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INTRODUCING EMILI: COMPUTER-AIDED EMISSION LINE IDENTIFICATION

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ABSTRACT

The identification of spectral lines can be a tedious process requiring the interrogation of large spectroscopic databases, but it does lend itself to software algorithms that can determine the characteristics of candidate line identifications. We present here criteria used for the identification of lines and a logic developed for a line identification software package called EMILI, which uses the v2.04 Atomic Line List as the basic line database. EMILI considers all possible database transitions within the wavelength uncertainties for observed optical emission lines and computes an approximate intensity for each candidate line. It searches for other multiplet members that are expected to be seen with each candidate line, and rank-orders all of the tentative line identifications for each observed line based on a set of criteria. When applied to the spectra of the Orion Nebula and the planetary nebula IC 418, EMILI's recommended line IDs agree well with those of previous traditional manual line assignments. The existence of a semiautomated procedure should give impetus to the study of very high signal-to-noise spectra, enabling the identification of previously unidentified spectral lines to be handled with ease and consistency.

Subject headings: line: identification — methods: data analysis — planetary nebulae: individual (IC 418)

On-line material: machine-readable table

1. LINE IDENTIFICATION IN RICH EMISSION-LINE SPECTRA

Correct identification of spectral lines is fundamental to all spectroscopic analyses. For lines commonly observed in astronomical spectra, a century of study has resulted in agreement on those transitions that give rise to the stronger lines observed at visible wavelengths. However, there is still uncertainty about the proper identification of many lines, and this problem is even more severe in other wavelength regions. As spectra achieve fainter detection limits, the increasing number of transitions observed leads to a larger fraction of uncertain identifications. The effort involved in making correct line identifications for the large numbers of lines detected in high signal-to-noise (S/N) spectra can be daunting, especially since identifications must be made on the basis of overall astrophysical consistency, causing correct line identifications to be mutually interdependent. This problem has been studied in the past for stellar absorption spectra, and techniques have been developed for distinguishing between chance coincidences and true identifications (Hartoog, Cowley, & Cowley 1973; Cowley & Adelman 1990).

Line identification is often problematic for emission-line objects because, unlike absorption lines, which are usually formed near conditions of thermodynamic equilibrium, emission lines are formed under conditions where coincidental resonances and unusual excitation mechanisms cause isolated individual transitions to have strengths that deviate from their equilibrium values by many orders of magnitude. The difficulty in making correct identifications for the large numbers of faint lines observed in emission spectra has acted as a disincentive to obtain the very high signal-to-noise spectra that are necessary for their detection. However, deep high-resolution spectra of both H II regions (Esteban et al. 1998, 1999; Baldwin et al. 2000) and planetary nebulae (Liu et al. 1995, 2000) are now becoming routinely available. Valuable information exists in the detection of previously unobserved faint ionic species (Pequignot & Baluteau 1994), so it is important to confront the challenge of line identifications in an efficient and systematic way.

The usual approach to identifying emission lines in these high-quality spectra has been to start with the line identifications available in the literature for the spectra of similar objects. After that, it is necessary to manually work through multiplet tables and other line lists to try to arrive at identifications that make physical sense in terms of wavelength agreement, line intensities, and the presence or absence of other transitions within the same multiplet or from the same ion. This procedure, which we will refer to as the "traditional" approach, is both tedious and prone to being unsystematic.

One technique that is now being tried is to construct synthetic spectra of the object under study and fit them to

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the observed spectrum (Walsh et al. 2001), similar to well-developed methods for analyzing absorption-line spectra. This technique has many strengths, including a rigorous treatment of blended features and flexibility in dealing with the wavelength uncertainties of the spectral database(s). There is no doubt that this procedure should figure prominently in efforts to identify spectral lines.

In this paper we employ a different approach in which we describe a semiautomated technique for identifying emission lines. The centerpiece is a computer program called EMILI (Emission Line Identifier). It automatically applies the same logic that is used in the traditional manual identification of spectral lines, working from a list of measured lines and a database of known transitions, and trying to find identifications based on wavelength agreement and the relative computed intensities of putative IDs, and on the presence of other confirming lines from the same multiplet or ion.

