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A spectroscopic study of some suspected chemically peculiar stars

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Abstract. Time-resolved spectra in the 410 - 700 nm range have been obtained to investigate 10 stars which are classified as suspected chemically peculiar stars in *The General Catalogue of Ap and Am stars* by Renson et al. (1991) or in the latest literature.

Among the studied stars, HD 20629 presents metal abundances which are significantly different from main sequence star values and it should be classified as Silicon star. From the HeI 587.6 nm line, we conclude that HD 35575 is a helium weak star.

Because of the found radial velocity variability and the derived abundances, the periodic photometric variable HD 38602 could be an ellipsoidal variable.

Key words: stars: chemically peculiar – abundances – individual: HD 20629, HD 35575, HD 38602

1. Introduction

Chemically peculiar (Cp) stars are characterised by *i*) large scale organised magnetic fields, *ii*) abundances which are not consistent with their effective temperatures, *iii*) spectral and photometric variability with a single period. As to abundances, usually helium is underabundant in the cool and overabundant in the hot Cp stars. Carbon, oxygen and nitrogen are underabundant. Magnesium is also underabundant and iron peak elements are overabundant. Because of the anomalous metallicity, classical calibrations are not reliable and *ad hoc* methods are necessary to determine the effective temperatures of Cp stars.

In *The General Catalogue of Ap and Am stars* by Renson et al. (1991) are listed 6032 stars. Among these stars only 317 are confirmed Cp stars, 1526 are given as suspected Cp stars and the remaining are considered very probably Cp stars. An important step toward the comprehension of the Cp phenomenon is the correct classification of these stars. We have obtained time resolved spectra of 10 suspected chemically peculiar stars with the aim to ascertain if they are really Cp stars and determine their peculiarity class.

2. Observations and data analysis

Spectroscopy with resolving power R=13000 has been performed in the 410 - 700 nm range at the 2.1 m telescope of the Complejo Astronómico El Leoncito equipped with a Boller & Chivens cassegrain spectrograph in December 1995 for the suspected chemically peculiar stars listed in Table 1.

The data have been analysed using the IRAF package. The lines of the wavelength calibration lamp show that the instrumental broadening can be reproduced with a FWHM = 25 km s^{-1} Gaussian. The achieved S/N was between 100 and 200.

The observed spectra have been analysed using *a*) ATLAS9 (Kurucz 1993) to compute the atmosphere models, this code takes into account the metal opacity using Opacity Distribution Functions for multiples of the solar metallicity, *b*) SYNTHE (Kurucz & Avrett 1981) to identify spectral lines, *c*) WIDTH9 (Kurucz & Avrett 1981) to derive the abundances from single lines and *d*) XLINOP9 (Kurucz & Avrett 1981) to derive the abundances from blended lines. To identify spectral lines and derive abundances, we have adopted the atomic parameters from the Kurucz (1993) line list.

For all stars, we have determined the effective temperature and gravity from Strömgren photometry according to the grid of Moon & Dworetsky (1985) as coded by Moon (1985). The photometric colours have been de-reddened with the Moon (1985) algorithm. The source of the Strömgren photometric data was SIMBAD.

With these values of effective temperature and gravity, determined assuming that we are analysing a main sequence star, we have derived abundances which have been compared with the values given by Adelman (1986), Gies & Lambert (1992) and with the solar abundances given by Kurucz (priv. comm.) (Table 2). When differences were indicative of an enhanced metal-

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Table 1. Observed suspected chemically peculiar stars. Spectral type (ST) and peculiarity class (PC) are from *The General Catalogue of Ap and Am stars* by Renson et al. (1991). V magnitudes are form SIMBAD database. Effective temperatures, gravities, microturbulent and rotational velocities have been fixed as described in the text.

