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FAR UV *STIS* SPECTRA OF THE WHITE DWARF REJ 1032+532 II: STELLAR SPECTRUM[1,2]

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ABSTRACT

We discuss the Hubble Space Telescope *STIS* UV echelle spectrum of the hot DA white dwarf REJ 1032+532. The interstellar data from this spectrum are presented in Holberg et al. (1999b). In this paper we discuss a number of strong photospheric features due to C, N, and Si which are present in the REJ 1032+532 spectrum. While the inferred heavy element content of REJ 1032+532 roughly matches the predictions of radiative levitation for carbon and silicon, the observed nitrogen abundance greatly exceeds predictions by a factor of 50. The observed shapes of the N V lines provide the first evidence, at UV wavelengths, of heavy element stratification in a hot DA white dwarf. Homogeneous models are unable to reproduce the shape of the REJ 1032+532 N V lines, nor can they account for the relatively low degree of EUV opacity in the star. We present a simple stratified nitrogen model which resolves these problems. The high degree of stratification in REJ 1032+532 is the signature of ongoing mass loss in this star. The radial velocity of REJ 1032+532 obtained with *STIS* differs by 44 km s^{-1} from that obtained from the Balmer H I lines with the Multi-Mirror Telescope. This suggests that REJ 1032+532 is likely a member of a binary system containing either a late M star or another white dwarf.

Subject headings: stars:– abundances – stars; individual (REJ 1032+532) – ultraviolet: stars – white dwarfs

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[2]Observations reported here have been obtained in part with the Multiple Mirror Telescope, a joint facility of the University of Arizona and Smithsonian Institution.

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1. INTRODUCTION

The UV spectra of hot white dwarfs provide a wealth of information on the content and structures of their atmospheres. Much of the work in this field was done with the *International Ultraviolet Explorer* (*IUE*) satellite and a summary of most of the *IUE* echelle data for the white dwarfs is contained in Holberg, Barstow, & Sion (1998, hereafter, HBS). The advent of the *Hubble Space Telescope* (*HST*), first with the *Goddard High Resolution Spectrograph* (*GHRS*) and now the *Space Telescope Imaging Spectrograph* (*STIS*), has provided even better spectral resolution and permitted observations of even fainter stars.

These observations have led to a number of important advances in the study of the photospheres of hot DA and DO white dwarfs. First, a wide variety of heavy elements, up to and including iron, have been identified, primarily in the UV (see HBS). From these lines it is usually straightforward to obtain photospheric abundances. These abundances can, in turn, be compared with the abundances predicted by radiative levitation (Chayer et al. 1995), which is the primary mechanism that counteracts the downward diffusion of heavy elements. In general, (Chayer et al. 1995) and Holberg, et al. 1997a, (hereafter, H97) have shown that observed and predicted abundances are not in good agreement. This supports the view that non-equilibrium processes such as mass loss and accretion are important for determining the observed abundances of heavy elements.

REJ 1032+532 (WD 1029+537) was discovered as a bright EUV source with the *Wide Field Camera* (*WFC*) during the *ROSAT* all-sky EUV surveys, where it was first identified as a hot DA white dwarf (Pounds et al. 1993). Spectroscopic determinations of the effective temperature and surface gravity of this white dwarf have been made by Marsh et al. (1997b), Vennes, et al. (1997), and Finley, Koester & Basri (1997), all of whom are in substantial agreement. In addition, Marsh et al. (1997a) also provided Johnson UBV photometry of REJ 1032+532.

Good quality EUV spectra of REJ 1032+532 were obtained by the *Extreme Ultraviolet Explorer* (*EUVE*) and have been analyzed by Barstow et al. (1997, hereafter B97) and by Wolff et al. (1998). These authors, using somewhat differing assumptions to define the relative mix of heavy elements in the photosphere of REJ 1032+532, both found evidence of low but significant metal abundances in the star. REJ 1032+532 is also among the five white dwarfs for which B97 were able to obtain direct measurements of the H I, He I, and He II interstellar column densities from *EUVE* spectra. From these measurements it was possible to determine the ionization state of hydrogen and helium along the line of sight to REJ 1032+532 and the four other white dwarfs. It was primarily this unique knowledge about the ionization state of the LISM that led to the inclusion of REJ 1032+532 (Holberg, et al. 1999a, hereafter Paper I) among the white dwarfs to be observed with *STIS* in Cycle 7.

In Table 1 we provide measurements and estimates of the key stellar parameters for REJ 1032+532. The visual UBV photometry is from Marsh et al. (1997a) while the temperature and gravity are mean values, weighted by the quoted uncertainties, from the optical spectroscopy of Marsh et al. (1997b), Vennes et al. (1997) and Finley et al. (1997). The mass, radius, and distance are determined from the observed T_{eff}, log g, and V using the models of Wood (1995) to specify the temperature dependent theoretical relation between mass and radius. The distance then follows from the relation between the V band surface brightness of a DA white dwarf (Bergeron, Wesemael, & Beauchamp 1995) and the apparent V magnitude of the star and the estimated stellar radius. We use these values consistently throughout this paper and Paper I.

