= SAO 85766	SWP	55916	LARGE	12 Sept. 1995	1800
	LWP	22865	LARGE	21 April 1992	300
	LWP	31454	LARGE	12 Sept. 1995	600
18371-3159	SWP	50588	LARGE	19 April 1994	4799.563
= LSE 63	LWP	27936	LARGE	19 April 1994	2399.723
	LWP	27972	LARGE	23 April 1994	899.768
18379-1707	SWP	47531	LARGE	23 April 1993	3899.672
= LSS 5112	LWP	25398	LARGE	23 April 1993	1199.595
22023+5249	SWP	48454	LARGE	24 August 1993	2399.716
= LSIII +5224	SWP	48593	LARGE	9 Sept 1993	4799.563
	SWP	55915	LARGE	12 Sept 1995	7199.819
	LWP	26209	LARGE	24 August 1993	1199.595
	LWP	31453	LARGE	12 Sept 1995	2399.723
22495+5134	SWP	48453	LARGE	24 August 1993	2399.716
= LSIII +5142	LWP	26322	LARGE	9 Sept. 1993	2099.487

Table 3. Hot post-AGB candidates with negligible circumstellar extinction

IRAS	V mag	$(B-V)_{obs}$	E(B−V) I.S.	E(B−V) (2200Å)	Sp. Type Optical	E(B−V) total	Standard star	Sp.Type std. star	E(B−V) std. star
12584-4837	10.58[a]	0.07[a]	0.18	0.25	Be[1]	–	–	–	–
17203-1534	12.02[a]	0.35[a]	0.44	0.56	B1IIIpe	0.61	HD173502	B1II	0.09
17460-3114	7.94[b]	0.23[b]	–	0.54	O8III	0.54	HD162978	O7.5II	0.35
18379-1707	11.93[b]	0.45[b]	–	0.70	B1IIIpe	0.71	HD173502	B1II	0.11

Photometry is from : [a]Hog et al.(2000); [b]Reed(1998) Spectra types of the hot post-AGB candidates are from Parthasarathy et al. (2000a) except [1]Kazarovets et al. (2000).

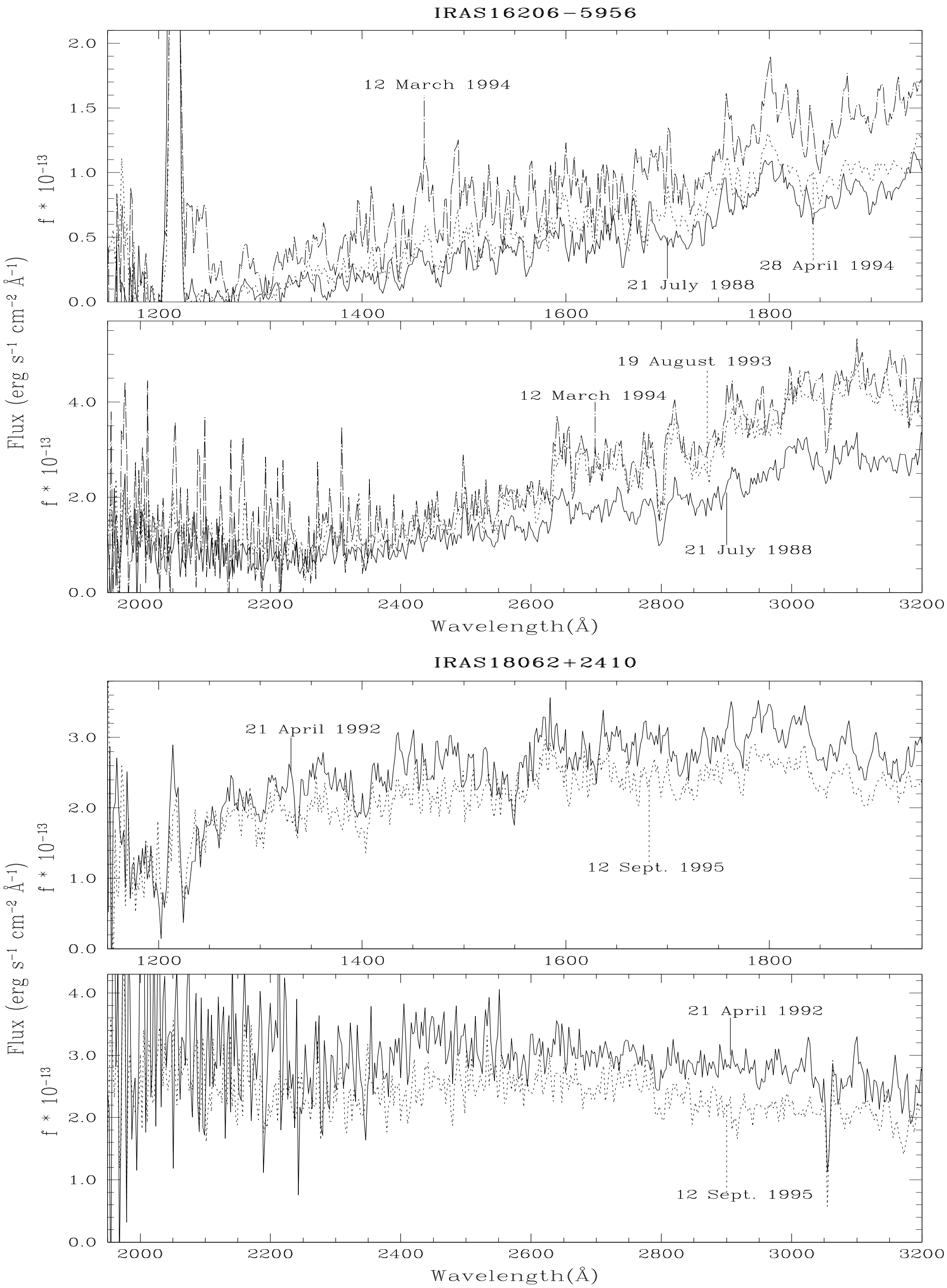

Fig. 1. The observed LWP and SWP spectra of IRAS16206-5956(SAO 243756) and IRAS18062+2410(SAO 85766) showing the variability.

the circumstellar extinction ($E(B-V)_{C.S.}$) in magnitudes (Tables 4a and b) Δ had to be multiplied by -2.5 and $\lambda = 0.44\mu$ was used.

For IRAS22023+5249 (LSIII +5224), only a B spectral type is listed in literature. We compared the spectrum of this star with that of a B2-supergiant standard star. IRAS22495+5134 (LSIII +5142) was detected as a PN with an angular extent of $0.5''$(Tylenda & Stasinska, 1994). Central stars of PNe have temperatures in excess of $\sim$ 30000K corresponding to spectral types of O9 or hot-

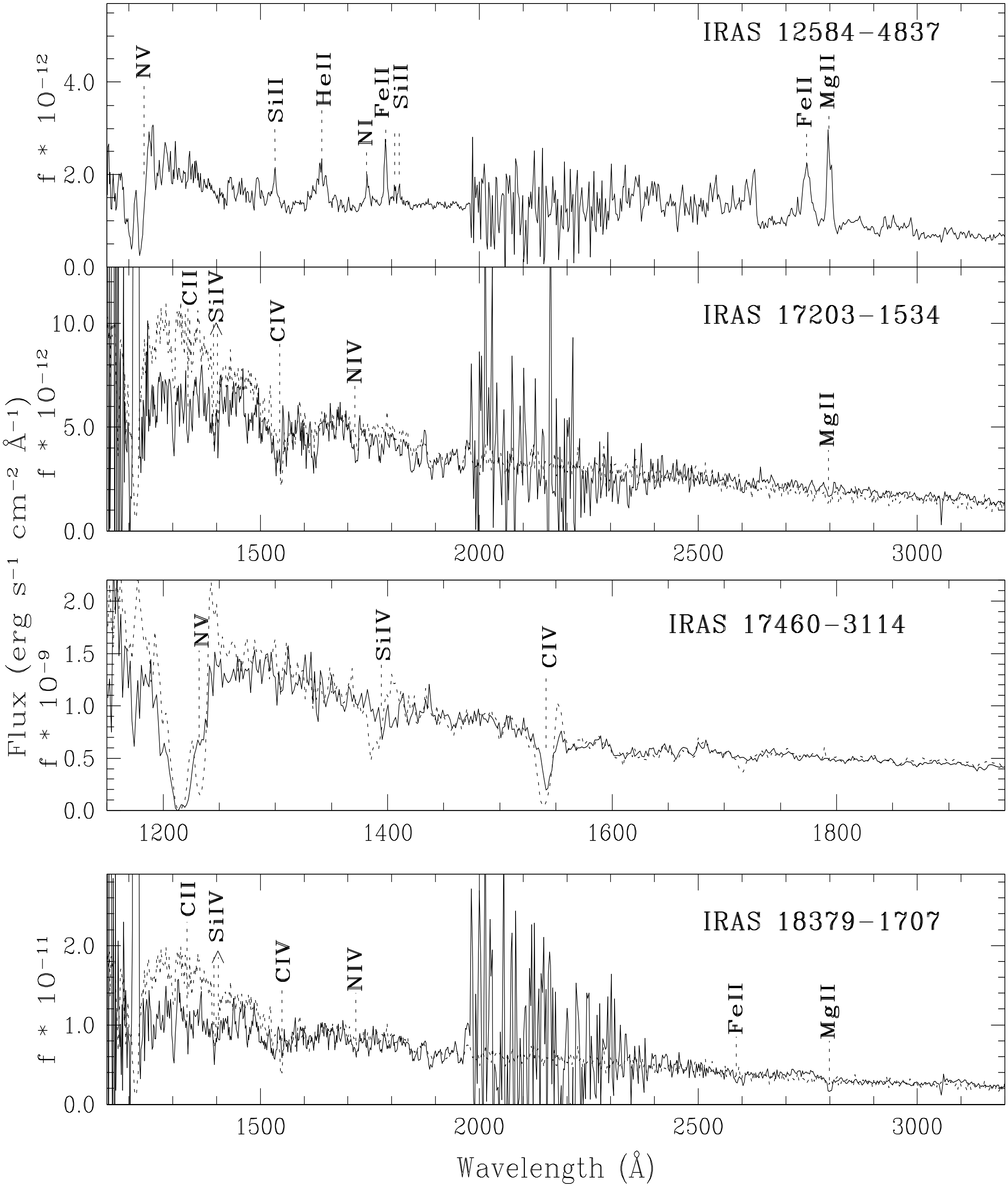

Fig. 2. The dereddened UV(IUE) spectra of hot post-AGB candidates with negligible circumstellar extinction (solid lines) compared with the dereddened UV(IUE) spectra of standard stars (dotted lines) from the atlas by Heck et al. (1984, Table 3). The spectra were dereddened using E(B−V) estimated from the 2200Å feature in the UV. IRAS17460-3114 was dereddened using $E(B-V)_{total}$ for the star. IRAS12584-4837 is a Be star in the optical.

ter. We compared the UV(IUE) spectra of this star with a standard O9V star (HD38666).