We have developed EMILI in the context of analyzing high S/N echelle spectra of planetary nebulae that can typically contain 500–1000 emission lines, some down to an intensity level 10^5 times fainter than Hβ. Our interest is in measuring chemical abundances from the faint lines of elements heavier than H and He. We have found that these spectra include large numbers of emission lines for which atomic parameters such as collision strengths and transition probabilities are not accurately known, but we realize the importance of including these lines in the analysis so that we can establish which ions are represented in the spectrum. EMILI is therefore designed in the spirit of using rough, order-of-magnitude estimates of atomic parameters. We believe that this is far better than ignoring such lines when in fact they are seen in large numbers in the observed spectra. Since EMILI's goal is simply to give possible identifications for lines, only a very crude model of the ionized nebula is needed. EMILI works from an input list of the wavelengths and intensities of the many hundreds of observed emission lines, and for each line develops a short output list of suggested identifications, rank-ordered in a preliminary way according to their plausibility. The astronomer then reviews the output list and chooses the best identification, based on physical insight. Eventually, after we have obtained sufficient experience with EMILI for different types of objects and have incorporated additional criteria by which correct line identifications can be discerned, the situation will evolve to one in which line IDs can be assigned automatically without the necessity of insight. EMILI is most beneficial in being applied to spectra which reveal large numbers of lines not normally seen in emission spectra. Since the identifications of virtually all of the stronger lines in most astronomical objects have long been known, this occurs for (1) unusual types of objects and (2) high S/N spectra for which large numbers of faint lines are detected.

2. PRELIMINARY DATA REDUCTION STEPS

As stated above, the input to EMILI is a long list of observed wavelengths and intensities of emission lines. Before using EMILI, these must be measured in some way from calibrated, co-added spectra. Our technique and level of accuracy for reducing deep echelle spectra are described by Baldwin et al. (2000) and in a forthcoming companion to the present paper (B. Sharpee, J. A. Baldwin, & R. Williams 2003, in preparation). Basically, we use a combination of standard IRAF and specialized FORTRAN programs to extract one-dimensional spectra, binned along the slit, from the two-dimensional images that come from the spectrograph. The flux calibration is determined by observing several standard stars through a wide slit. The observational uncertainties are assessed from the quality of the fits to the wavelength calibration and standard star spectra, by comparing with previously published results for the same object, and by comparing overlapping parts of the observed spectrum that come either from adjacent echelle orders or from different grating setups. In our 9 km s^{-1} FWHM spectra, the wavelength accuracy is typically 1 km s^{-1} and the line flux accuracy is 10%–20% for all but the very weakest lines.

The next step is to detect and measure the emission lines contained in these extracted spectra, down to as faint a level as possible. The specification of what constitutes an emission line and what its characteristics are is a critical part of line identification. It is very helpful if the object is spatially resolved and a two-dimensional spectrum is available to aid in distinguishing real lines from artifacts, the latter of which contaminate the object spectrum and are problematical at low signal-to-noise levels. We use the *rdgen* algorithm, which is part of the *vpfit* software package of Carswell et al.[2] The *rdgen* program takes a calibrated spectrum and passes a window along in wavelength to determine the flux and S/N at each wavelength. The probability that a particular feature is an actual emission line is then determined from criteria related to the local flux relative to a fitted continuum level and the flux profile, e.g., line width. The flux, width, S/N, wavelength and its uncertainty are determined for each line, and this information is then used to compile an observed line list that serves as the basis for the identification procedure. The major benefit of using *rdgen* is that it finds a complete set of emission lines down to a consistent S/N limit, so that we can assess the significance of the failure to find emission lines that in principle should be present at some intensity level. However, we caution that EMILI in its present form does not make use of the S/N for measured lines or for the upper limits of unobserved lines.

3. THE EMILI CODE

EMILI is a stand-alone FORTRAN code that runs in 5–10 minutes on any UNIX, LINUX, or Windows computer that has a suitable FORTRAN compiler. It is publicly available over the Web[3] with a primer and has the following logical flow. For each line in a list of unidentified observed lines submitted to EMILI, a transition database is queried for all transitions within the immediate wavelength vicinity. A separate list of preidentified "signature lines" from the same spectrum is used to establish kinematic and ionization models of the observed object. EMILI calculates a predicted template flux for all candidate emission lines considered in the line list based upon these models and upon the characteristics of each transition. For each candidate transition in the database EMILI searches the line list to identify other transitions from the same multiplet. EMILI then ranks each

[2] R. F. Carswell, J. K. Webb, A. J. Cooke, & M. J. Irwin. 2001, VPFIT Manual, http://www.ast.cam.ac.uk/~rfc/vpfit.html.

[3] B. Sharpee, R. E. Williams, J. A. Baldwin, & P. van Hoof. 2003, EMILI Code and Manual, http://www.pa.msu.edu/astro/software/emili/.

candidate ID for an observed feature according to wavelength agreement, strongest relative predicted flux, and the numbers of multiplet members detected, and it presents the results to the user for final ID determination.

In the following sections we specify in more detail the algorithms and general approach used in EMILI.