Star HD	*ST + PC*	$T_{\rm eff}$ K	$\log g$	*V*	ξ $km\,s^{-1}$	$v_e \sin i$ $km\,s^{-1}$
20629	*A0SiSrCr*	12900	4.4	7.4	2.1	35
24587	*B6*	14100	4.2	4.6	1.5	40
33331	*B7He*	13100	4.1	6.9	1.2	55
35575	*B3He weak*	19300	4.0	6.4	2.0	90
36589	*B7*	14000	4.0	6.2	3.4	115
36629	*B3He weak*	20400	4.0	7.7	2.2	35
38602	*B9Si*	12400	3.6	6.0	1.0	25
60325	*B3He weak*	22000	3.0	6.2	15.0	125
65575	*B3Si*	17200	3.5	3.5	1.0	65
79469	*A0He weak*	10700	4.2	3.9	1.1	85

licity, we have adopted the effective temperature and gravity using the Napiwotzki et al. (1993) calibration for chemically peculiar stars. To taken into account the enhanced metallicity, a metal opacity equal to ten times the solar value has been assumed to compute the atmosphere model and derive the abundances.

The microturbulent velocity (ξ) has been determined demanding that the abundance, derived from unblended lines, be independent of the equivalent width and minimising the scatter of the derived abundances; the adopted step was $\Delta\xi$ = 0.1 km s^{-1} (Table 1).

For each element, the abundance has been derived from all the unblended lines. The average abundance values and the relative standard deviation are reported in Table 2. Following Leone et al. (1997), the magnesium abundances have been derived from the MgII448.1 nm multiplet by using XLINOP9. These authors have shown that because of the expected errors in the effective temperature, gravity and microturbulent velocity, an error equal to 0.3 dex should not be a surprise.

The difficulties in theoretically reproducing the observed behaviour of helium lines even for main sequence B-type stars have been pointed out by Leone & Lanzafame (1997). To ascertain if the stars considered here present a peculiar helium abundance we have compared the measured equivalent widths of the HeI587.6 nm line with the values given by Leone & Lanzafame (priv. comm.) for a sample of main sequence B-type stars (Fig. 1).

The projection of the rotational velocities ($v_e \sin i$) has been measured matching unblended lines with the function obtained from the convolution of the instrumental broadening profile with the theoretical line profile given by Gray (1992) for a rotating star. A 5 km s^{-1} step has been assumed for the rotational velocity.

For all stars, results are summarised in Table 1.

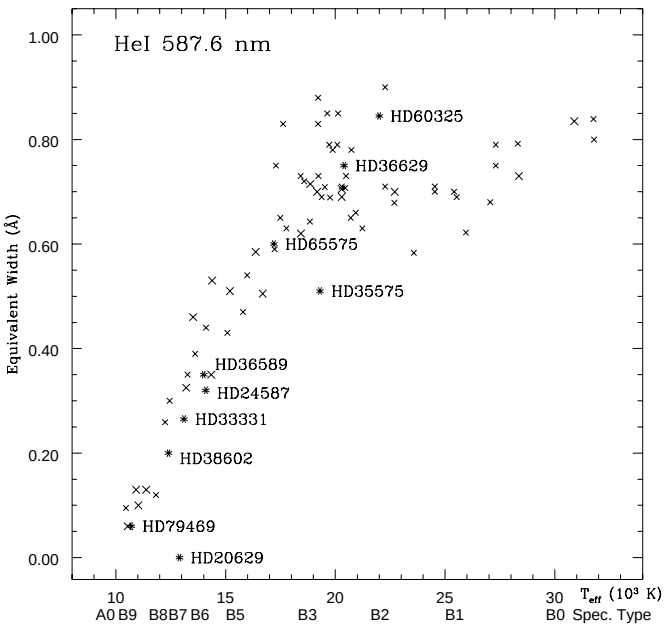

Fig. 1. The behaviour of the equivalent width of the HeI587.6 nm line for main sequence B-type stars ($\times$) with the effective temperature as given by Leone & Lanzafame (1997). $*$ are the suspected chemically peculiar stars.

3. Individual stars

3.1. HD 20629 (= XX Ari)

The star HD 20629 was classified A0SiSrCr by Cutispoto et al. (1990) and B9SiCrSr by Cutispoto et al. (1996) who determined a photometric variability period equal to 2.5$\pm$0.05 days.