For each of the 10 hot post-AGB candidates we found that the circumstellar extinction varies as λ^{-1} (Fig. 4). The derived $E(B-V)_{C.S.}$ values in Table 4a account well for the difference between the total and the interstellar extinction (from the 2200Å feature) values. $E(B-V)_{C.S.}$ values in Table 4b are in excess of the difference between

Table 4a. Hot post-AGB candidates with observable circumstellar extinction

IRAS	V mag	$(B-V)_{obs}$	E(B−V) I.S.	E(B−V) (2200Å)	Sp. Type Optical	E(B−V) total	Standard star	Sp.Type std. star	E(B−V) std. star	E(B−V) C.S.
13266-5551	10.68[b]	0.31[b]	0.53	0.38	B1Ibe	0.51	HD77581	B0.5Ia	0.77	0.15
14331-6435	10.90[b]	0.58[b]	–	0.44	B3Ie	0.71	HD198478	B3Ia	0.58	0.26
17074-1845	11.47[a]	0.46[a]	0.28	0.24	B3IIIe	0.66	HD51309	B3II	0.13	0.39
17311-4924	10.68[c]	0.40[c]	0.22	0.28	B1IIe	0.66	HD51283	B2III	0.02	0.39
17423-1755	12.64[d]	0.66[d]	0.67	–	Be	–	–	–	–	–
18023-3409	11.55[b]	0.46[b]	0.44	0.30	B2IIIe	0.70	HD51283	B2III	0.02	0.43
18371-3159	11.98[a]	0.11[a]	0.15	0.13	B1Iabe	0.30	HD122879	B0Ia	0.42	0.11
22023+5249	12.52[a]	0.69[a]	–	0.37	B[1]	–	HD41117	B2Ia	0.52	0.44
22495+5134	11.78[a]	0.22[a]	0.357	0.33	PN[2]	–	HD38666	09V	0.02	0.20

Photometry is from : [a]Hog et al.(2000); [b]Reed(1998); [c]Kozok (1985a); [d] Gauba et al.(2003)
Spectral types of the hot post-AGB candidates are from Parthasarathy et al. (2000a) except [1]Simbad database; [2]Acker et al.(1992)

Table 4b. Hot post-AGB candidates showing variation in the UV

IRAS	V mag	$(B-V)_{obs}$	E(B−V) I.S.	E(B−V) (2200Å)	Sp. Type Optical	E(B−V) total	Standard star	Sp.Type std. star	E(B−V) std. star	E(B−V) C.S.
16206-5956	9.76[a]	0.31[a]	0.22	0.13	A0Ia[1]	0.29	HD21389	A0Ia	0.79	0.54 (21/07/88)
										0.24 (12/03/94)
18062+2410	11.54[b]	0.05[b]	0.11	0.08	B1I[2]	0.24	–	–	–	0.03 (21/04/92)
										0.30 (12/09/95)

Photometry is from : [a]Reed(1998); [b]Arkhipova et al.(1999)
Spectral types are from : [1]Schild et al.(1983); [2]Parthasarathy et al. (2000b)

$E(B-V)_{total}$ and the interstellar extinction from 2200Å . This may be because of the variable nature of these stars and because the V and (B−V) magnitudes at each epoch of the IUE observations are not known. Mean V and (B−V) magnitudes from literature have been used for each of these two stars (see Sec. 3.3.2 below).

3.3.2. Variations in the UV(IUE) spectra of IRAS16206-5956 (SAO 243756) and IRAS 18062+2410 (SAO 85766)

IRAS 16206-5956 was found to be variable in the UV (Fig. 1). The spectrum of the star has changed from 21 July 1988 to 12 March 1994 and from 12 March 1994 to 28 April 1994 suggesting both long term and short term variability. The maximum flux in the UV was observed on 12 March 1994. Schild et al (1983) found it to be variable in the optical with ΔV=0.13. Since the V magnitudes of the star at the epochs of the UV(IUE) observations are not known, we used a mean V magnitude (=9.76) from the photometric and spectroscopic database for Stephenson-Sanduleak Luminous Stars in the Southern Milky Way (Reed, 1998). Its spectral type in literature is listed as A3Iabe (Humphreys, 1975, Parthasarathy et al., 2000a) and A0Iae (Schild et al. 1983, Garrison et al., 1977). Oudmaijer (1996) listed it as B8Ia, citing the Simbad database. However, we could not find a reference for the same. We compared the dereddened IUE spectra of the star at different epochs with the dereddened spectra of A3Ib (HD104035) and A0Ia (HD21389) standard stars (Fig. 5a). A match could not be obtained in either case. Finally, we adopted the A0Ia standard star (HD21389) and modelled the circumstellar extinction in the case of SAO 243756 (as outlined in Sec. 3.2.1) for the spectra taken on 12 March 1994 (maximum observed IUE flux) and 21 July 1988 (minimum observed IUE flux). The circumstellar extinction was found to be linear in λ^{-1} at both epochs (Fig. 5b, Table 4b).

The UV flux from IRAS18062+2410 has decreased in Sept. 1995, compared to the flux from the hot central star in April, 1992 (Fig. 1). From an analysis of the high resolution optical spectra of the star, Parthasarathy et al. (2000b) and Mooney et al. (2002), found it to be metal-poor ([M/H] ~ -0.6). Since there are no hot (OB-spectral types), metal-poor standard stars in the UV, we compared the UV spectrum of this star with a Kurucz model closest to the effective temperature, gravity and metallicity of the star in the optical (Parthasarathy et al. 2000b, Mooney et al., 2002) We adopted T_{eff}=23000K, log g=3.0 and [M/H]=−0.5 (Fig. 6a). Arkhipova et al. (1999, 2000) found that it shows irregular rapid light variations in the optical with an amplitude of upto $0^{m}.3$. in V. We adopted mean V = $11^{m}.54$ (Arkhipova et al., 1999). Following the prescription in Sec. 3.2.1, we find that the circumstellar extinction varies as λ^{-1} (Fig. 6b, Table 4b) and has increased in magnitude from 1992 to 1995.

3.4. Central star parameters and Energy Budget

For the 3 hot post-AGB candidates with negligible circumstellar extinction, IRAS17203-1534, IRAS17460-3114 (SAO 209306) and IRAS18379-1707 (LSS 5112), we modelled the spectra using solar metallicity Kurucz (1994) model atmospheres (Fig. 7) and derived the effective temperatures and gravities of these stars. The V-band fluxes of the stars were corrected for extinction assuming the normal interstellar extinction law, i.e. $A_v = 3.1 \times E(B-V)_{2200Å}$ (see eg. Seaton, 1979). The stellar flux distributions normalised to the corrected V-band flux of each star were compared with Kurucz models normalised to the respective model's flux at 5500Å . Log g in the case of the O8III star, IRAS17460-3114 (SAO 209206) was estimated to be 4.0. This value is uncertain due to the non-availability of Kurucz models of lower gravity at the high temperature (T_{eff}=35000K) of the star. The star may also be slightly metal deficient as discussed in Sec. 3. For the remaining stars, we obtained the effective temperatures and gravities based on their optical spectral types (Lang, 1992). Table 5 lists the adopted T_{eff} and log g values. The T_{eff} and log g values estimated from the optical spectral types of the stars may be uncertain by ∼ ± 1000K and ± 1.0 respectively. High resolution optical spectra of these stars are required for an accurate determination of T_{eff} and log g. The stars were placed on Schönberber's (1983, 1987) post-AGB evolutionary tracks for core masses (M_c) of 0.546, 0.565, 0.598 and 0.644 $M_\odot$ (Fig. 8).

The far-IR flux distributions of the hot post-AGB candidates must necessarily be due to flux from the hot central stars absorbed and re-radiated by the cold circumstellar dust envelopes which are a remnant of mass-loss on the AGB phase of the star. Hence, the integrated far-IR flux (F_{fir}) must be comparable to or less than the integrated stellar flux (F_{star}). We estimated F_{fir} from the 12μ to 100μ IRAS flux distributions for the stars. The integrated stellar flux (F_{star}) from 1150Å to 5500Å was estimated by combining the IUE spectra with the U,B,V magnitudes of the stars from literature. The IUE spectra and the U,B,V magnitudes were corrected for interstellar extinction derived from the 2200Å feature. IRAS17423-1755 was not detected in the UV. Its U,B,V,R,I magnitudes (Gauba et al., 2003) were corrected for interstellar extinction using the standard extinction law (Rieke & Lebofsky, 1985) and the integrated stellar flux from 3650Å (U-band) to 9000Å (I-band) was estimated. In the three cases with negligible circumstellar extinction (IRAS 17203-1534, IRAS17460-3114 and IRAS18379-1707), F_{fir} was comparable to or significantly less than F_{star}. In contrast stars with circumstellar extinction in the UV, eg. IRAS14331-6435, IRAS17074-1845, IRAS17311-4924, IRAS17423-1755, IRAS18062+2410 and IRAS22023+5249) showed a high ratio of F_{fir}/F_{star} indicating partial obscuration of the central stars. These stars may have dusty circumstellar disks.

3.5. Terminal wind velocity

The wavelength at which the shortward edge of the CIV (or NV) absorption profile intersects the stellar continuum is usually used to estimate the terminal wind velocities (v_∞) of hot stars from low resolution IUE spectra. However, this value is usually an upper limit to the true v_∞. Alternatively, the difference between the absorption and emission line centers (Δv) are used to estimate v_∞ from low resolution IUE spectra (Prinja, 1994). But high dispersion studies (see eg. Perinotto et al., 1982) have shown that Δv is less than v_∞.

Considerable circumstellar extinction in 10 of the 15 stars discussed in this paper, has significantly distorted the continuum flux distributions and line intensities of the CIV profiles. Hence, the point where the blue absorption edge of the CIV profile intersects the UV continuum is not reliable. These factors also contribute to the fact that the CIV P-Cygni profiles are not clearly observed in the low resolution spectra of these stars. The emission peaks may be too weak or lost in the reddened continuum. Hence it is not possible to estimate v_∞ from the shortward edge of the CIV absorption profile or from the difference between the absorption and emission line centers.