3.1. *Input File of Observed Lines*

EMILI requires an ASCII input file containing the measured (1) wavelength, (2) 1 σ wavelength uncertainty due to measurement error, (3) intensity relative to a fiducial line such as Hβ, (4) line width (FWHM), and (5) signal-to-noise relative to the adjacent continuum. In our case the output file from *rdgen*, after repeat measurements have been averaged together and night-sky lines and obviously spurious lines (due to cosmic ray hits, etc.) removed, serves as the input file for EMILI.

3.2. *Spectroscopic Database*

A second major input to EMILI is a database of atomic transitions that are to be used as candidate IDs for observed emission lines. Recent compilations of large electronic databases of transitions are what now makes it practical to use computers to suggest line identifications using the same logic that has been employed in the traditional identification of lines. Computer-aided identification is especially valuable in facilitating a comparison of possible identifications for a given line with the putative identifications for other lines. The key to the identification procedure is the database of transitions used in the search process. Fortunately, several extensive databases have been developed in recent years that are accessible electronically and that are continually being augmented as new data are made available. One of the most authoritative of these is the NIST Spectroscopic Database,[4] which consists largely of transitions that have been observed in laboratory measurements. The NIST transitions information is generally quite reliable, although incomplete. Some lines that are observable in astrophysical spectra have been added, most notably forbidden transitions, but still many transitions of ions do not appear because confirming data are considered to be lacking by NIST standards. The incompleteness of databases, especially proper wavelengths, is a problem for line identification for which there is no alternative. Incomplete information will always limit the viability of making line identifications by any technique.

Other line lists exist, and one of the most complete and inclusive of these for UV/optical/IR wavelengths is the v2.04 Atomic Line List compiled by van Hoof.[5] This list uses a very different approach in its construction. It is based on observed energy levels of ions rather than observed transitions. This set of levels is supplemented with theoretical predictions and Ritz extrapolations where it is meaningful to do so. The actual line list is constructed by a computer program that imposes a carefully chosen set of selection rules to determine which levels have either allowed, intercombination, or forbidden transitions connecting them. The wavelengths of the lines, including an estimate for the uncertainty, are calculated from the straight difference of the level energies (Ritz wavelengths). This procedure allows the line list to be far more complete since the only requirement is that the upper and lower level have been observed, which is less restrictive than the requirement that the line itself has been observed. This is especially important in the infrared where very few laboratory experiments have been undertaken. One drawback of this approach is that observed transitions without a proper spectroscopic identification cannot be included in the line list. However, in the long run this situation will remedy itself once these lines are identified and an updated term analysis becomes available.

Numerous spectroscopic databases exist, and it is preferable to interrogate line lists that are as complete as reasonably possible because a successful identification logic will reject specious transitions. As is done in traditional studies to identify spectral lines, multiple sources that list valid atomic and molecular transitions should be utilized when considering putative line identifications in astronomical spectra. However, for the initial development of EMILI we have confined the present study to the use of only one database, the v2.04 Atomic Line List, because of the different formats used in the electronic databases, which would require separate interrogation schemes. We eventually intend to extend the capabilities of the software to interrogate multiple line lists.

3.3. *Signature Lines*

Many emission-line objects have a kinematical structure that segregates lines from different ionization stages in velocity. Additionally, the level of ionization can vary greatly from object to object, affecting the relative intensities of lines from different ions. Since wavelength agreement and predicted intensity are important criteria for making identifications, we define a set of signature lines spanning a range of ionization stages whose IDs are reasonably secure, and we use these lines to establish radial velocity corrections to determine the zero-velocity, or laboratory, wavelength for each observed line and to find an approximate ionization distribution for the object that is used to predict template fluxes for candidate line IDs. This information is then used with generic cross sections and spontaneous transition coefficients to compute a rough template flux for every putative line ID that is considered from the transition database. The signature lines are identified manually by traditional procedures at the beginning of the process.

3.4. *Identification Criteria*

Although there are clear criteria by which a possible line identification can be rejected, there are no criteria by which a line identification can be guaranteed to be correct. Even a line such as Hβ has at times been ascribed to a feature that was later shown to actually be due primarily to He II 8–4. So, astrophysical consistency and reasonableness are important considerations when assigning identifications, which mitigates against unexpected IDs, and final consensus is often achieved only after a body of data has been gathered for a large group of similar objects. For weak lines from ions with few other lines present or detectable, some doubt may persist about the correctness of an ID.

The criteria we have used in making emission-line identifications are (1) wavelength agreement, (2) the relative intensities of the candidate transitions, as determined from an approximate calculation using generic cross sections, and (3) the detection of other lines from the same multiplet that

[4] See http://www.physics.nist.gov/cgi-bin/AtData/main_asd.