We present here some of the first white dwarf spectra obtained with *STIS* in echelle mode, which are

Table 1: Stellar Parameters

V	=	14.455 ± 0.02	Marsh et al. (1997a)
B-V	=	-0.276 ± 0.016	Marsh et al. (1997a)
U-V	=	-1.195 ± 0.025	Marsh et al. (1997a)
T_{eff}	=	46,330 $\pm$ 500 K	Mean
log g	=	7.781 ± 0.03	Mean
M	=	0.583 ± 0.02 $M_{\odot}$	Finley et al. (1997)
R	=	0.01639 ± 0.00006 $R_{\odot}$	Calculated
d	=	132 ± 7 pc	Calculated

described in §2.1. A discussion of evidence for radial velocity variations in RE 1032+532, based on new data obtained with the MMT is provided in §2.2. An analysis of the photospheric elemental content of REJ 1032+532, including the stratification of nitrogen is given in §3.1. Model atmosphere results for a stratified nitrogen photosphere are described in §3.2.

2. Observations

2.1. *STIS* Observations

The interstellar features in our *STIS* observations of REJ 1032+5322 are discussed in detail in Paper I. Briefly, a spectrum covering the 1150 Å to 1725 Å band at a resolution of R $\sim$ 46,000 was obtained on 5 February 1998. A total exposure time of 2163 s was obtained through the *STIS* $0.2'' \times 0.09''$spectroscopic slit using the E140M echelle grating. A discussion of the data reduction procedures is also given in Paper I.

In Table 2 we list the stellar features found in REJ 1032+532, their apparent heliocentric velocities, equivalent widths and associated uncertainties. Strong resonance lines due to N V, Si IV and C IV are present. In addition, there are a number of features due to transitions between exited levels of C III and Si III, including the $^3P^0 - ^3P$ sextuplet of C III (see Fig. 1) and Si III. To within the uncertainty of the data, all the features in Table 2 share a common velocity of $+38.39 \pm 0.80$ km s^{-1}, which are the weighted mean and uncertainty of the mean calculated from the velocities (and uncertainties) of the stellar features. The presence of the excited transitions and the fact that the photospheric abundances derived from second and third ionization stages of C and Si agree, leave no doubt that these features arise in the stellar photosphere.

The strongest photospheric features, due to the N V, C IV and Si IV resonance lines, are partially resolved by the E140M grating. None of these show any evidence of multiple components or structure; in particular no blue-shifted features are seen. This is significant because such features are common in hot DO white dwarfs (HBS) and are seen in at least two hot DA white dwarfs, REJ 1614$-$085 (H97) and REJ 0457-289 (HBS). The presence of blue-shifted features is assumed to be evidence of mass loss. The most surprising aspect of the stellar features observed in REJ 1032+532 is the strength of the N V lines, which implies a very high photospheric nitrogen abundance (see §3.1). This makes REJ 1032+532 an apparent counterpart of the somewhat cooler DA, REJ 1614$-$085, which has an even higher nitrogen abundance (H97).

Table 2: Photospheric Lines

Ion	Lab. (Å)	Observed (Å)	V (km s^{-1})	Unc. (km s^{-1})	E.W. (mÅ)	Unc (mÅ)
N V	1238.8210	1238.9785	38.11	1.40	81	6
N V	1242.8040	1242.9688	37.75	1.52	73	7
Si IV	1393.7550	1393.9374	39.23	1.86	90	8
Si IV	1402.7770	1402.9532	37.67	1.68	78	8
C IV	1548.2020	1548.3906	36.52	1.65	113	12
C IV	1550.7740	1550.9592	35.80	1.57	94	10
Si III	1206.5220	1206.6499	33.25	2.09	23	6
Si III	1294.5430	1294.7120	38.15	3.21	6	4
Si III	1296.7260	1296.8960	39.31	4.60	6	5
Si III	1298.9510	1299.1238	39.87	2.47	11	5
Si III	1301.1460	1301.3304	42.50	3.37	10	6
Si III	1303.3199	1303.4919	39.56	9.29	4	5
C III	1174.9330	1175.0736	35.88	2.28	63	11
C III	1175.2629	1175.4193	39.89	2.54	45	11
C III	1175.5900	1175.7328	36.42	2.28	29	9
C III	1175.7111	1175.8541	36.48	1.48	78	10
C III	1175.9871	1176.1344	37.56	2.93	49	12
C III	1176.3700	1176.5248	39.45	1.95	52	11
C III	1247.3831	1247.5454	39.02	2.12	25	5
		<V>	38.39	0.80		