The CIV resonance doublet (1548Å , 1550Å) is not resolved in the IUE low resolution spectra. Stellar wind may be assumed to be absent in a B0V star. We measured the absorption minimum of the CIV feature in the UV(IUE) spectrum of a B0V standard star, HD36512 (1548.4Å) from the atlas by Heck et al. (1984). The difference between this wavelength and the absorption minima of the CIV feature in the IUE spectra of our hot post-AGB candidates was used to estimate the wind velocities in these stars. If instead, we had used the mean laboratory wavelength of the CIV resonance doublet (1549Å), the estimated terminal wind velocites would have been greater by $116 kms^{-1}$. The NV resonance doublet (1238Å , 1242Å) is also unresolved in low resolution IUE spectra. Moreover, the NV feature is often contaminated by geocoronal Lyman α. From the standard star atlas (Heck et al., 1984) we were unable to find a star in which the NV line is distinguishable from Lyman α and unaffected by stellar wind. Hence, in the case of IRAS12584-4837, we estimated the wind velocity from the difference between the NV absorption minimum and the mean laboratory wavelength of the line (1240Å). The estimated wind ve-

Table 5. Central star parameters and Energy budget

Star No.	IRAS	T_{eff}(K)	log g	F_{fir} X10^{-12} Wm^{-2}	F_{star} X10^{-12} Wm^{-2}	F_{fir}/F_{star}	Wind velocity kms^{-1}
1.	12584-4837	–	–	10.90	6.07	1.79	-3769
2.	13266-5551	20800	2.8	5.41	9.29	0.58	-1821
3.	14331-6435	16200	2.6	15.40	4.50	3.42	–
4.	16206-5956	11200	2.3	1.73	2.61 (21/07/88)	0.66	–
					2.97 (12/03/94)	0.58	–
5.	17074-1845	17100	3.4	1.67	1.44	1.16	–
6.	17203-1534[1]	19000±1000	2.5±0.5	1.51	8.86	0.17	-2402
7.	17311-4924	20300	3.0	21.80	4.01	5.44	-1066
8.	17423-1755	–	–	6.41	1.17	5.48	–
9.	17460-3114[1]	35000±2500	4.0±1.0	4.95	876.8	0.006	-1463
10.	18023-3409	20300	3.0	0.58	1.13	0.51	-2048
11.	18062+2410[2]	23000	2.6	2.90	1.64 (21/04/92)	1.77	–
					1.33 (12/09/95)	2.18	–
12.	18371-3159	20800	2.9	0.93	2.17	0.43	–
13.	18379-1707[1]	19000±1000	2.5±0.5	3.20	16.96	0.19	–
14.	22023+5249	–	–	3.45	1.14	3.03	-3978
15.	22495+5134	–	–	1.74	3.72	0.47	–

[1] The effective temperatures and gravities were estimated using solar metallicity Kurucz (1994) models.
[2] Effective temperature and gravity are from Mooney et al. (2002)

locities are listed in Table 5. No shift was observed in the case of IRAS17074-1845, IRAS18062+2410, IRAS18379-1707 and IRAS22495+5134. CIV (or NV) lines were not observed in IRAS14331-6435 and IRAS16206-5958. The SiIV (1394Å) absorption line in IRAS14331-6435 did not show a wavelength shift due to stellar wind. For low resolution IUE spectra, the FWHM of the instrumental width is 5Å (Castella & Barbero, 1983). Assuming a 3Å measurement error in estimating the blue shift of the lines from our low resolution spectra, would correspond to an error of $\sim$ 580 kms^{-1} and 726kms^{-1} in the estimate of wind velocites from CIV and NV respectively. However, our terminal wind velocities exceeded this error estimate. So, we may conclude that although a crude estimate is obtained of the terminal wind velocities, it nevertheless indicates the presence of stellar winds and post-AGB mass-loss in some of these stars.

4. Notes on individual objects :

#IRAS 12584-4837 (Hen3-847)
Henize (1976) identified it as an Hα emission line star. Based on its far infrared flux distribution and high galactic latitude (b=+13.95°) Parthasarathy(1993a) classified it as a post-AGB star. It was found to be variable in the optical (Kazarovets et al., 2000, de Winter et al., 2001). The Hipparchos magnitudes at maximum and minimum are $10^{m}.52$ and $10^{m}.70$ respectively. Thé et al. (1994) listed it as a candidate Herbig Ae/Be star. The presence of HeII line (1640Å) indicates a very high temperature. The UV spectrum and the presence of several emission lines (Fig. 2) suggest that it may be a massive young star. Another possibility is that it may be a luminous blue variable. Photometric monitoring and high resolution spectroscopy may enable us to further understand the evolutionary stage of this star. From the NV profile we estimated a terminal wind velocity of -3769 kms^{-1}.

#IRAS 13266-5551 (CPD-55 5588)
It was classified as a post-AGB star on the basis of its far infrared flux distribution (Parthasarathy, 1993a). From the optical spectra, Parthasarathy et al. (2000a) classified it as B1Ibe. They found the Balmer lines in emission upto Hδ. The LWP spectrum of the star is saturated from 2600Å to 3000Å . The central star has a terminal wind velocity of -1821 kms^{-1}.

#IRAS 14331-6435 (Hen3-1013)
Henize(1976) identified it as an Hα emission line star. It is listed as a Be star in Wackerling (1970). Based on its far infrared flux distribution it was classified as a post-AGB star (Parthasarathy & Pottasch 1989, Parthasarathy 1993a). Assuming a Be spectral type, Kozok (1985b) derived a distance of 1.9 kpc to the star. Loup et al. (1990) detected CO emission in this object and derived an expansion velocity of 15kms^{-1}. They derived a distance of 1.3kpc using the total IR flux in IRAS bands and assuming a post-AGB luminosity of $10^4L_\odot$. Parthasarathy et al. (2000a) found it to be a B3 supergiant (B3Ie) with Hβ in emission and Hγ filled in. Modelling yielded a circumstellar extinction value of $0^{m}.26$. The F_{fir}/F_{star} (= 3.42) ratio also suggests obscuration of the hot central star.

#IRAS 16206-5956 (SAO 243756)
On the basis of IRAS data, high galactic latitude, and supergiant spectrum, Parthasarathy (1993a) considered it to be a post-AGB star. Hα and Hβ were detected in emission (Oudmaijer 1996, Parthasarathy et al., 2000a). The variation in the UV may be attributed to variable circumstellar extinction.

#IRAS 17074-1845 (= Hen3-1347)
Henize (1976) identified it as an Hα emission line object. It was classified as a hot post-AGB star on the basis of its high galactic latitude, far-IR colors similar to PNe and Be spectral type (Parthasarathy, 1993a). It was classified as a B3IIIe star (Parthasarathy et al., 2000a).

#IRAS 17203-1534
On the basis of its high galactic latitude, early spectral type (B1IIIpe), Balmer line emission (Hβ) and far-IR colors similar to PNe, Parthasarathy et al. (2000a) classified it as a possible post-AGB star. We found that the UV spectrum closely follows that of a standard B1II star (HD173502). Using solar metallicity Kurucz (1994) models we obtained T_{eff} = 19000 ± 1000K and log g = 2.5 ±0.5.

#IRAS 17311-4924 (Hen3-1428)
It was classified as a post-AGB star on the basis of its IRAS data (Parthasarathy & Pottasch 1989, Parthasarathy 1993a). Loup et al. (1990) detected CO emission in this object typical for circumstellar shells around evolved objects. They derived a distance of 1.1 kpc and an expansion velocity of 11 kms^{-1}. Nyman et al. (1992) found an expansion velocity of 14.1 kms^{-1} from CO observations similar to that found by Loup et al. (1993). Assuming a Be star, Kozok (1985b) derived a photometric distance of 2.6kpc. Parthasarathy et al. (2000a) classified it as B1IIe. We found no apparent change between the UV(IUE) spectra taken in 1988 and 1993.

#IRAS17423-1755 (= Hen3-1475)
It was found to be a B-type emission line star (Henize, 1976). On the basis of IRAS data, Parthasarathy & Pottasch (1989) first classified it as a hot post-AGB star. It is a bipolar PPN (Bobrowsky et al. 1995, Riera et al. 1995, Borkowski et al., 1997) with wind velocities greater than 1000 km s^{-1} (Sánchez Contreras & Sahai, 2001, Borkowski & Harrington, 2001). Borkowski et al. (1997) concluded that Hen3-1475 is a point symmetric nebula. HST images of the object revealed outflows perpendicular to the dusty torus obscuring the hot central star. From the spectral energy distribution, Gauba et al. (2003) detected a hot dust component (∼ 1000K) indicating cirumstellar dust close to the central star as a result of ongoing post-AGB mass-loss. The non detection of the B-type central star in the SWP spectrum (35 minutes exposure) may be due to obscuration of the star by the dusty torus seen in the HST image. The F_{fir}/F_{star} (= 5.48) ratio also suggests obscuration of the hot central star by the dusty disk.

#IRAS 17460-3114 (SAO 209306)
It shows far-IR colors similar to PNe (Parthasarathy, 1993a). Based on low resolution spectra, it was classified as O8III (Parthasarathy et al., 2000a). In the UV(IUE) spectrum of the star, CIV (1550Å) shows a P Cygni profile with a strong absorption and weak emission component. The NV (1240Å) feature is contaminated by Lyman α.

#IRAS 18023-3409 (LSS 4634)
It is listed in the LSS (Luminous stars in the southern Milky Way) catalogue (Stephenson & Sanduleak, 1971) as an OB+ star. Parthasarathy et al.(2000a) found Hβ in emission and Hγ filled in. They classified it as B2IIIe. The UV(IUE) spectrum of the star shows considerable circumstellar extinction ($E(B-V)_{C.S.}$=0.43).

#IRAS 18062+2410 (SAO 85766)
Stephenson(1986) identified it as an Hα emission line star. The star appears to have rapidly evolved in the last 20-30 years (Arkhipova et al. 1999, Parthasarathy et al. 2000b). It was classified as a high galactic latitude, post-AGB star having far-IR colors similar to PNe (Volk and Kwok, 1989, Parthasarathy, 1993a). According to the HDE Catalog, its spectral type in 1940 was A5. The UV colors of this star listed in the Catalogue of Stellar Ultraviolet Fluxes (Thompson et al., 1978) and based on observations with the Ultraviolet Sky Survey Telescope (S2/68) onboard the ESRO satellite TD-1 indicated that in 1973 its spectral type was still A5I (Parthasarathy et al., 2000b). However, the spectral energy distribution of this star obtained in 1985-87 indicated a Be spectral type. (Downes and Keyes, 1988). An analysis of its high resolution spectra, revealed the underabundance of carbon and metals, high radial velocity and the presence of low excitation nebular emission lines (Arkhipova et al. 1999, Parthasarathy et al., 2000b). On the post-AGB evolutionary tracks of Schönberner (1983, 1987), it appears to be evolving into the PN phase with $M_c \simeq 0.644 M_\odot$. Variable circumstellar extinction, which may be due to a dusty torus in motion around the hot central star may explain the observed variations in the UV.