[5] P. A. M. van Hoof. 1999, Atomic Line List v2.04, http://www.pa.uky.edu/~peter/atomic/.

are expected to be present with the candidate line. Based on the extent to which each candidate line satisfies the above criteria a numerical value is assigned to that transition, and a relative ranking of all reasonable IDs from the database is arrived at for each observed line. Line IDs are made on the basis of this ranking.

3.5. *Velocity Shifts and Ionization*

Basic information about the spectrum that is necessary for normal line identification procedures is obtained from the "signature" lines that can be among the stronger of those observed in emission spectra. These lines, which span a wide range in ionization, are searched for and identified manually before the software is applied to the spectrum. The signature lines are used to determine the velocity shift of the spectrum being studied, including differences in velocity between lines of different levels of ionization, and an approximate distribution in ionization of the emitting ions which is used to calculate expected line intensities, i.e., template fluxes, of candidate lines. For most objects H and He are the dominant sources of continuum opacity, and therefore we specify levels of ionization according to the ionization potentials of these elements. We arbitrarily establish five different levels of ionization, from very low to very high, by defining the discrete bins that are specified in Table 1. Listed for each ionization bin are selected lines from ions belonging to that bin, i.e., the signature lines. The observed intensities of the signature lines are proportional to the fractional abundances of their parent ions, which pertain to the ionization level of that bin, and their intensities are used to determine the general ionization of the spectrum. The fractional abundances x_k of ions in each energy bin are determined from the intensities of the signature lines for each bin as follows.

Bin 1 represents those ions having ionization potentials less than that of hydrogen, and although the intensities of lines such as Mg I], [S I], [C I], and Ca II depend upon the heavy element abundance and kinetic temperature, we determine x_1 independent of these parameters in the following manner. Let F_1 be the flux of the strongest of the signature emission lines for Bin 1. Then,

$$x_1 = \begin{cases} 10^{-3}\,, & \text{when} \quad F_1/F_{\mathrm{H}\beta} < 10^{-4}\,; \\ 10^{-2}\,, & \text{when} \quad F_1/F_{\mathrm{H}\beta} = 10^{-4}\text{–}10^{-2}\,; \\ 10^{-1}\,, & \text{when} \quad F_1/F_{\mathrm{H}\beta} > 10^{-2}\,. \end{cases} \quad (1)$$

The ionization correction factors for moderately ionized species are determined from the relative strengths of the He I lines compared with Hβ, which depend on an assumed helium abundance (default is solar) through the relation from recombination theory that

$$x_3/x_2 = 0.7\,YF_{\lambda 5876}/F_{\mathrm{H}\beta} = 2.0\,YF_{\lambda 4471}/F_{\mathrm{H}\beta}\,, \quad (2)$$

where Y is the He/H abundance by number.

The fractional ionization of more highly ionized ions is obtained from the intensity of He II λ4686 relative to the He I lines through the relations

$$x_4/x_3 = 0.04F_{\lambda 4686}/F_{\lambda 4471} = 0.11F_{\lambda 4686}/F_{\lambda 5876}\,. \quad (3)$$

Finally, the ionization correction factors for the very highest ionization levels (I.P. > 100 eV) are determined from the intensities of lines such as [Ne V], [Fe VII], [Fe X], and [Ar X] via the relation

$$x_5 = 10^{-3} + F_5/F_{\mathrm{H}\beta}\,, \quad (4)$$

up to a maximum value of $x_5 = 0.3$, where F_5 is the flux of the brightest of the signature lines for Bin 5 (see Table 1). The above relations for the x_k, together with the condition that $\sum x_k = 1$ when summed over all of the ionization bins, specify the ionization level of the spectrum. In cases where no signature lines are observed for a particular ionization bin, EMILI sets a minimum value of $x_k = 10^{-3}$.

Once the general ionization distribution for the spectrum is determined from the above relations, the relative ion abundance for specific elements is arrived at in the following manner. Designate the lower and higher ionization energy limits for each bin $k = 1$–5 by E_{k-1} and E_k, and the fractional abundance of ions associated with that bin as x_k. Designate the ionization potential of ion i and that of its next lower stage of ionization as χ_i and χ_{i-1}. When an ion i and its next lower stage of ionization fall within the same energy bin, i.e., when $E_{k-1} \le \chi_{i-1} < \chi_i \le E_k$, set $x_i = x_k$. However, when two consecutive ionization stages fall into different energy bins, e.g., when $E_{k-1} \le \chi_{i-1} \le E_k$, and $E_k \le \chi_i \le E_{k+1}$, EMILI sets $x_i = (x_k + x_{k+1})/2$. For the special cases of H and He, $x(\mathrm{H}^+) = x_2, x(\mathrm{He}^+) = x_3$, and $x(\mathrm{He}^{+2}) = x_4$. Although ionization fractions determined this way are only approximate, they are adequate for order-of-magnitude intensity calculations for lines from different ions.