According to the calibration of the effective temperature and gravity by Moon, $T_{\rm eff}$ = 13950 K and log g = 4.33 for HD 20629. With these values we have computed an ATLAS9 atmosphere model with solar metal opacity and derived the abundances. Metals being overabundant with respect to the sun, we have used the calibration given by Napiwotzki et al. (1993) for chemically peculiar stars and obtained $T_{\rm eff}$ = 12900 K and log g = 4.36. Consistently with the enhanced metallicity, the ATLAS9 atmosphere model has been computed assuming a metal opacity increased by a factor ten with respect to the sun. The derived peculiar abundances, listed in Table 2, are much larger than what is expected for main sequence stars.

Two spectra of HD 20629 have been obtained four days apart. Iron and silicon lines are constant. The equivalent width of the MgII448.1 nm line changes from 115 to 185 mÅ. The SrII407.7 nm line is not strong enough to be measured in our spectra. Because of the effective temperature, the absence of the HeI587.6 nm line (Fig. 1) is indicative of a helium underabundance.

We conclude that HD 20629 is a chemically peculiar star that, according to the derived effective temperature and chemical abundances, should be classified as a B7SiCr star.

Table 2. Derived abundances and standard deviation for the program stars. As to the error for the magnesium abundance see text. Abundances for main sequence B-type stars are from Adelman (1986) and Gies & Lambert (1992). Solar values are from Kurucz (priv. comm.).

	20629	24587	33331	35575	36589	36629	
				$log(N/N_{\rm Tot})$			
C	–	–	–	-3.8 ± 0.2	–	-3.6 ± 0.2	
N	–	–	–	-3.9 ± 0.1	–	-4.5 ± 0.1	
O	–	–	–	-3.1 ± 0.1	–	-3.5 ± 0.2	
Ne	-3.0 ± 0.4	-3.5 ± 0.2	-3.6 ± 0.1	–	–	-3.2 ± 0.1	
Mg	-5.9	-5.0	-4.0	-4.4	-4.2	-4.7	
Al	–	-5.7 ± 0.1	-5.4 ± 0.1	–	–	-6.0 ± 0.1	
Si	-3.2 ± 0.5	-5.0 ± 0.2	-4.5 ± 0.3	-4.3 ± 0.1	-4.4 ± 0.1	-4.6 ± 0.2	
S	-2.6 ± 0.5	-4.7 ± 0.1	-4.6 ± 0.2	-4.9 ± 0.4	-4.6 ± 0.2	-4.6 ± 0.2	
Ti	-5.9 ± 0.1	–	–	–	–	–	
Cr	-4.8 ± 0.1	–	-6.1 ± 0.1	–	–	–	
Fe	-2.8 ± 0.4	-5.2 ± 0.1	-4.4 ± 0.1	–	-4.3 ± 0.2	-4.8 ± 0.1	
Ni	-4.3 ± 0.4	–	–	–	–	–	
	38602	60325	65575	79469	G&L	A	Sun
				$log(N/N_{\rm Tot})$			
C	–	-4.1 ± 0.1	-3.8 ± 0.1	–	-3.7 ± 0.2	-3.4	-3.5
N	–	-4.8 ± 0.1	-4.4 ± 0.1	–	-4.2 ± 0.2	–	-4.0
O	–	-3.8 ± 0.1	-3.3 ± 0.2	-3.1 ± 0.1	-3.2 ± 0.2	-3.3	-3.1
Ne	–	–	-3.1 ± 0.2	–	-3.5 ± 0.2	-4.1	-4.0
Mg	-4.1	-4.9	-4.2	-4.2	–	-4.3	-4.5
Al	-5.4 ± 0.2	-5.6 ± 0.1	–	–	-5.2 ± 0.3	-5.8	-5.6
Si	-4.4 ± 0.3	-4.7 ± 0.2	-4.7 ± 0.3	-4.9 ± 0.1	-4.9 ± 0.4	-4.4	-4.5
S	-4.7 ± 0.1	-4.5 ± 0.1	-4.9 ± 0.1	–	-4.8 ± 0.1	-4.7	-4.8
Ti	–	–	–	-6.4 ± 0.1	–	-7.0	-7.0
Cr	-5.9 ± 0.1	–	–	-6.3 ± 0.1	–	-6.0	-6.4
Fe	-4.2 ± 0.2	-4.8 ± 0.2	-4.6 ± 0.1	-4.4 ± 0.1	-4.3 ± 0.2	-4.4	-4.4
Ni	–	–	–	–	–	–	-5.8