#IRAS 18371-3159 (LSE 63)
It is listed as OB+ in the extension to the Case-Hamburg OB-star surveys (Drilling & Bergeron 1995). Parthasarathy et al. (2000) classified it as B1Iabe. Preite-Martinez (1988) classified it as a possible new PN and estimated a distance of 2.4 kpc to the star. On the post-AGB evolutionary tracks of Schönberner (Fig. 8), it appears to be evolving into the PN stage with $M_c = 0.565 M_\odot$.

#IRAS 18379-1707 (LSS 5112)
Parthasarathy et al. (2000) classified it as B1IIIpe. The photometry of the star is from Reed (1998). IRAS colors similar to PNe, high galactic latitude, early B-type giant spectra in the UV and optical and the presence of CII (1335Å), SiIV (1394,1403Å), CIV(1550Å), NIV (1718Å) and MgII (2800) lines in the IUE spectrum support its classification as a hot post-AGB star. Using solar metallicity Kurucz (1994) models we determined T_{eff}=19000 ± 1000K and log g = 2.5 ± 0.5.

#IRAS 22023+5249 (LSIII +5224)
Its IRAS colors were found to be similar to PNe and Parthasarathy et al. (2001) classified it as a hot post-AGB star. The photometry of the star was obtained from the Tycho-2 Catalogue (Hog et al., 2000). It is listed in Wackerling's (1970) catalog of early-type emission-line stars. The B spectral type of the star was obtained from the Simbad database. We compared the UV spectrum of this star with that of a B2I standard star (HD41117) and found it to be similar. The F_{fir}/F_{star} (=3.03) ratio suggests obscuration of the hot central star and lends support to the modelled circumstellar extinction value of $0^{m}_{.}44$. There

was no difference between the 1993 and 1995 UV(IUE) spectra.

#IRAS 22495+5134 (LSIII +5142)

It is classified as a PN in the Strasbourg-ESO catalogue of Galactic planetary nebulae (Acker et al., 1992). Tylenda and Stasinska (1994) reported an angular diameter of 0.5″, expansion velocity of 10 kms^{-1} and V=12.08. The V magnitude from the Tycho-2 Catalogue (Hog et al., 2000) is $11^{m}_{.}78$. Handler (1999) found it to be variable with amplitude variations of $0^{m}_{.}3$ in the Johnson V band. While the long term variations (several days) were non periodic, the short term variations were quasi-periodic with time scales of either 8.9 or 14.3 hours. Variations in the stellar mass-loss coupled with stellar pulsation may explain the observed long and short-term variability. From the Hipparchos catalog, the Hipparchos magnitudes at maximum and minimum are $12^{m}_{.}11$ and $12^{m}_{.}47$ respectively. From the logarithmic extinction at Hβ using radio flux at 5Gz (c=0.41), Kaler(1983) obtained E(B-V)=$0^{m}_{.}28$. Using the Hα to Hβ ratio (c=0.55), Tylenda et al. (1992) obtained E(B-V)=0.37. These values are in good agreement with the interstellar E(B-V)=0.33 derived from the 2200Å feature in the UV.

5. Discussion & Conclusions

We analysed the UV(IUE) spectra of 15 hot post-AGB candidates. In 11 cases (IRAS13266-5551 (CPD-55 5588), IRAS14331-6435 (Hen3-1013), IRAS16206-5956 (SAO 243756), IRAS17074-1845 (Hen3-1347), IRAS17311-4924 (Hen3-1428), IRAS17423-1755 (Hen3-1475), IRAS18023-3409 (LSS 4634), IRAS18062+2410 (SAO 85766), IRAS18371-3159 (LSE 63), IRAS22023+5249 (LSIII +5224) and IRAS22495+5134 (LSIII +5142)), the UV spectra revealed obscuration of the hot central stars due to circumstellar dust. While IRAS17423-1755 (Hen3-1475) was not detected at all in a 35 minute exposure, the UV continua of the remaining 10 stars were found to be considerably reddened. We found that the circumstellar extinction in these 10 stars varies linearly as λ^{-1}. A λ^{-1} law for the circumstellar extinction was also found in the case of the post-AGB star, HR4049 (Waters et al., 1989, Monier & Parthasarathy, 1999). In the context of Mie scattering (Spitzer, 1978), linear extinction arises from dust grains small compared to the wavelength of light. The shortest wavelength of light at which the extinction is linear can give an estimate of the size of the smallest grains in the circumstellar environment of these stars ($\lambda = 2\pi$a, where, a is the radius of the dust grain). However our IUE SWP observations are limited to 1150Å ($\lambda^{-1} \approx 8.7\mu^{-1}$). Shortward of 1300Å the spectra are noisy and often contaminated by Lyman α. Taking 1300Å as the shortest observed wavelength at which the extinction is linear in λ^{-1}, we may infer an upper limit of a ≈ 200Å for the radii of the small grains. Waters et al. (1989) speculate that the destruction of these grains in the vicinity of the hot central stars of PPNe and PNe may give rise to smaller grains and polyaromatic hydrocarbons (PAHs). PAH features at 8.2, 8.6 and 11.3 μ have been detected in the circumstellar environment of several post-AGB stars, PPNe and PNe (see eg. Beintema et al., 1996). It would be interesting to study the infrared spectra of our hot post-AGB candidates to know more about the chemical compositions (carbon-rich or oxygen-rich nature) of the dust grains and the evolution of these grains in the circumstellar environment of these stars. Variation of IRAS16206-5956 (SAO 243756) and IRAS18062+2410 (SAO 85766) in the UV may be due to stellar pulsations and/or due to variable circumstellar extinction similar to that observed in the case of HR4049 (Waters et al., 1989, Monier & Parthasarathy, 1999). Significant circumstellar extinction was not observed in the case of IRAS17203-1534, IRAS17460-3114 (SAO 209306) and IRAS18379-1707 (LSS 5112). The effective temperatures and gravities of these three stars were estimated using Kurucz model atmospheres.

$F_{fir}/F_{star} >> 1.0$ in the case of IRAS14331-6435 (Hen3-1013), IRAS17311-4924 (Hen3-1428), IRAS17423-1755 (Hen3-1475), IRAS18062+2410 (SAO 85766) and IRAS22023+5249 (LSIII +5224) indicates the presence of dusty disks around these stars. From the UV(IUE) spectra we found that 7 (IRAS12584-4837, IRAS13266-5551 (CPD-55 5588), IRAS17203-1534, IRAS17311-4924 (Hen3-1428), IRAS17460-3114 (SAO 209306), IRAS18023-3409 (LSS 4634) and IRAS22023+5249 (LSIII +5224)) of the 15 hot post-AGB candidates have stellar wind velocities in excess of 1000kms^{-1} indicating post-AGB mass-loss.

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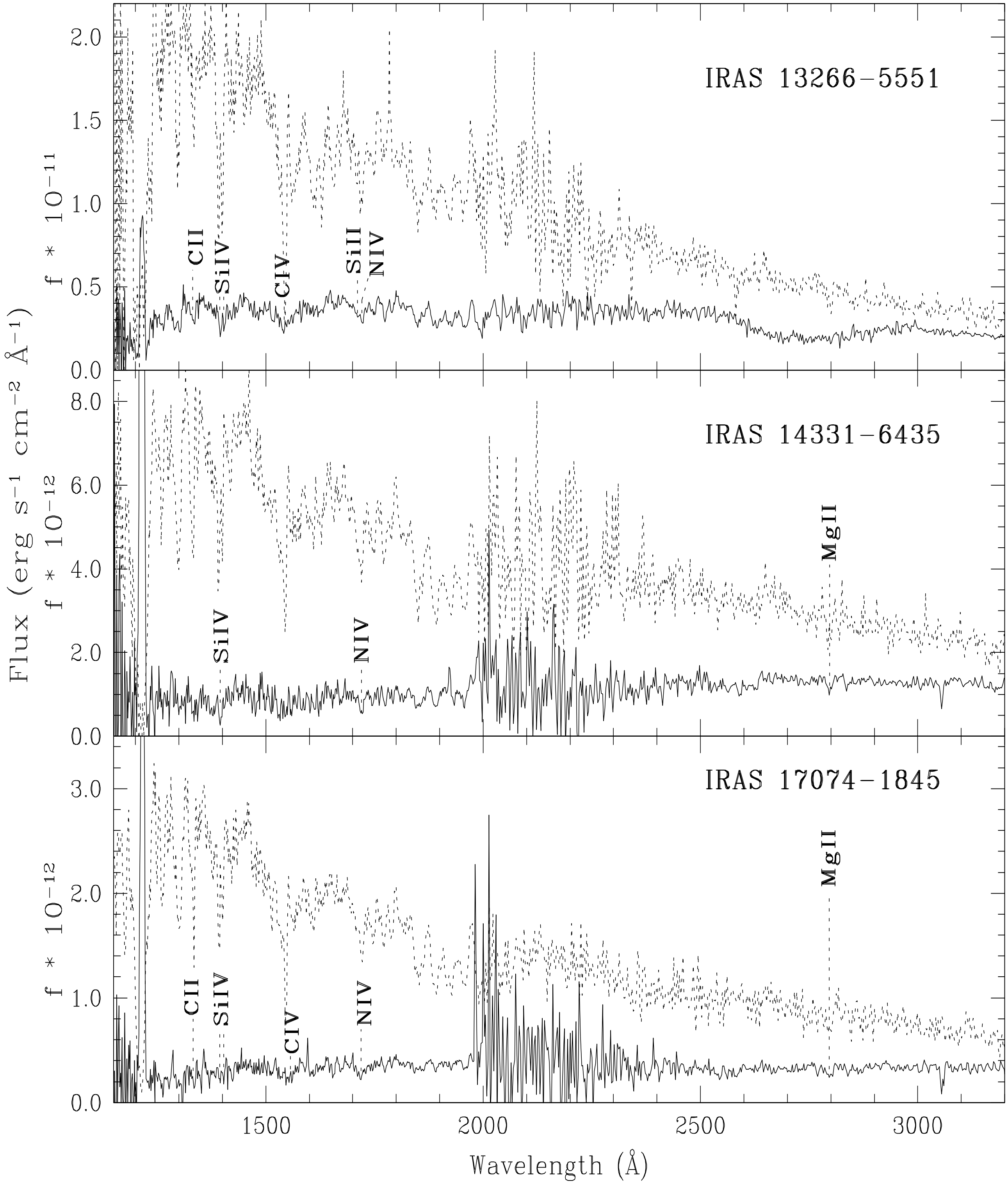

Fig. 3. The dereddened UV(IUE) spectra of hot post-AGB candidates (solid line) plotted alongwith the dereddened spectra of standard stars (dotted line) of similar optical spectral types from the atlas by Heck et al. (1984, Table 4a). The spectra have been dereddened using the 2200Å feature in the UV. Notice the reddened continua of the hot post-AGB candidates in comparison with the standard stars. The hot central star of IRAS17423-1755 is not observed in the UV, possibly due to obscuration of the star by a dusty torus
.