TABLE 1
Signature Lines for Ionization Bins

Bin	Energy Range (eV)	Signature Lines
1..................	0–13.6	Mg I] λ4571, Na I λ5892, [S I] λ7775, [C I] λ8727, Ca II H and K
2..................	13.6–24.7	Hβ
3..................	24.7–54.5	He I λ5876, 4471
4..................	54.5–100.0	He II λ4686
5..................	>100.0	[Fe X] λ6375, [Ne V] λ3426, [Fe VII] λ6087, [Ar X] λ5533

3.6. *Template Fluxes*

One of the obvious criteria for making line IDs, especially useful for distinguishing between transitions that have essentially the same wavelength, is the expected flux of each candidate line ID compared with the intensity of the observed line. The excitation mechanisms and relevant cross sections for each transition are required to compute its expected intensity, and these are not known for the vast majority of lines. However, for purposes of dealing with large numbers of lines, generic cross sections can be used and the excitation processes that are common for most observed lines can be assumed to operate for all levels. These assumptions can be substantially in error for individual transitions, but for the purposes of helping to distinguish between the relative strengths of transitions of different ions such calculations should have some validity in a statistical sense when applied to large numbers of transitions.

For nebular conditions, i.e., low-density gas in a dilute radiation field, excitation is normally caused by electron impact from the ground state and electron recapture from the next higher stage of ionization. Near a strong continuum source absorption by resonance transitions followed by cascading can also produce line emission. Cross sections for each of these processes have been calculated for numerous levels of many ions, and they have dispersions of several orders of magnitude for different levels. Thus, it is easy for the predicted, or template, flux of a transition to be in error by factors of 100 when generic cross sections are used. Nevertheless, if the relative abundances of the different ions are known, the predicted fluxes of two competing candidate transitions of widely different abundance or excitation level still can be a telling criterion for preferring one line over the other as a putative identification for an observed feature.

We use a simple approximation to compute the template flux, F_t, of emission lines associated with each and every transition in the database. We consider all emission lines to be excited by both collisional excitation and recombination processes, representing their contributions to the flux of any line from ion i by the expression (Osterbrock 1989),

$$F_t = A\{x_i[\exp(-0.8\chi_j)]/(1 + K_j n_e) + 10^{-5} x_{i+1}(i+1)^{1.7} C_j\} , \quad (5)$$

where A is the element abundance relative to H, x_i and x_{i+1} are the fractional abundances of the ions i and $i+1$, χ_j is the excitation potential of the upper level of the transition in eV, and n_e is the electron density of the gas (cm^{-3}). The term with constant K_j accounts for collisional deexcitation of low-lying levels, and the constant C_j is proportional to the transition probability of the line. Both constants take on values that depend on the type of transition, such that for (1) permitted electric dipole transitions, $K_j = 10^{-14}$ and $C_j = 1$; for (2) electric dipole intercombination, or spin forbidden, transitions, $K_j = 10^{-9}$ and $C_j = 10^{-4}$; and (3) all other types of transitions, e.g., magnetic dipole and electric quadrupole, $K_j = 10^{-6}$ and $C_j = 10^{-7}$. Equation (5) predicts an approximate relative flux for any transition under typical nebular conditions. All line intensities so calculated are normalized to the Hβ flux predicted from the same expression and are referred to as the template fluxes of the database lines.

3.7. *Associated Multiplet Lines*

The presence of other lines originating from the same upper level or from within the same multiplet is one of the more useful criteria by which line identifications can be judged. Although multiplets are defined by the coupling scheme appropriate for the ion, except for very level-dependent excitation processes involving resonances one generally expects for a given ion that lines originating from levels of similar excitation potential tend to be present with similar intensities. This is especially true within individual multiplets. Most of the more abundant elements have low atomic number and the stronger optical transitions of many of the ions of these elements tend to obey *LS* or *jK* coupling, so the multiplets that are most likely to be present in astronomical spectra can generally be clearly specified. If experience shows that this assumption is too frequently violated, different methods for determining associated transitions may be considered.

The current EMILI algorithm will determine for all possible *LS* coupling transitions in the database other members of the same multiplet that are expected to be present with intensities similar to that of the primary transition. Since relevant atomic data are not known for the vast majority of transitions, we rely upon general principles. Additionally, all multiplet lines grouped within the instrumental resolution or natural line width are considered to be a single line.