3.2. HD 24587 (=HR 1213 = τ^8Eri)

The star HD 24587 has been found by Mathys et al. (1986) to be a photometric variable with a 1.728 day period. These authors concluded that the photometric behaviour of HD 24587 resembles that of many Cp stars.

Adopting the effective temperature and gravity, i.e. $T_{\rm eff}$ = 14100 K and log g = 4.23, given by Moon's calibration, we have derived the abundances of HD 24587 (Table 2). Silicon and iron are not over but even slightly underabundant with respect to main sequence stars. Figure 1 shows that the equivalent width of the HeI587.6 nm line is consistent with the assigned effective temperature.

The derived value of the projected rotational velocity (40 km s^{-1}) is close to the 33 km s^{-1} value given by Buscombe & Stoeckley (1975).

We have observed HD 24587 on Dec. 6, 8 and 10, 1995 and found no equivalent width variations. Unfortunately these observations do not rule out the possibility that HD 24587 is a spectroscopic variable with the 1.728 day photometric period. According to the ephemeris given by Mathys and co-workers our spectra were obtained at very similar values of the variability phase.

We conclude that the abundances found for HD 24587 are slightly below those normal for main sequence stars. Further time resolved spectroscopic observations are necessary to ascertain if the photometric variable HD 24587 is also a spectroscopic variable.

3.3. HD 33331 (=TU Pic)

Manfroid & Renson (1981) found that HD 33331 is a photometric variable with a 1.144±0.004 day period and suggested that it might be a Cp star. Andersen & Nordström (1981) found no spectral variations and concluded that spectroscopic behaviour is consistent with the $uvby$ indices.

We have derived the abundances of HD 33331 adopting the effective temperature and gravity given by Moon's calibration, i.e. $T_{\rm eff}$ = 13100 K and log g = 4.08, and found that these abundances are close to the values usually assumed for main sequence B-type stars (Table 2). Our observations of HD 33331 carried out on Dec. 6, 8, 10 and 12 present no evidence of spectral variability. Figure 1 shows that the equivalent width of the HeI587.6 nm line is not indicative of a peculiar helium abundance.

The measured $v_e \sin i$ = 55 km s^{-1} confirms the value given by Andersen & Nordström (1981): 50 km s^{-1}.

As in the case of HD 24587, the periodic photometric variability is the only characteristic of Cp stars presented by HD 33331.

3.4. HD 35575

Classified as a suspected B3 helium weak star in the catalogue of Renson and co-workers, HD 35575 is a spectroscopic binary with a 2.410±0.0001 day period (Morell & Levato 1991). The weakness of helium lines was found by Nissen (1976). The presence of TiII lines and possible CrII lines has been reported by Bidelman (1988). Using the photometric index Δa, which was introduced by Maitzen (1976), Joncas & Borra (1981) concluded that HD 35575 is not a peculiar star.

The effective temperature derived using Moon's calibration, i.e. T_{eff} = 19300 K, is confirmed by the coincidence of silicon abundances obtained from SiII and SiIII lines. For this value of T_{eff}, the HeI587.6 nm line appears to be weaker than in main sequence stars (Fig. 1). Moreover metal abundances are as large as expected in main sequence stars (Table 2). We have observed HD 35575 on Dec. 5 and 11 and measured constant equivalent widths. We confirm that helium lines are weak in the star HD 35575.

3.5. HD 36589 (= HR 1860)

Cowley (1972) has classified HD 36589 as a B6 star and found that the K lines are rather strong.

According to Moon's calibration: T_{eff} = 14000 K and log g = 3.97. With these atmosphere parameters, the abundances derived here are close to the main sequence star values (Table 2). In our spectra obtained on Dec. 5 and 11, 1995 there is no evidence of variability.