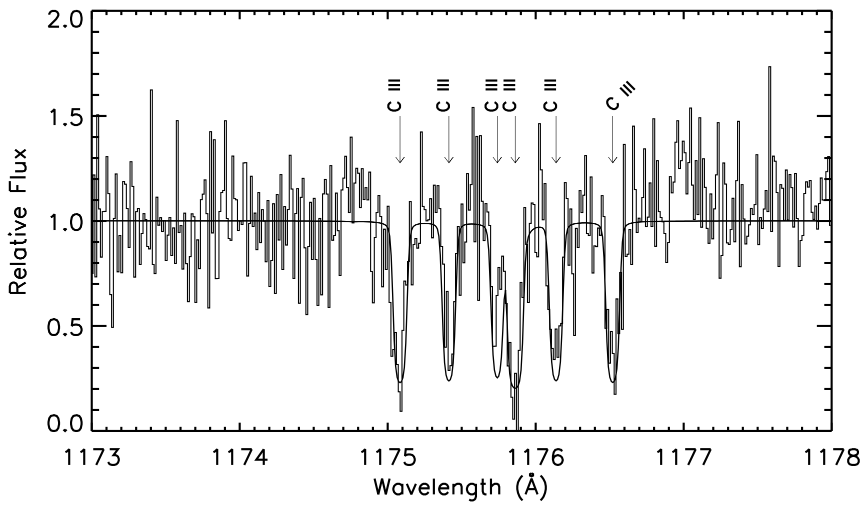

Fig. 1.— The 1172 Å to 1178 Å region containing the C III sextuplet. The smooth curve is a TLUSTY model atmosphere having a homogeneous carbon abundance log(C/H) = -6.34.

2.2. MMT Spectra

REJ 1032+532 was observed at the Multiple Mirror Telescope (MMT) using the Blue Channel Spectrometer and the Loral 3072×1024 CCD on 2 March 1997. Four consecutive spectra, totaling 2951 s, were obtained using the 832 line mm^{-1} grating in second order, with $CuSO_4$ and UV-36 blocking filters and a 1.25 ″slit. These spectra cover the 3920 - 5010 Å region at a $\sim$ 1 Å resolution, although only the central 950 Å is usable. Calibration spectra using He/Ar arc lamps with exposures of 60 s were taken immediately before and after the observation. The observational procedures and the reduction follow closely that described in Holberg, Barstow, & Green 1997b and H97. Briefly, the absolute wavelength scale was determined with respect to the He/Ar arc spectra and placed on an absolute scale using the Hg I λ4358.35 night sky line. We have used synthetic stellar spectra with accurate Balmer line profiles as cross-correlation templates to determine the heliocentric stellar photosperic velocity. Several masking techniques were employed in which variousv combinations of a Balmer line profile and stellar continuum were used. These experiments allow an estimate of the uncertainty in our final result; $v = -5.6 \pm 10$ km s^{-1}. Experience determining the Balmer line velocity for other white dwarfs, (see H97), supports the validity of this approach.

A second independent observation of REJ 1032+532 supports our MMT results. Specifically, an observation obtained on 7 July 1998 with the William Herschel Telescope on the island of La Palma in the Canary Islands yielded an H_α line velocity of -5.5 ± 13 km s^{-1} (T. Marsh, private communication).

The above Balmer line velocities for REJ 1032+532 are significantly different from the +38 km s^{-1} obtained with *STIS* for the UV photospheric features. These differences are well beyond known systematic uncertainties of the instrumentation. We have investigated the possibility of a significant error in the *STIS* measurements but are unable to reconcile this difference. An obvious explanation is that the observations, obtained at different epochs, result from a velocity variation intrinsic to REJ 1032+532, namely that this is a binary system containing an unseen companion. No such companion has been reported nor does the UBV photometry of Marsh et al. (1997a) offer any evidence of a red component. As we will see, it is possible to explain the radial velocity difference and the UBV photometry by postulating either a cooler white dwarf companion or the presence of a red dwarf later than M4.

Good precedent exists for either explanation. Numerous hot DA stars, such as Feige 24 and REJ 1629+706 (Sion et al. 1997) are observed to have M dwarf secondaries. Moreover, the hot DAO white dwarf Feige 55 was discovered by Holberg, et al. (1995a) to show radial velocity variations due to a cooler unseen degenerate companion. Unfortunately, the 11 month interval between our *STIS* and MMT spectra of REJ 1032+532 and the deduced 44 km s^{-1} difference in velocity allow a considerable range of possible periods and companions. The star obviously warrants further radial velocity observation.