Level populations and spontaneous transition rates within a multiplet tend to be larger for those lines originating from upper levels with the highest statistical weights. We determine for every transition those lines within the same multiplet that are expected to be observable at intensities comparable with or greater than its flux. We call these lines within the multiplet the "associated lines" of the candidate line (or putative ID), and we arbitrarily define them to be those lines within the multiplet originating from upper levels with $J' \geq J_u - 1$ and ending on lower levels $J'' \geq J_l - 1$, where J_u and J_l are the angular momenta of the upper and lower levels of the line under consideration. This definition may be unnecessarily restrictive, especially in its limitation on the lower levels of the associated transitions, but we wish to err on the side of considering those multiplet members that are most likely to have intensities comparable with the candidate line. The detectability of associated lines is also dependent upon the signal-to-noise of the lines and is affected by chance coincidences and line blends, so the presence or absence of associated lines as a constraint for identification of a line has limitations, but the general concept is an important one to invoke for the validation of line identifications.

3.8. *Numerical Identification Index*

We base all line identifications on the three criteria discussed above: wavelength agreement, strongest computed template flux, and presence/absence of associated lines from the same multiplet. In order to put line identification on a quantitative basis, we establish a numerical identification index (IDI) that assesses the extent to which every putative line ID for an observed line satisfies the criteria. Since the three criteria are independent of each other, separate numerical values are defined for each of the individual component criteria, and the IDI is defined as the sum of the three components. For the present we arbitrarily assign numerical values to how well candidate lines satisfy each of the criteria; however, in the future it might be instructive to weight each component in such a way that the line IDs suggested by the resulting IDI produce the best agreement with previous published work. Of course, there is no guarantee that identifications in previous studies are correct.

The IDI which we have instituted for EMILI is defined to be

$$\mathrm{IDI} = W + F + M , \quad (6)$$

where W, F, and M are the wavelength, flux, and multiplet components, respectively, of the IDI, and each take on integer values between 0 and 3, with lower scores being better, according to the following conditions.

3.8.1. *Wavelength Component*

Define λ_0 to be the wavelength of an observed line corrected for the object radial velocity, and λ_l to be the wavelength of a candidate line from the database corrected for any ionization-dependent velocity shifts deduced from the signature lines. Let 1 σ be the standard deviation in the measured wavelength of the observed line. Then, $W = 0$ for $|\lambda_0 - \lambda_1| \leq 0.5\ \sigma$, $W = 1$, 2, and 3 for $|\lambda_0 - \lambda_1| \leq 1\ \sigma$, 1.5 σ, and 2σ, respectively, and $W = 4$ for $|\lambda_0 - \lambda_1| > 2\ \sigma$. Uncertainty in the laboratory wavelengths are not taken into account in this determination, although consideration will be given to doing so in the future.

3.8.2. *Flux Component*

Designate the computed template flux of a candidate line by f_1, and let f_b designate the brightest template flux of all candidate lines within 5 σ in wavelength of the observed line. Then, $F = 0$ for that line having the brightest predicted flux if $f_b > 10f_1$ for all other candidate lines within that wavelength interval. Otherwise, $F = 1$, 2, or 3 for lines having $f_1 \geq 0.1f_b$, $0.01f_b$, and $0.001f_b$, respectively. Thus, the flux component of the IDI takes into consideration comparison of the predicted template fluxes of the candidate lines with each other but not with the observed flux of the line.

3.8.3. *Multiplet Component*

For each candidate line from the line list designate P as the number of associated multiplet lines, as defined above in § 3.7, for that line. Define D to be the number of associated multiplet lines that appear to be detected, i.e., for which a line is observed at the appropriate wavelength and having a flux within an order of magnitude of the primary candidate line. Then, (i) $M = 0$ when $P : D = 1 : 1$, or when $D \geq 2$. (ii) $M = 1$ when $P : D = 0 : 0$ or 2:1. (iii) $M = 2$ when $P : D = 1 : 0$ or $(\geq 3) : 1$. And (iv) $M = 3$ when $P : D = (\geq 2) : 0$.

For every observed feature in the spectrum the master line list is searched for possible IDs within a specified wavelength range, typically $\pm 5\ \sigma$ of the wavelength of the observed feature, and the IDI is determined for each candidate line. Identifications are assigned on the basis of the IDI, with lower values of IDI signifying a higher probability of correct identification.