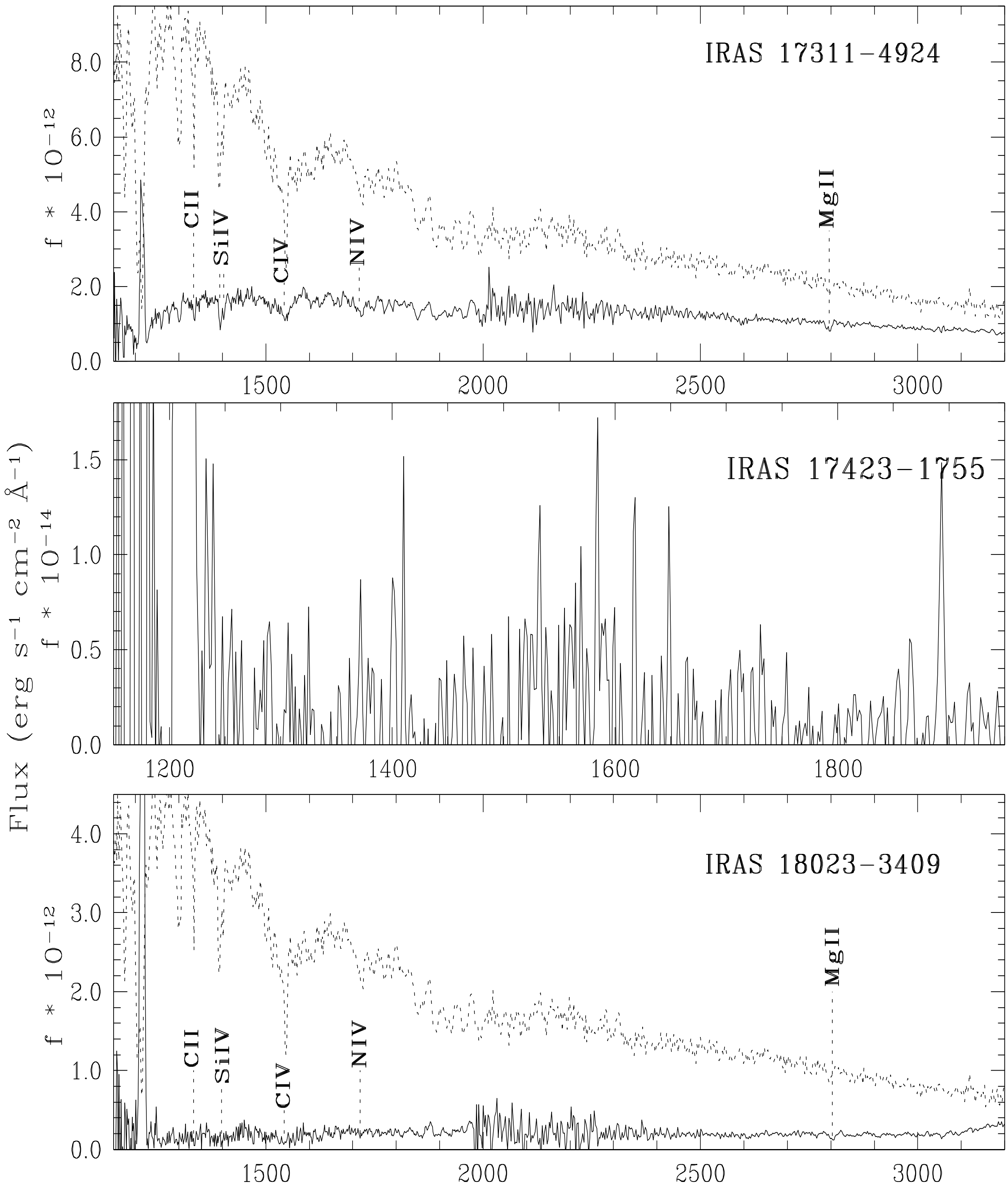
IRAS 17311−4924
IRAS 17423−1755
IRAS 18023−3409
Flux (erg s^{-1} cm^{-2} Å^{-1})
f * 10^{-12}
f * 10^{-14}
CII
SiIV
CIV
NIV
MgII
1500
2000
2500
3000
1200
1400
1600
1800

Fig. 3. contd....

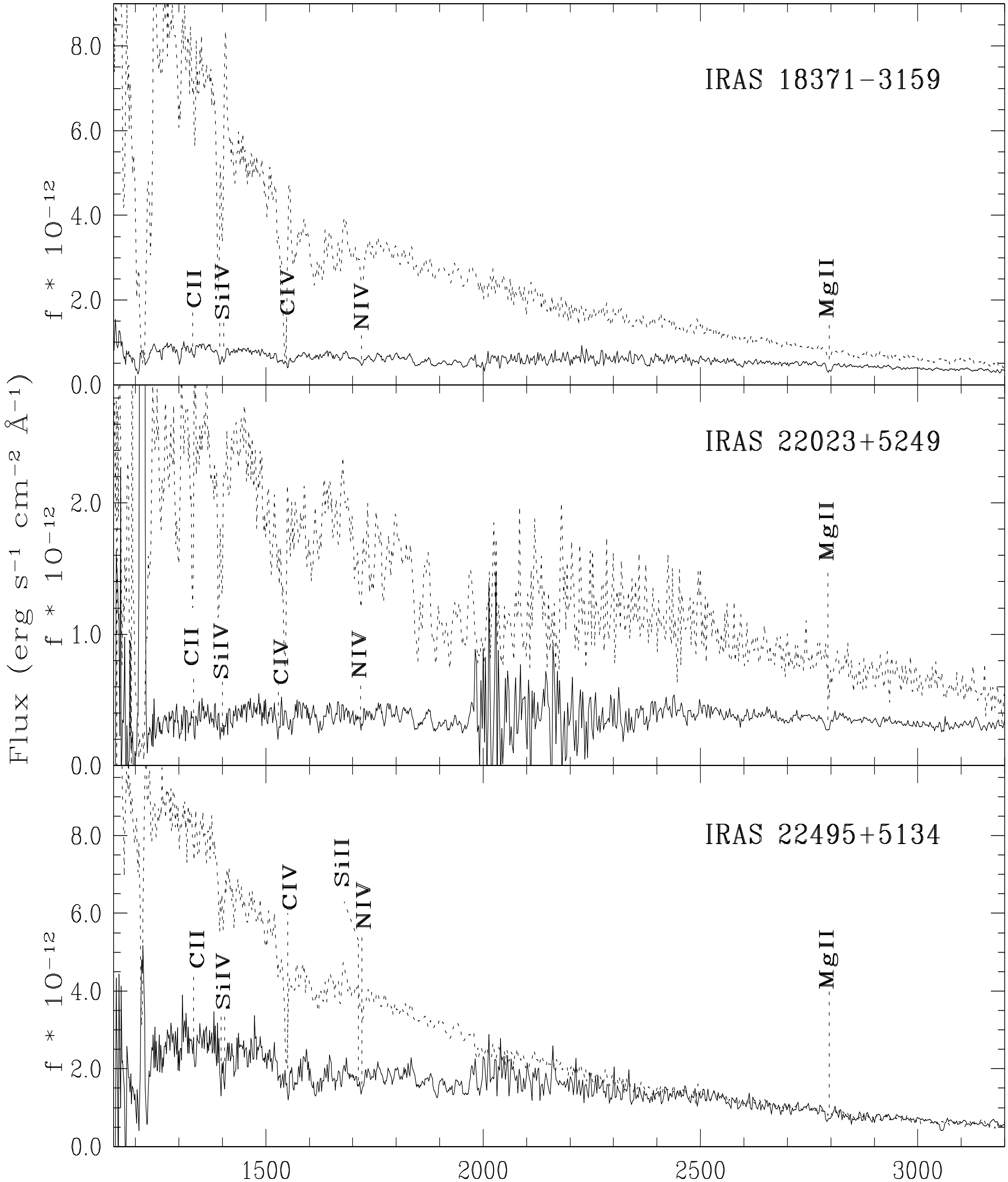
IRAS 18371−3159
IRAS 22023+5249
IRAS 22495+5134
CII
SiIV
CIV
NIV
SiII
MgII
Flux (erg s⁻¹ cm⁻² Å⁻¹)
f * 10⁻¹²
0.0
2.0
4.0
6.0
8.0
1.0
1500
2000
2500
3000

Fig. 3. contd....