We can use the synthetic photometry of Bergeron et al. (1995) to estimate the maximum amount of V band excess due to a secondary star that is consistent with the observed UBV photometry (see Table 1) of Marsh et al. (1997a). The agreement between the observed and synthetic photometry is within the uncertainties for both B−V and U−B, so we can estimate a 2 σ limit on any V band excess at 0.032 magnitudes. This corresponds to an unseen companion with a V magnitude fainter than 18.3. At the estimated distance to REJ 1032+532, of 132 pc, the absolute magnitude of any companion must be fainter than $M_v = 12.69$. For an M dwarf this would correspond to a secondary mass with $M_S \leq 0.2\ M_\odot$ and spectral type later than M4 (Henry & McCarthy 1993). If the companion is instead a cool white dwarf, then its maximum allowed effective temperature could range from 6000 K to 20,000 K, depending on its mass.

2.3. *EUVE* Spectra

The *EUVE* spectrometers were used to observe REJ 1032+532 for a total of 230,000 s between 7 and 15 April 1995. The resulting spectra in the short and medium wavelength spectrometers covered the wavelength range from 80 Å to 380 Å. As mentioned in the introduction, these data have been analyzed by both B97 and Wolff et al. (1998) using different assumptions about the photospheric mix of heavy elements. In their analysis, B97 assumed that the relative proportions of heavy elements (C,N,O and Si) in REJ 1032+532 was fixed by the radiative levitation calculations of Chayer et al. (1995) but that the absolute level of these elements could be adjusted by a single scaling factor. They also determined a range of allowable effective temperatures (T_{eff} = 45,000 K $^{+300}_{-800}$) and surface gravities (log g = 7.68 $^{+0.09}_{-0.04}$) provided by the Balmer line spectroscopy of Marsh et al. (1997b). The interstellar H, He I, and He II column densities, however, were estimated assuming a pure H atmosphere. They determine that REJ 1032+532 was best fit by a photospheric heavy element content was 0.10 $^{+0.01}_{-0.04}$ of that predicted by Chayer et al. for C,N,O and Si. Wolff et al., following a different approach, defined their metal content relative to the heavy element abundances of the hot DA star G191-B2B. They found evidence for a metal content in REJ 1032+532 at a level less than 5 % that of G191-B2B.

In both the above analyses it was necessary to define the relative mix of heavy elements because there were no spectral features in the *EUVE* data which could be uniquely identified with any particular photospheric species other than hydrogen. With the independent measurements of C, N, O, and Si abundances from *STIS* we are now in a position to revisit the analysis of the *EUVE* spectrum. The approach adopted is similar to that of B97, except that the slightly different T_{eff} and log g values given in Table 1 are adopted and the homogeneous C, O, and Si abundances given in Table 3 are employed. Nitrogen, as we will see, poses particular problems for both the *EUVE* and *STIS* observations which require the adoption of a highly stratified distribution of this element in the photosphere.

Table 3: Observed and Predicted Photospheric Abundances

Element	Observed	Predicted	Relative to Solar
log(C/H)	−6.34 ± 0.05	−6.13 ± 0.29	−2.72
log(N/H)	−4.31 ± 0.05	−6.06 ± 0.29	−0.28
log(O/H)	≤ −5.95	−7.12 ± 0.24	≤ −2.82
log(Si/H)	−7.25 ± 0.04	−6.28 ± 0.32	−2.80

3. Discussion

3.1. Photospheric Abundances

Estimates of the heavy element composition of REJ 1032+532 can be directly obtained from the equivalent widths in Table 2. We have used the TLUSTY model atmosphere code (Hubeny, 1988 and Hubeny & Lanz 1992, 1995) to compute predicted equivalent widths and line profiles for the lines listed in Table 2. The model atmosphere grid assumes local thermodynamic equilibrium (LTE) and an H-rich composition with trace abundances of carbon, nitrogen, oxygen and silicon. In estimating abundances we have used the observed equivalent widths (and uncertainties) together with the T_{eff} and log g (and uncertainties) for REJ 1032+532 to calculate abundances and uncertainties for each of the four elements mentioned above. In the case of oxygen, observed upper limits on the equivalent widths of the O IV $\lambda\lambda$1338, 1343 lines are used to establish an upper limit for the oxygen abundance. The results are summarized in Table 3 along with the corresponding predicted abundances from the radiative levitation calculations of Chayer et al. (1996) as well as observed abundances relative to solar levels.

The high apparent nitrogen abundance in REJ 1032+532 is certainly anomalous with respect to the DA white dwarfs; only the previously mentioned REJ 1614−085 possesses a similar level. Among the hotter He-rich DO white dwarfs, however, several examples most notably PG 1034+001, REJ 0503−289 and PG 0038+199 (Dreizler & Werner 1996) exist with higher nitrogen abundances. Such high nitrogen abundances in some DO stars can possibly be explained as nitrogen remaining from a late CNO thermal pulse while the white dwarf was on its post-AGB cooling track. In cooler DA stars, however, pre-white dwarf heavy element abundances are expected to have undergone heavy modification due gravitational diffusion and radiative levitaion making any such link less clear.