4. AN EXAMPLE: APPLICATION OF EMILI TO IC 418

We have undertaken a program to obtain high-dispersion, high signal-to-noise spectra of a few selected PNe because they are among the best objects to observe for the detection of faint emission lines. The primary motive has been to identify as many CNONe recombination lines as possible in order to compare the relative intensities of these lines between themselves and with the strong forbidden lines from object to object. Data obtained and reduced for the relatively low-ionization PN IC 418 using the CTIO Blanco 4 m telescope + echelle at a spectral resolution of 33,000 over the wavelength range of 3400–9700 Å are described in Paper II of this series (B. Sharpee, J. A. Baldwin, & R. Williams 2003, in preparation). We have taken the list of emission lines defined by *rdgen* as applied to the spectrum in that paper and have applied EMILI to the line list using the procedure that has been outlined in § 3 above, and which is also described on the EMILI Web site. For a line to be considered real we require $S/N > 7$, with the exception of 23 features in the range $7 > S/N > 3$, which were deemed real lines upon inspection of the original two-dimensional spectra images.

Line identifications are made on the basis of the IDI defined in equation (6), with the most probable ID taken to be that line among the candidates considered that has the smallest value of the index. In order to present the information used to compute the index for every candidate ID, for each observed feature EMILI lists all reasonable IDs for that line together with the wavelength, predicted flux, and associated multiplet lines for each candidate ID. The output table for EMILI thus consists of a list of every emission line that is observed in the spectrum, as defined by *rdgen*, together with the possible transitions (and their characteristics) that might be identified with that observed feature.

As an illustration of EMILI output and results, we consider the identification of an emission line observed at 5536.60 Å in the spectrum of IC 418, with the relevant EMILI output for this line listed in Table 2. The data were obtained with the CTIO 4 m echelle in 2001 December at a resolution of 9 km s^{-1} ($R = 33{,}000$), and the relevant wavelength region of that spectrum is shown in Figure 1. The measured wavelength of the line is 5536.60 Å, which when corrected for the +68.6 km s^{-1} radial velocity of the object determined from the higher Balmer and Paschen lines, corresponds to a rest wavelength of 5535.33 Å. Its observed flux relative to Hβ is 4.5×10^{-5}, and the line has a signal-to-noise ratio of $S/N = 26$ and a width (FWHM) of

TABLE 2
SAMPLE EMILI OUTPUT

A	B	C	D	E	F	G	H	I	J	K
5535.36	5535.04	P IV	1.30E−06	17.4	2/0	*				
5535.33	5535.169	Mn II	9.40E−06	8.6	5/1	9	5764.28	8.7		
+5535.36	5535.325	Ni III	5.40E−06	1.9	5/0	7D				
+5535.33	5535.347	N II	3.10E−04	−1	2/2	1A	5530.242	−2.9	5551.922	−1.3
+5535.33	5535.353	C II	1.10E−03	−1.4	1/0	3B				
+5535.33	5535.383	Fe II]	1.60E−06	−3	7/0	7D				
+5535.33	5535.384	N II	3.10E−04	−3.1	8/1	4C	5526.234	−3.1		
5535.28	5535.378	[V II]	8.20E−05	−5.1	7/0	7D				
5535.36	5535.476	Fe III	9.90E−05	−6.2	8/0	8				
5535.28	5535.413	Fe I]	2.50E−06	−7	5/0	9				
5535.28	5535.418	Fe I	5.60E−05	−7.3	5/0	8				
5535.33	5535.466$	Ar II	1.00E−05	−7.5	0/0	7D				
5535.28	5535.455	Mg I	3.50E−05	−9.3	0/0	7D				
5535.33	5535.525$	S II	4.90E−05	−10.7	0/0	7D				

NOTES.—Observed line: 5536.60 Å. Flux: 4.5E−05. S/N: 26.40. FWHM: 16.9.

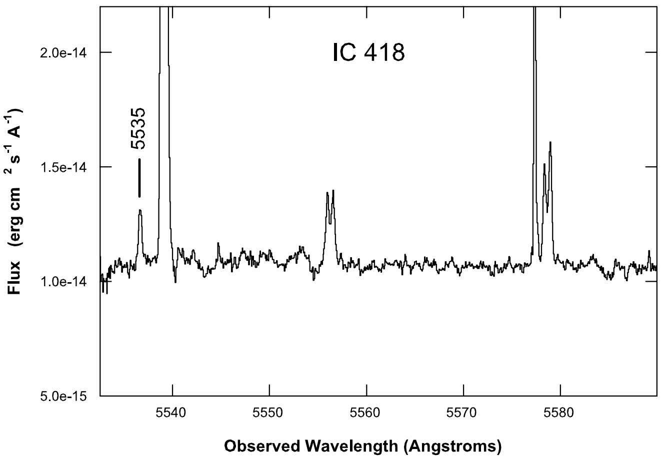

FIG. 1.—Portion of our echelle spectrum of IC 418, showing the emission line at 5535 Å that is used as an example in Table 2.