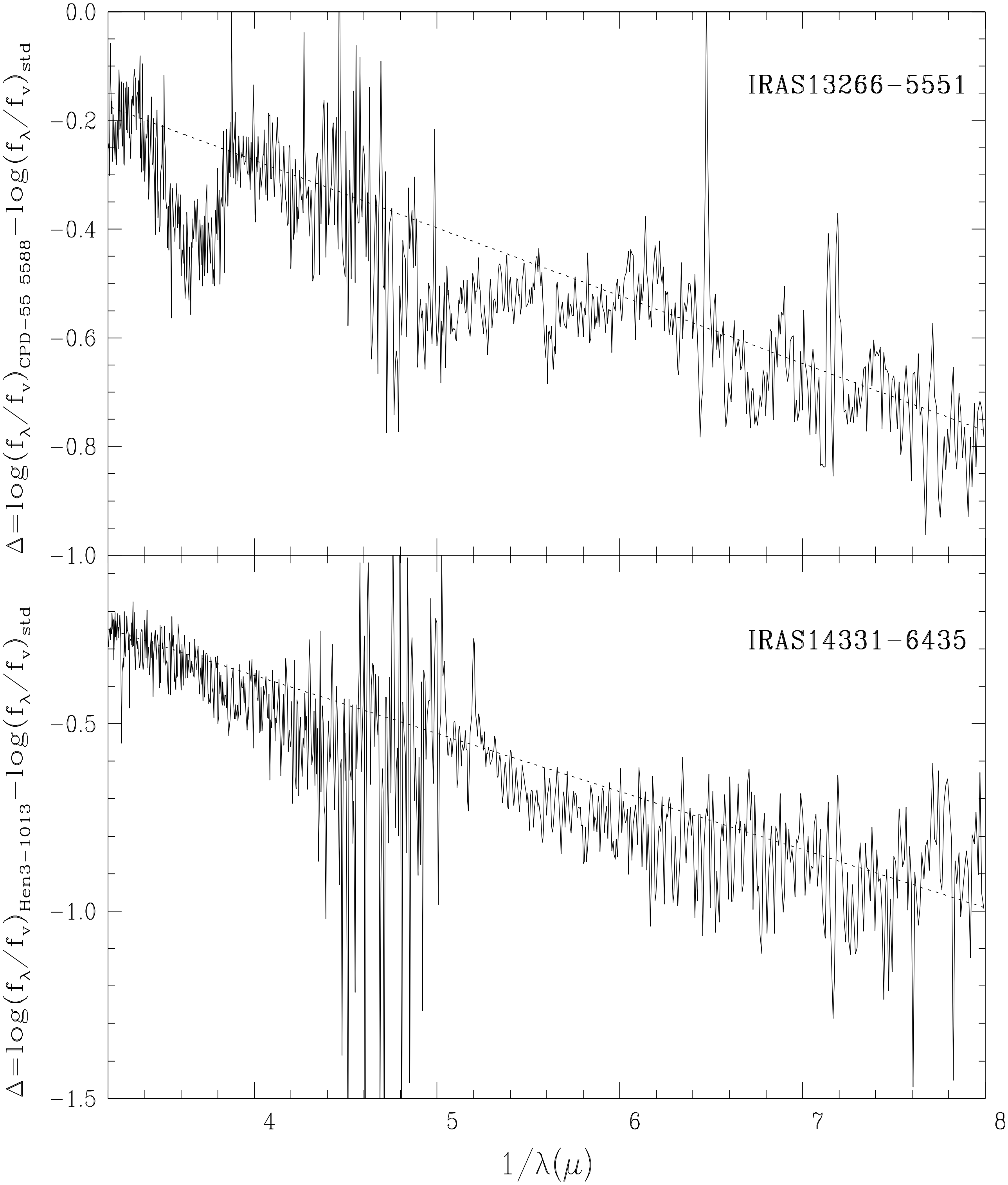

Fig. 4. 10 hot post-AGB candidates showed a pronounced UV deficiency when compared with standard stars of similar optical spectral types. Here, we have plotted the logarithmic flux deficiency of these stars in the UV from 3.2 to 8 μ^{-1}. The straight line fits are obtained by minimising the chi-square statistic. We find that the flux deficiency in the UV is proportional to λ^{-1}. The bump at $\sim 3.7\mu^{-1}$ in the plot of IRAS13266-5551 is due to the saturated LWP spectrum of the star. This region was not used in obtaining a fit. Similarly, for IRAS18023-3409, the LWP spectrum appears to have saturation effects. For IRAS18371-3159, the bump from $\sim$ 5 to $5.6\mu^{-1}$ is observed because of spurious broad absorption features from 1800Å to 1950Å in the SWP spectrum of the star.

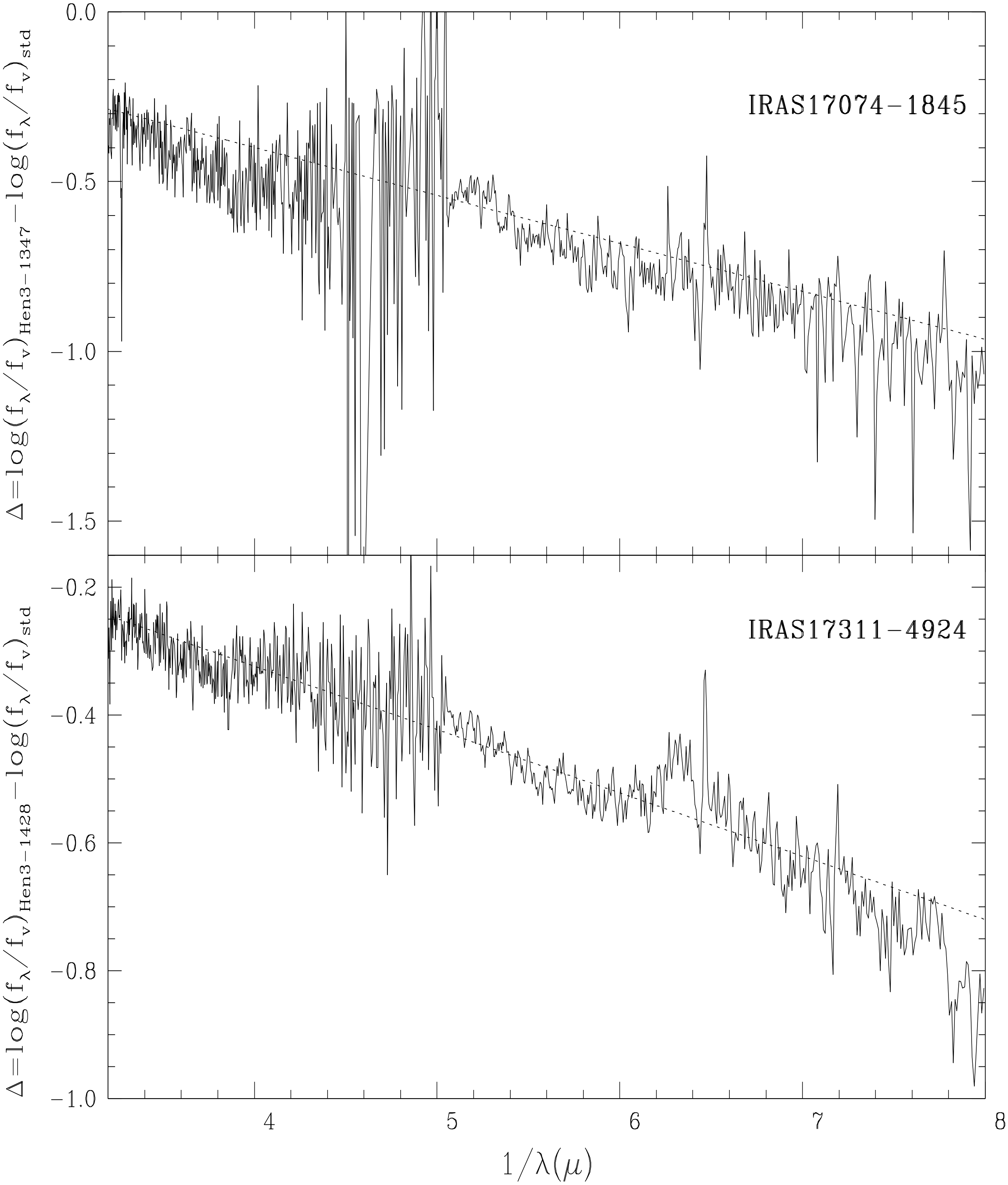
IRAS17074−1845
IRAS17311−4924
$\Delta = \log(f_\lambda/f_\nu)_{Hen3-1347} - \log(f_\lambda/f_\nu)_{std}$
$\Delta = \log(f_\lambda/f_\nu)_{Hen3-1428} - \log(f_\lambda/f_\nu)_{std}$
0.0
−0.5
−1.0
−1.5
−0.2
−0.4
−0.6
−0.8
−1.0
4
5
6
7
8
$1/\lambda(\mu)$

Fig. 4. contd...

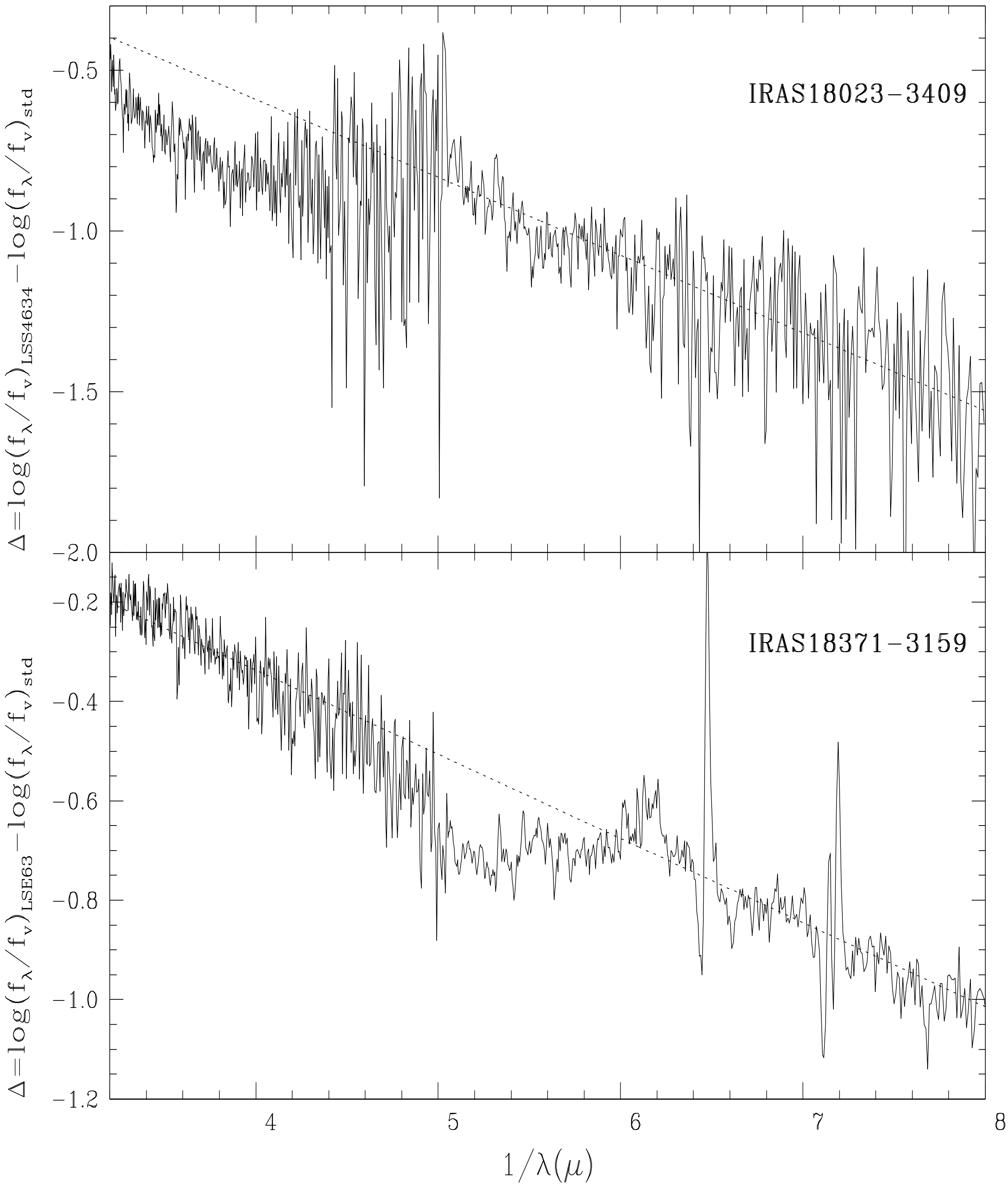
IRAS18023−3409
IRAS18371−3159
Δ=log(fλ/fv)LSS4634−log(fλ/fv)std
Δ=log(fλ/fv)LSE63−log(fλ/fv)std
1/λ(μ)

Fig. 4. contd...