Because the E140M grating partially resolves the stellar features in REJ 1032+532, we have also compared observed and theoretical profiles for the lines in Table 2. In computing the line profiles we employ the abundances listed in Table 3. With the singular exception of nitrogen, the theoretical profiles provide a good match to the observed lines. In Figs. 1 and 2 we show the comparison for the C III sextuplet at 1175 Å and C IV resonance line profiles, respectively. In Figs. 3 and 4 we show the respective comparisons for the Si III λ 1206 line and the Si IV resonance lines $\lambda\lambda$ 1393, 1402.

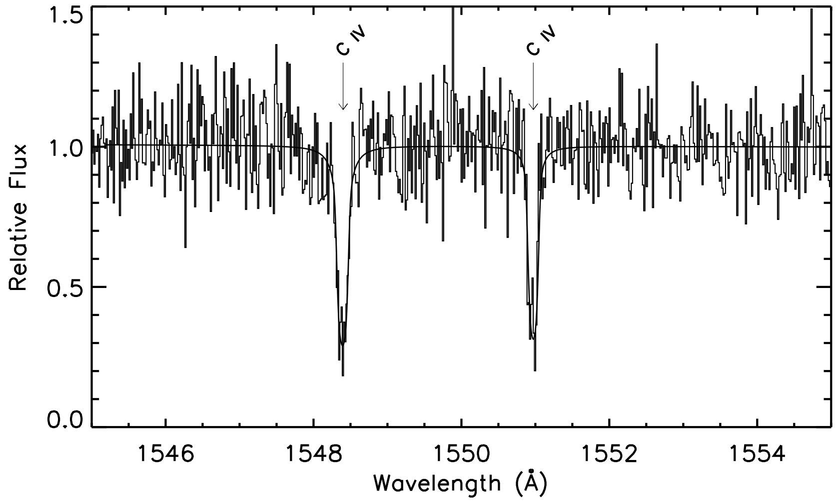

Fig. 2.— The 1545 Å to 1555 Å region containing the C IV doublet. The smooth curve is a TLUSTY model atmosphere having a homogeneous carbon abundance of log(C/H) = -6.34.

A similar comparison of the theoretical and observed line profiles for nitrogen, however, show large discrepancies. In Fig. 5 we plot the observed N V resonance lines and the theoretical profiles for a homogeneous nitrogen abundance of log(N/H) = − 4.31. The predicted lines have cores which are too shallow and wings which are too broad to fit the observation. Increasing the nitrogen abundance does not improve matters. While this deepens the line cores, it also broadens the wings. An even more serious problem occurs with the N IV λ1718 line, which has a predicated strength of $\sim$ 120 mÅ, about 5 times the observed upper limit for the equivalent width at the expected location of the line.

The presence of such a large superabundance of nitrogen in the photosphere of REJ 1032+532 presents

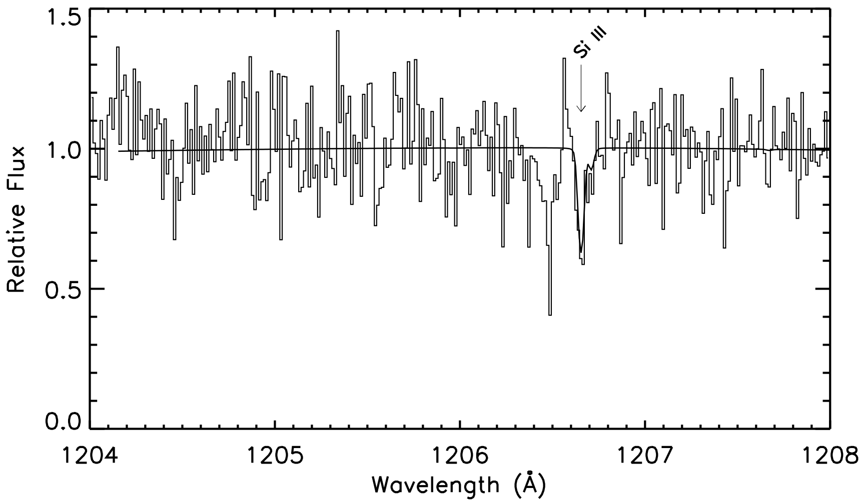

Fig. 3.— The 1204 Å to 1208 Å region containing the Si III λ 1206 line. The smooth curve is a TLUSTY model atmosphere having a homogeneous silicon abundance log(Si/H) = -6.28. The feature to the left of the stellar line is the interstellar Si III feature discussed in Paper 1.

another dilemma. The high nitrogen levels implied by the strength of the UV N V lines is completely inconsistent with the *EUVE* spectrum (see solid curve Fig. 6). In particular, nitrogen at these levels would effectively cut off the REJ 1032+532 flux at wavelengths below 260Å. Both the problem with the line profiles and the EUV flux can be traced to the assumption of a homogeneous mixing ratio of nitrogen in the photosphere.