Since HD 36589 is not a photometric variable (Bossi & Guerrero (1989) and Hao et al. (1996) have adopted it as a photometric comparison star), the here derived abundances are *normal* and we found no spectral variability, we conclude that HD 36589 is not a chemically peculiar stars.

3.6. HD 36629

According to McNamara & Larsson (1962), HD 36629 presents weak helium lines for the spectral type inferred from the $(U-B)_0$ colour. The magnetic field of HD 36629 was measured by Sargent et al. (1967). Molnar (1972) concluded that HD 36629 is a normal B-type star.

Applying the effective temperature and gravity calibration by Moon, we have obtained: T_{eff} = 20400 K and log g = 3.97. The silicon abundances derived from SiII and SiIII lines are almost coincident and confirm the adopted value of the effective temperature. Derived abundances are almost coincident with the main sequence star values (Table 2) and are close to the values derived by Cunha (1993) and Cunha & Lambert (1994).

The $uvby$ photometry by Heck et al. (1987) presents no evidence of variability. We have observed HD 36629 on Dec. 5 and 10, 1995 and found no evidence of spectral variability.

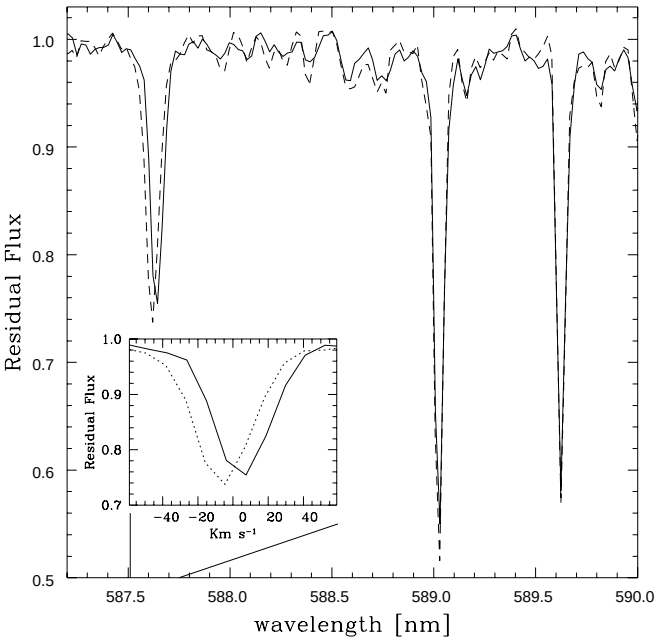

Fig. 2. Spectra of HD 38602 obtained on Dec. 8 and 9 1995. The wavelength shift in the HeI587.6 nm line with respect to the interstellar sodium lines shows that the stellar radial velocity has changed by about 20 km s^{-1}.

HD 36629 is classified as a suspected B3 helium weak star. In spite of this, the HeI587.6 nm line is as strong as we expected for the value determined for the effective temperature. We can conclude that, if we assume an effective temperature equal to 20400 K, the star HD 36629 presents no peculiar abundances.

3.7. HD 38602 (=HR 1991 = ι Men)

Because of its photometric variability (Naqvi & Gronbech 1976) with the 2.644±0.001 day period (Gronbech & Naqvi 1976) HD 38602 is supposed to be a Cp star. From ultraviolet lines, Cucchiaro et al. (1977) classified HD 38602 as a B8III star.

Adopting T_{eff} = 12400 K and log g = 3.61, which have been obtained using Moon's calibration, we have derived the abundances of HD 38602. These values are typical of main sequence stars (Table 2). A comparison of the measured equivalent width of the HeI587.6 nm line with the values of main sequence stars with equal effective temperature shows that the helium abundance of HD 38602 is not peculiar (Fig. 1). We have observed HD 38602 on Dec. 6, 8, 9, 10 and 11, 1995 and found no equivalent width variations suggesting that HD 38602 is a Cp star.