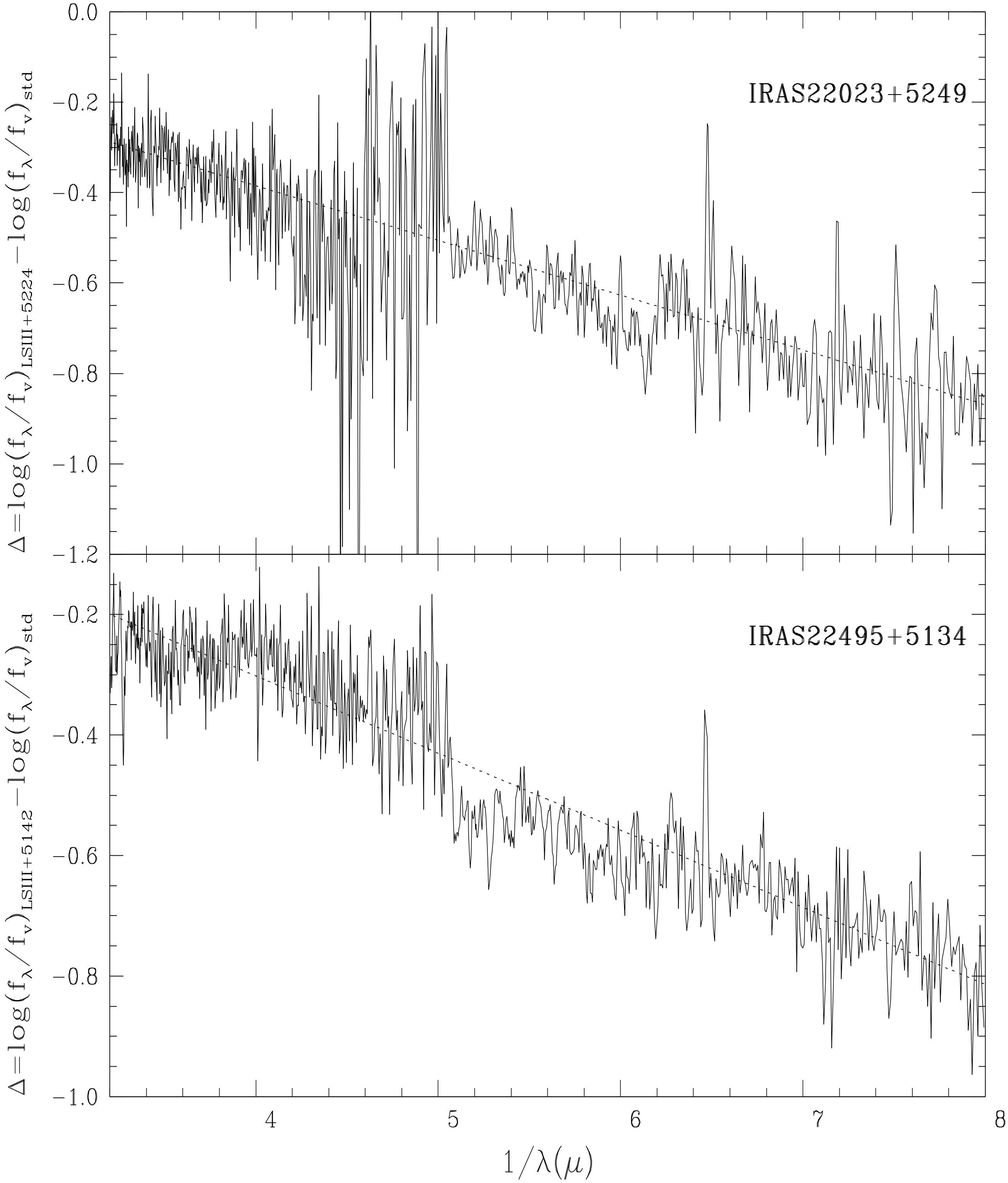
IRAS22023+5249
IRAS22495+5134
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
4
5
6
7
8
1/λ(μ)
Δ=log(fλ/fv)LSIII+5224−log(fλ/fv)std
Δ=log(fλ/fv)LSIII+5142−log(fλ/fv)std

Fig. 4. contd...

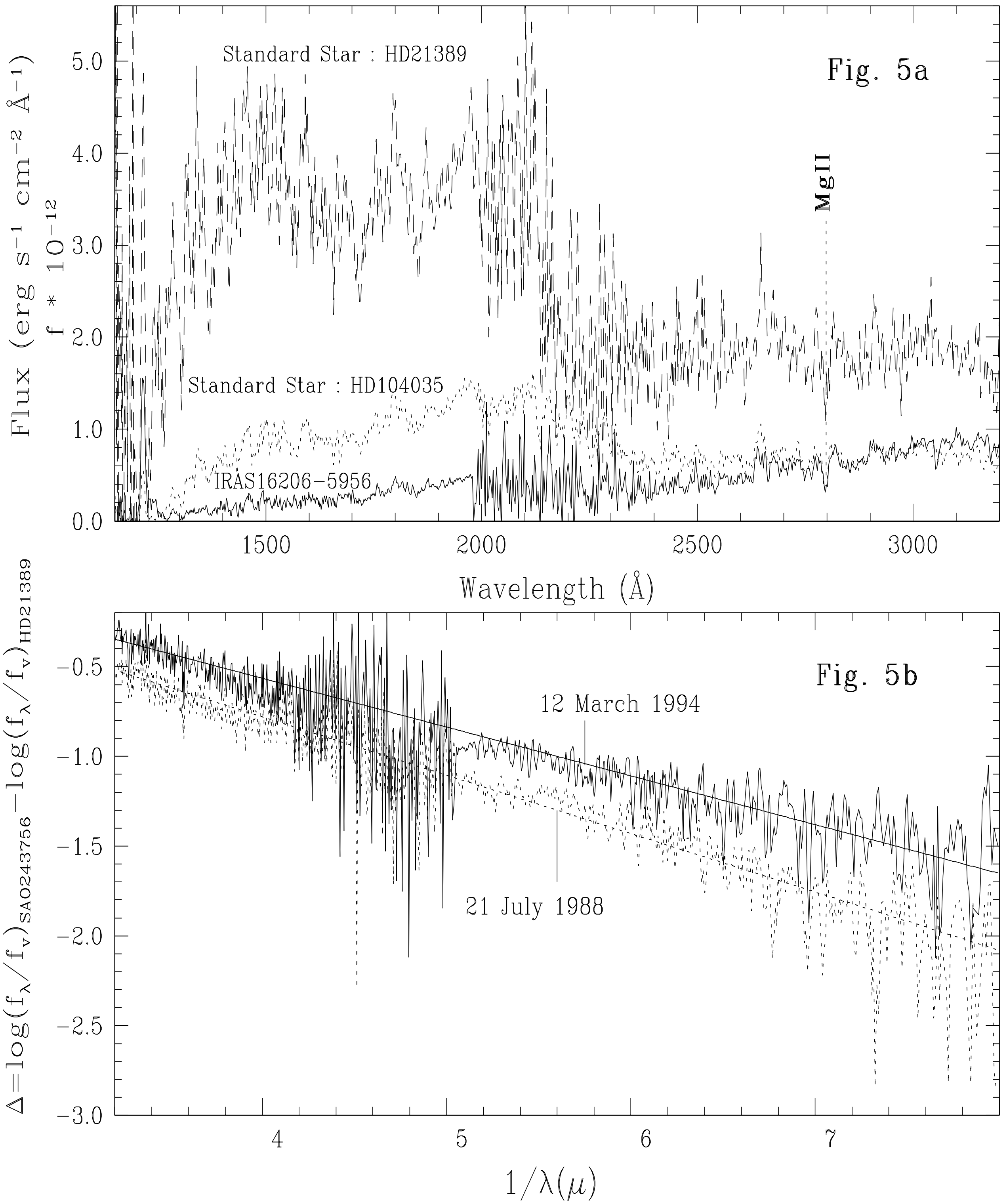

Fig. 5. IRAS16206-5956 (SAO243756) and the standard A3Ib (HD104035) and A0Ia (HD166937) stars were dereddened using the 2200Å feature in the UV. Fig. 5a shows the dereddened 12 March 1994 spectrum of SAO 243756 (solid line) alongwith the dereddened spectra of the standard A0Ia (dash line) and A3Ib stars (dotted line). SAO 243756 is fainter in the spectrum taken on 21 July 1988 (ref. Fig. 1). Adopting the A0Ia standard star, Fig. 5b shows the modelled circumstellar extinction for the spectrum on 12 March 1994 (solid line) and 21 July 1988 (dotted line) respectively