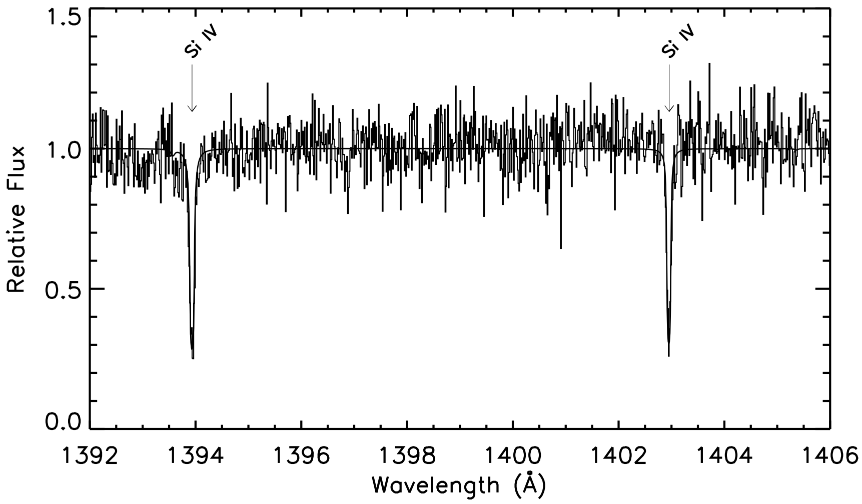

Fig. 4.— The 1390 Å to 1405 Å region containing the Si IV doublet. The smooth curve is a TLUSTY model atmosphere having a homogeneous silicon abundance of log(C/H) = -6.28.

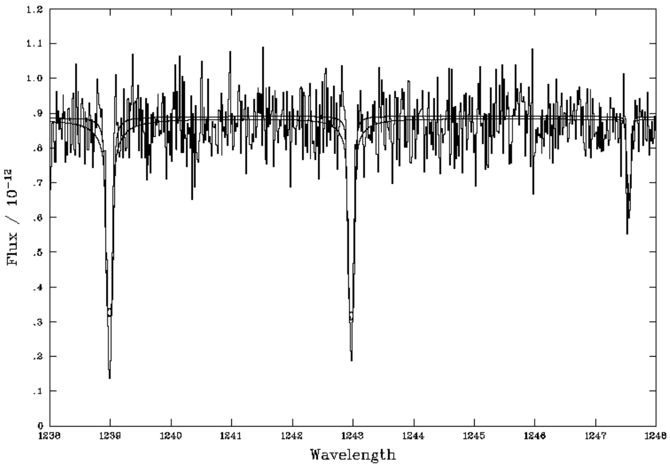

Fig. 5.— The 1238 Å to 1248 Å region containing the N V resonance lines. Two models are shown; the slightly lower curve with the broader N V lines is the homogeneous model with log (N/H) = −4.31. The upper curve with narrower N V lines is the stratified model described in the text. Both models assume NLTE. The line seen near 1247.5 Å is due to C III λ 1247.38.

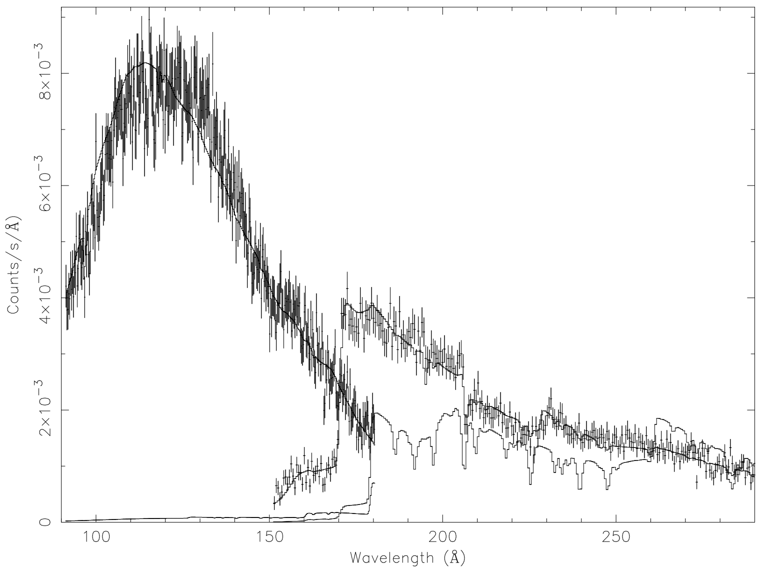

Fig. 6.— *EUVE* spectrum of REJ 1032+532 showing SW and MW spectra. The two models correspond to the stratified model described in the text (upper curve) and the homogeneous model containing the nitrogen abundance (log(N/H = −4.31) implied by the observed equivalent width of the UV NV lines (lower curve).