Because of a large spread in the three available radial velocities, Gronbech & Naqvi (1976) suggested that HD 38602 could belong to a close binary system and be an ellipsoidal variable. Our spectra show that the radial velocity is variable. Even if our data are not sufficient to determine the period of the binary system, we note that the radial velocity changes strongly even from one day to another. Figure 2 shows the HeI587.6 nm and the two inter-stellar NaI 589.0 and 589.6 nm lines which are relative to the Dec. 8 and 9, 1995.

We have found no peculiar abundances in our spectra of HD 38602 but evidence of a short time variability of the radial velocity. As suggested by Gronbech & Naqvi (1976), it could be that HD 38602 is an ellipsoidal variable.

3.8. HD 60325 (= HR 2897)

Lesh (1968) found HD 60325 to be a B2III star whose HeI400.9 nm line is weak.

Applying Moon's algorithms, we find T_{eff} = 18700 K and log g = 2.98. With these values we found that the silicon abundance derived from SiIII lines is much larger than the one derived from SiII lines. An almost equal abundance value from SiII and SiIII lines is derived for $T_{eff} \sim 22000$ K.

Adopting the ATLAS9 model with T_{eff} = 22000 K and log g = 3.0, we have derived the abundances listed in Table 2. These abundances are not very different than the values given for main sequence B-type stars. We have obtained two spectra of HD 60325 on Dec. 10 and 11, 1995 and found no spectral variability. According to the equivalent width of the HeI587.6 nm line, HD 60325 is not a helium weak star (Fig 1). We conclude that HD 60325 is not a chemically peculiar star.

3.9. HD 65575 (= HR 3117 = χ Car)

The star HD 65575 has been classified as a peculiar star by Hiltner et al. (1969) because of the large strength of silicon lines with respect to helium and magnesium lines. Massa (1989) found that the ultraviolet silicon lines are in perfect accord with the MK classification of HD 65575. Leone & Lanzafame (1997) did not derive a peculiar helium abundance.

Applying Moon's calibration we have obtained: T_{eff} = 17200 K and log g = 3.54. With these values of effective temperature and gravity, the derived abundances (Table 2) are close to the values of main sequence stars. Our spectra of HD 65575, which were obtained on Dec. 6, 8, 10 and 11, 1995, show no evidence of spectral variability. The equivalent width of the HeI587.6 nm line is not indicative of a peculiar helium abundance (Fig 1).

We conclude that HD 65575 is not a peculiar star as reported in *The General catalogue of Ap and Am stars*.

3.10. HD 79469 (= HR 3665 = θ Hya = 22 Hya)

HD 79469 was classified as λ Boo star by Morgan et al (1943) and Maitzen & Pavlovsky (1989). Baschek & Searle (1969) from spectroscopy, Hauck & Slettebak (1983) from Geneva photometry and Faraggiana et al. (1990) from ultraviolet spectroscopy concluded that HD 79469 is not a λ Boo stars. HD 79469 was classified as a possible A0He weak star by Molnar (1972).

From Moon's calibration we obtained: T_{eff} = 10700 K and log g = 4.19 . The derived abundances are almost coincident with main sequence star abundances. The equivalent width of the HeI587.6 nm line is indicative of a normal helium abundance.

On Dec. 6 and 11, 1995, we have obtained two spectra of HD 79469 which show no variability. It appears that HD 79469 is not a peculiar star (Fig. 1).

4. Conclusion

We have carried out time-resolved spectroscopy for a sample of 10 stars (Table 1), which are classified as suspected chemically peculiar stars in the literature, with the aim to ascertain if they really present anomalous abundances with respect to main sequence stars.

Among the considered stars, only the abundances of HD 20629 and HD 35575 are so different from the values of main sequence B-type stars to be classified as chemically peculiar stars.

HD 24587 is classified as a suspected Cp star because of its photometric variability with a 1.728 day period determined by Mathys et al. (1986). Since we have derived abundances which are close to the main sequence star values and measured constant equivalent widths, we should conclude that HD 24587 is not a Cp star. Unfortunately our spectra have been obtained at the same variability phase and we cannot rule out that spectral variability which characterizes chemically peculiar stars.

The short time variation of the radial velocity suggests that the photometric variable HD 38602 could be an ellipsoidal variable.