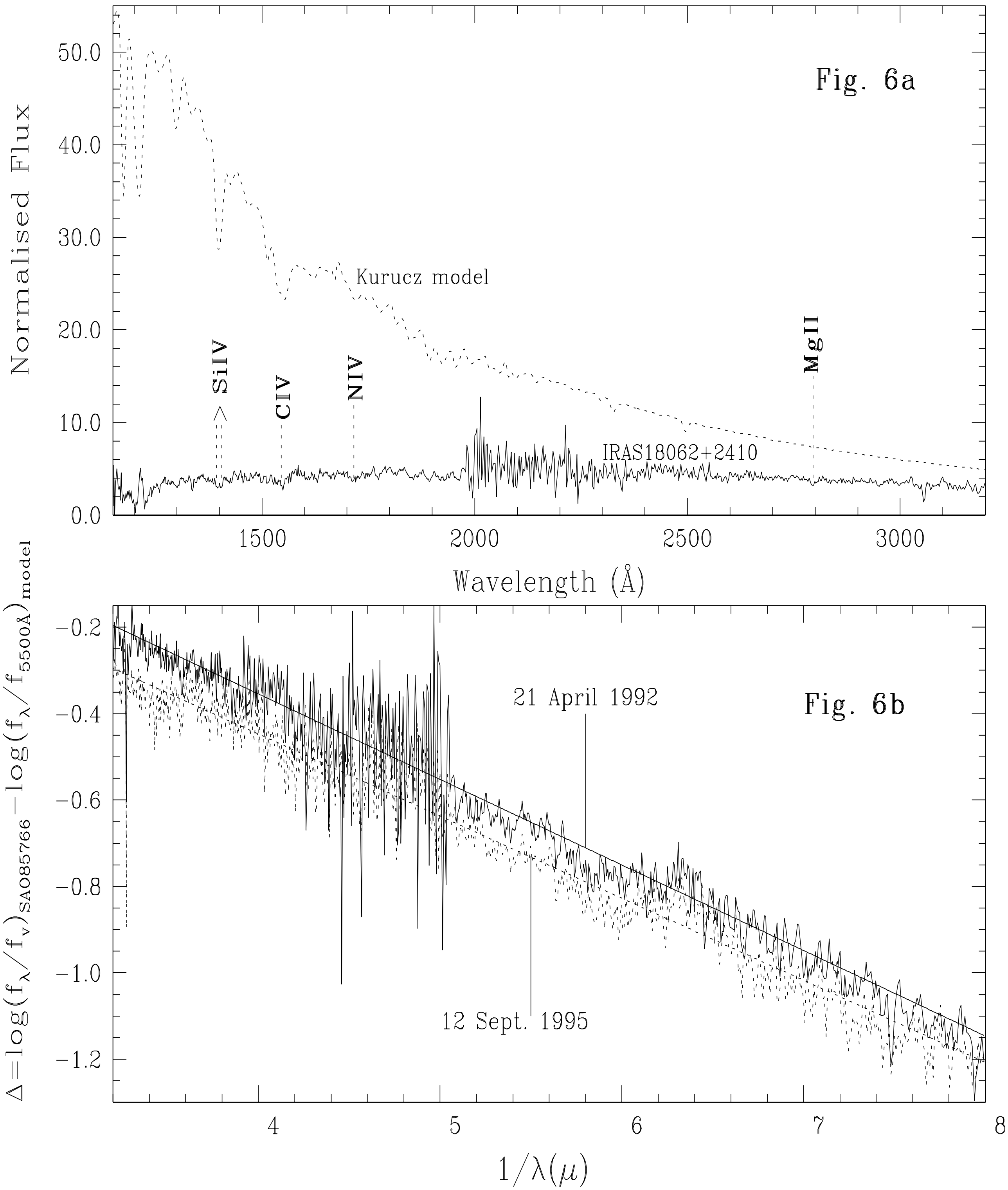

Fig. 6. IRAS18062+2410 (SAO 85766) was dereddened using the 2200Å feature in the UV. Fig. 6a shows the dereddened 1992 spectrum of SAO 85766 normalised to its V-band flux (solid line) alongwith Kurucz model (dotted line) of T_{eff}=23000K, log g=3.0, [M/H]=−0.5 normalised to the flux at 5500Å . SAO 85766 has become fainter in the 1995 spectrum of the star. Fig. 6b shows the modelled circumstellar extinction for 1992 (solid line) and 1995 (dotted line).

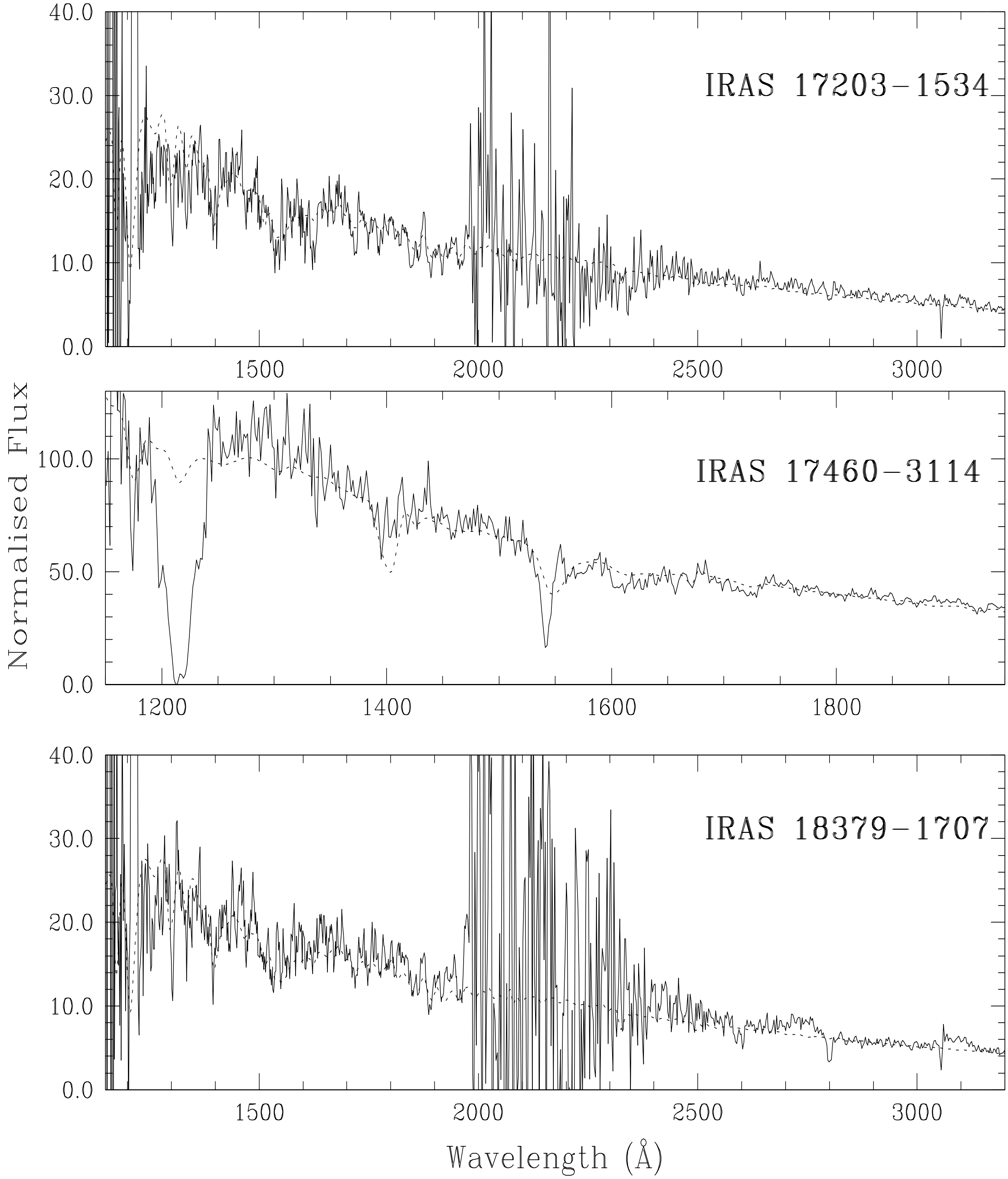

Fig. 7. The dereddened UV(IUE) spectra of hot post-AGB candidates with negligible circumstellar extinction (solid line), normalised to their V-band fluxes are plotted alongwith solar metallicity Kurucz (1994) model spectra (dotted line), normalised to each model's flux at 5500Å .

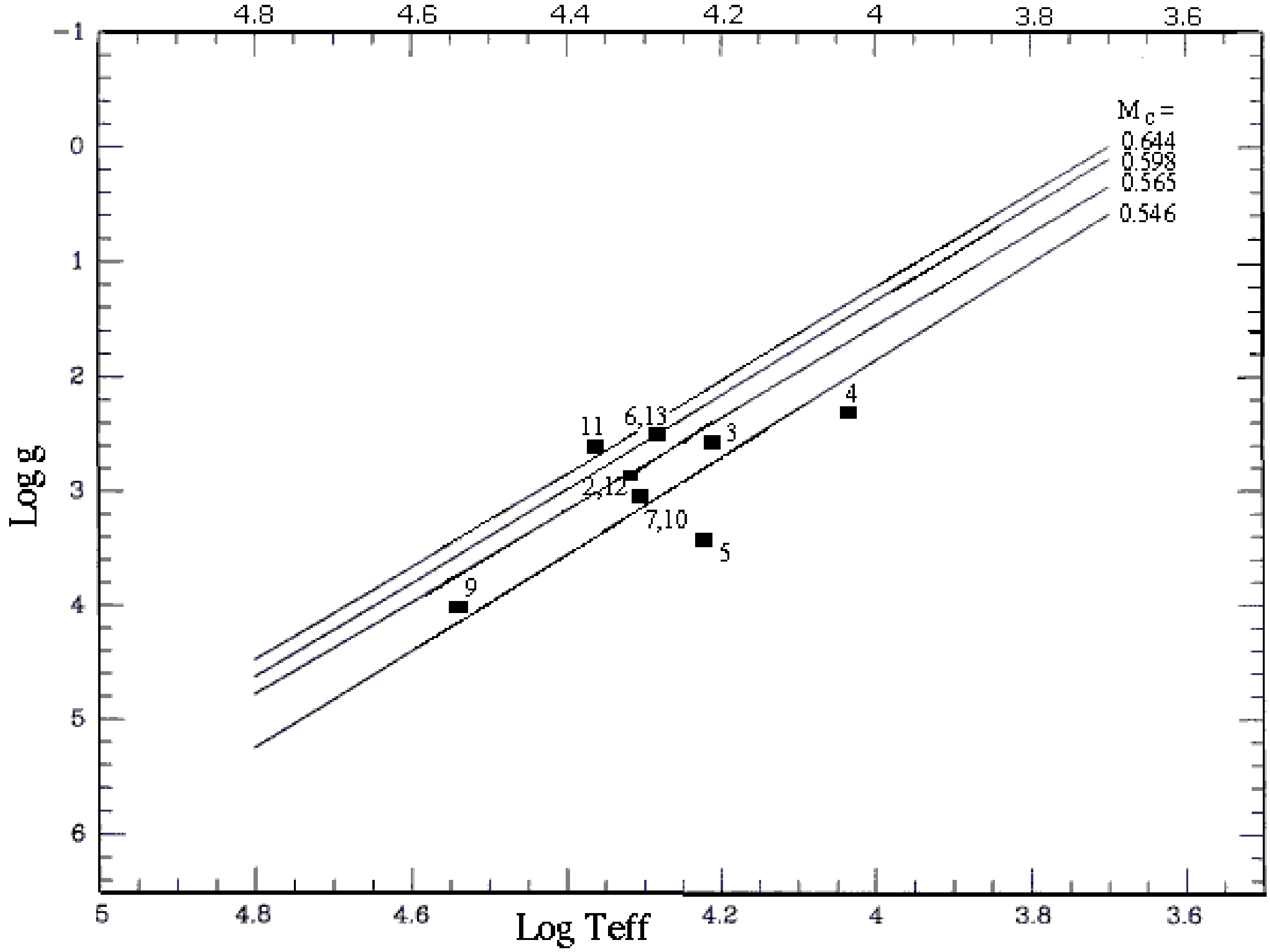

Fig. 8. Positions of the hot post-AGB candidates on the Log g−Log $T_{\rm eff}$ diagram showing the post-AGB evolutionary tracks of Schönberner (1983, 1987) for core masses of 0.546, 0.565, 0.598 and 0.644$M_\odot$