3.2. Nitrogen Stratification

A very likely explanation for these nitrogen-associated anomalies is that this element is highly stratified in the photosphere of REJ 1032+532. In particular, it is required that nitrogen have a positive radial gradient in the photosphere with greater abundances at the higher levels where the N V lines are formed and lower abundances deeper in the photosphere where the EUV continuum is formed. A similar stratified configuration of heavy elements has recently been invoked to account for the short wavelength EUV spectrum of the hot DA star G191-B2B (Barstow, Hubeny, & Holberg 1999, BHH, hereafter). These authors demonstrate that a steeply stratified Fe profile is capable of matching both the short wavelength EUV flux below 190 Å and the UV spectrum of G191-B2B. However, in this situation the Fe abundance gradient is *negative* with higher Fe abundances at levels deeper in the photosphere, the opposite of the required nitrogen gradient.

Such a high degree of stratification of nitrogen in the photosphere of REJ 1032+532 represents a strong departure from the equilibrium configuration predicted by radiative levitation. In fact, it is an expected signature of ongoing mass loss from the photosphere. Chayer, Fontaine, & Pelletier (1997) and Pelletier et al. (1989) have investigated the effects of mass loss on the abundance profiles of silicon and iron, respectively. They used time-dependent calculations which assumed various mass loss rates and followed the evolution of the abundances of these elements with depth in the atmosphere. For silicon, Chayer et al. (1997) found that a mass loss rate of 5×10^{-13} $M_{\odot}$ yr^{-1} could maintain large silicon abundances in the range $\log(Si/H) > -5$ and also produce large positive and negative gradients in the lower atmosphere. These calculations pertain primarily to atmospheric layers below $\log(\Delta M/M) = -15$. Our EUV and UV observations on the other hand, sample photospheric layers above this region. No calculations for nitrogen presently exist and none of the silicon calculations have been extended to the photospheric levels of interest; nevertheless it can be anticipated that nitrogen would exhibit effects similar to silicon in the photosphere in response to mass loss.

In the absence of any specific model for nitrogen stratification, we follow the procedures developed for treating Fe stratification in G191-B2B by BHH. We adopt a simple slab model in which the nitrogen abundance is set to log (N/H) = -4.3 in the upper layer and set to zero below that layer. The boundary between the two layers is then adjusted between mass depths $2\mathrm{x}10^{-16}$ and $1.14\mathrm{x}10^{-15}$. The best fitting model has a slab boundary at a mass depth of $3.1\mathrm{x}10^{-16}$. In Fig. 5 we show a comparison of the stratified and homogeneous models for the N V lines. Placing the bulk of the nitrogen at higher levels significantly lessens the pressure broadening in the wings of the lines, in agreement with the observations. In Fig. 6 we show the effect this stratification has on the EUV flux from REJ 1032+532. Diminishing nitrogen in the lower layers has the effect of lifting the strong nitrogen opacity below 260 Å, as can be seen in the upper curve in Fig. 6. No claim is made here that this particular stratification profile is unique or represents more than a demonstration of the existence of stratification of nitrogen in the photosphere in REJ 1032+532. Ideally, a theoretical description of the nitrogen abundance profile, consistent with the stars gravitational field, the diffusion of nitrogen and a specific mass loss rate needs to be constructed and incorporated into the model atmosphere. The other parameters corresponding to the best fit model of the *EUVE* spectrum are: T_{eff} = 43,000 K, and log g = 7.8, and interstellar columns of log N_{HI} = 18.84, log N_{HeI} = 17.25, and log N_{HeII} = 17.23. This interstellar H I column is a factor of 1.7 larger than that obtained from the pure-H model atmosphere described in Paper I.