The exclusion of the HD 65575 from *The General Catalogue of Ap and Am stars* by Renson et al. (1991) reduces the number of Cp stars which are considered X-ray sources. Leone (1994) concluded that out of the 98 examined Cp stars only 8 present a measurable X-ray flux and HD 65575 was one of them. Also the star HD 79469, which does not present peculiar abundances, should be excluded using the catalogue by Berghoefer et al. (1996) to infer the incidence of Cp stars presenting X-ray emission.

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References

Adelman S.J., 1986, A&AS 64, 173
Anderson J, Nordström B., 1981, IBVS 2024
Baschek B., Searle K., 1969, ApJ 155, 537
Berghoefer T.W., Schmitt J.H.M.M., Cassinelli J.P., 1996, A&AS 118, 481
Bidelman W.P., 1988, PASP 100, 108
Bossi M., Guerrero G., 1989, IBVS 3326
Buscombe W., Stoeckley T.R., 1975, Ap&SS 37, 197
Cowley A., 1972, AJ 77, 750
Cucchiaro A., Macau-Hercot D., Jaschek M., Jaschek C., 1977, A&AS 30, 71
Cunha K., 1993, RMxAA 27, 111
Cunha K., Lambert D.L., 1994, ApJ 426, 170
Cutispoto G., Tagliaferri G., Catalano F.A., 1990, IBVS 3542
Cutispoto G., Tagliaferri G., Pallavicini R. Pasquini L., Rodonò M., 1996, A&AS 115, 41
Faraggiana R., Gerbaldi M., Böhm C., 1990, A&A 235, 311
Gies D.R., Lambert D.L., 1992, ApJ 387, 673
Gray D.F., 1992, The observation and analysis of stellar photospheres. Cambridge University Press.
Gronbech B., Naqvi S.I.H., 1976, A&A 47, 314
Hao J.X., Huang L., Guo Z.H., 1996, A&A 308, 499

Hauck B., Slettebak A., 1983, A&A 127, 231
Heck A., Mathys G., Manfroid J., 1987, A&AS 70, 33
Hiltner W.A., Garrison R.F., Schild R.E., 1969, ApJ 157, 313
Joncas G., Borra E.F., 1981, A&A 94, 134
Kurucz R.L., 1993, A new opacity-sampling model atmosphere program for arbitrary abundances. In: M.M. Dworetsky, F. Castelli, R. Faraggiana (eds.) IAU Col. 138, Peculiar versus normal phenomena in A-type and related stars. A.S.P Conferences Series Vol. 44, p.87
Kurucz R.L., Avrett E.H., 1981, SAO Special Rep. 391
Leone F., 1994, A&A 286, 486
Leone F., Lanzafame A.L., 1997, A&A 320, 893
Leone F., Catalano F.A., Malaroda S., 1997, A&A (in press)
Lesh J.R., 1968 ApJS 151, 371
Maitzen H.M., 1976 A&A 51, 223
Maitzen H.M., Pavlovsky K., 1989, A&AS 81, 335
Manfroid J., Renson P., 1981, IBVS 2004
Massa D., 1989, A&A 224, 131
Mathys G., Manfroid J., Renson P., 1986, A&AS 63, 403
McNamara D.H., Larsson H.J., 1962 ApJ 135, 748
Molnar, M.R., 1972, ApJ 175, 453
Moon T.T., 1985 in: Communications from the University of London Observatory No.78
Moon T.T., Dworetsky M.M., 1985, MNRAS 217, 305
Morgan W.W., Keenan P.C., Kellman E., 1943, An Atlas of stellar spectra. Univ. of Chicago Press, Chicago.
Morrell N., Levato H., 1991, ApJS 75, 965
Napiwotzki R., Schönberner D., Wenske, V., 1993, A&A 268, 653
Naqvi S.I.H., Gronbech B., 1976, A&AS 26, 147
Nissen P.E., 1976 A&A 50, 343
Renson P., Gerbaldi M., Catalano F.A., 1991, A&AS 89, 429
Sargent W.L.W., Sargent A.I., Stritmatter P.A. 1967, ApJ, 147, 1185

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