It is not clear why REJ 1032+532 exhibits such strong N V lines and a peculiar nitrogen distribution while other stars of similar temperature and gravity apparently do not. In a preliminary survey of nitrogen abundances in DA stars observed with *IUE* and *HST*, Holberg et. al (1999a) find, with the exception of REJ 1032+532 and REJ 1614−085, (see below) all nitrogen abundance determinations were equal to or below the predicted equilibrium levels of Chayer et al. (1996). If, as suspected, the nitrogen stratification in REJ 1032+532 is a result of mass loss, then a similar phenomena is not readily apparent in other DA stars. There do exist two other DA stars with pronounced overabundances of nitrogen (REJ 1614−085) and silicon (GD 394) and one star, GD 659, where N V lines are seen in its *IUE* spectrum. H97 discuss the 38,500 K DA star REJ 1614−085, which has an even larger nitrogen abundance (log (N/H) = −3.6) than REJ 1032+532. There are, however, several significant differences between these two stars. First, *ROSAT* photometry indicates REJ 1614−085 possesses a strong EUV opacity essentially consistent with its high nitrogen abundance and thus there is no clear need for a stratified nitrogen distribution. Second, H97 report blue-shifted features in the wings of the Si IV and C IV resonance lines of REJ 1614−085. Similar features are not evident in REJ 1032+532. The 38,400 K DA GD 394 has long been known for its uniquely strong Si IV resonance lines and a high level of EUV opacity. Barstow et al. (1996) using stellar model atmospheres with a homogeneous silicon distribution were largely successful in modeling both silicon lines in the UV and the EUV spectrum of GD 394. A need for some additional EUV opacity was noted but this could be easily supplied by nitrogen or oxygen at levels below spectroscopic detection. Finally, the presence of N V (as well as Si IV and CIV) resonance lines in the spectrum of the 35,300K DA GD 659 are discussed in Holberg et al. (1995b). In this star, however, the UV resonance lines are not thought to be photospheric, based on the large apparent velocity differences ($\sim$ 72 km s^{-1}) between the photosphere, as defined by the Balmer lines, and the UV lines from *IUE*. Rather they are thought to be formed in a circumstellar environment some distance from the star. In short, neither REJ 1614−085, GD 394 nor GD 659 resembles REJ 1032+532 with respect to the existence of a stratification of heavy elements in the photosphere.

REJ 1032+532 is the first DA to show evidence, at UV wavelengths, of the a high degree of stratification of heavy elements in the photosphere. As discussed previously, BHH have recently demonstrated that stratification of Fe can explain the flux deficit below 190 Å in the EUV spectrum of G191-B2B. Their Fe gradient, however, is opposite that required for nitrogen in REJ 1032+532. This is not necessarily inconsistent since, not only do the two stars differ in temperature, and therefore in atmospheric structure, but nitrogen and iron differ in the details of their diffusive and radiative properties. At deeper atmospheric layers, Chayer et al. (1997) have shown that mass loss can produce both positive and negative abundance gradients in silicon and that the photospheric levels of these gradients shift with time in response to mass loss. It should be noted, however, that accretion can also produce similar stratification effects, under the the proper circumstances (Chayer et al. 1997). The possibility exists therefore that, if the suspect secondary companion of REJ1032+532 is a cool M dwarf, low levels of wind accretion onto the white dwarf could be occuring. Why such accretion, if it exists, should result in nitrogen only abundance anomalies is unknown.

As can be seen from Table 3, the observed abundances for carbon and silicon are in substantial agreement with the theoretical abundances. This apparent agreement is actually more of an exception than a rule for DA white dwarfs. As noted by Chayer et al. and H97, observed abundances for many heavy elements, silicon in particular, vary widely with respect to predicted levels. Such variations are likely the result of non-equilibrium processes such as mass loss and accretion which can modify photospheric abundances. The most striking aspect of REJ 1032+532 is its very high nitrogen abundance, more than fifty times above predicted values. Nitrogen is normally very difficult to detect in DA stars below 50,000 K because the N V resonance lines weaken substantially below this temperature and, with the exception of the N IV λ1718 line, there are few strong nitrogen lines in the *HST* or *IUE* bands. Nitrogen is frequently seen in hot DA stars above 50,000 K, such as G191-B2B, where logarithmic abundances of −5.6 to −6.8 are observed (Holberg et al. 1999a). The only other DA star below 50,000 K with a measured photospheric nitrogen abundance is REJ 1614−085, at 38,500 K with a nitrogen abundance of log(N/H) = − 3.6 (H97). It is therefore interesting to speculate that many more DA stars could contain significant levels of undetected nitrogen. Detection of nitrogen in such stars will become much more practical when the strong resonance lines of N II λ1036 and N III λ989 eventually become available through observations with the *Far Ultraviolet Spectroscopic Explorer* (*FUSE*).

In summary, we have obtained *STIS* echelle grating spectra of the hot DA white dwarf REJ 1032+532 which show strong photospheric features due to carbon, nitrogen and silicon. While carbon and silicon abundances are similar to predicted equilibrium abundances and to abundance levels observed in a number of other DA stars, nitrogen is strikingly overabundant. In contrast to carbon and silicon, the observed profiles of the nitrogen (N V) lines cannot be modeled under the assumption of a homogeneous mixing ratio, nor can the EUV flux be reconciled with the implied UV nitrogen abundance for a homogeneous atmospheric distribution. We show that if nitrogen is sharply stratified, with higher abundances at higher photospheric levels, then both the UV line shapes and EUV fluxes can be matched. We also find strong radial velocity evidence that REJ 1032+532 is a single line spectroscopic binary with an unseen late M dwarf or degenerate companion.

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