17 km s^{-1}. These measured line attributes appear in the note at the bottom of Table 2. In Columns labeled " A " through " K " appear all lines listed in the v2.04 Atomic Line List that have wavelengths within 5 σ (about 20 km s^{-1}, or 0.37 Å) of the observed line and which have template fluxes within a factor of 1000 of the brightest computed template flux for the entire group of candidate lines.

Column " A " lists the observed wavelength (air) of the unidentified lines corrected for any velocity shifts appropriate for the emitting ion of each candidate ID, according to the kinematical model. Transitions whose wavelengths are denoted by a plus sign are within 1.5 σ wavelength error from the measured line wavelength. The laboratory wavelength (in air) is given in column " B," and the emitting ion is listed in column " C." Columns " D " and " E " give the predicted template flux for each candidate line and the difference between its wavelength and that of the measured line in units of velocity (km s^{-1}). Column " F " lists the number of associated multiplet lines that should be observable compared with the number observed. In column " G " the IDI is given for each candidate line, and the capital alphabet letter following the numerical IDI gives the ranking of the line, with A representing the most likely ID, i.e., the lowest IDI value. Finally, in columns " H," " I," " J," and " K " appear the wavelengths of the strongest associated multiplet lines that are possibly observed together with their differences in wavelength (in km s^{-1}) from those of the observed lines. Our experience shows that when the associated lines are truly that, and not just coincidences, their differences in wavelength from the observed lines are virtually identical to the difference between the primary line and its measured line wavelength.

Looking in detail at the EMILI results for the observed IC 418 λ5536.60 Å line, a secure identification with N II λ5535.35 Å is indicated, although an ID with C II λ5535.35 Å is also a possibility. The N II line has a slightly (insignificantly) better wavelength agreement with the observed line than the C II transition, although the C II line is predicted to be slightly brighter than the N II line using the generic cross sections and abundances. Both putative IDs have computed template fluxes that are higher than that of the observed line. The key to the identification devolves to the associated multiplet lines for the two transitions: both possible lines in the N II multiplet are apparently present, whereas the one possible associated line for the C II line is not observed. The former lines could conceivably be due to chance coincidences with unrelated transitions; however, the wavelength differences between the N II associated line wavelengths and those of the observed lines are very similar: -1.0 km s^{-1} for the primary line versus -2.9 and -1.3 km s^{-1} for its associated multiplet lines, which argues against chance coincidences. The lack of detection of the C II associated multiplet line could be due to a number of factors having nothing to do with its true intensity, including its location at the very edge of an echelle order or its superposition on a strong night sky line or scattered ghost feature. Consequently, its nondetection may be explainable. These doubts can be addressed by visual inspection of both the original two-dimensional spectral image and the final reduced one-dimensional spectrum. This final manual check of the EMILI results is an important component of proper line identification when there are several competing transitions that are credible IDs.

It is worth noting that the particular N II λ5535.35 Å transition discussed above is a quartet line whose upper level is an autoionizing state that lies above the N^+ ionizing continuum. It is therefore almost certainly excited by dielectronic recombination of N^{+2}. Of particular significance is the fact that all three possible stabilizing transitions from the autoionizing state are observed in IC 418, making their identification quite secure.

We have applied EMILI to the full, final reduced high S/N echelle spectrum of IC 418 obtained at CTIO. We employed an updated version of the v2.04 Atomic Line List that includes higher level lines of He I, and a standard set of parameters in computing template fluxes for putative line IDs, i.e., solar abundances, and $n_e = 10^4$ cm^{-3} and $T_e = 10^4$ K. In making final IDs for this nebula, we have used the EMILI results as the initial basis for considering final line assignments; however, we have not blindly accepted the EMILI recommendation for each line. Rather, we have studied the entire spectrum and have considered the entire list of IDs collectively, using our judgment as to what lines we believe constitute the most reasonable identifications, and these are presented for the entire spectrum in Table 3.

In most cases we have accepted the EMILI top-ranked ID as the final ID. However, for some lines we have selected one of the IDs whose IDI was not the smallest of the candidate group, as evidenced by the ranking given in column (6) of Table 3. For almost every line our final ID was one that was ranked by EMILI as one of the four most probable lines, and we have listed all the final identifications together with the observed lines and their measured wavelengths and reddening corrected fluxes in the table. When the lowest value of IDI for an assigned line is higher than IDI ≥ 5, we consider the ID to be uncertain and therefore tag that ID with a colon. When the most likely putative ID has IDI ≥ 8, we place a question mark after the ID, believing that the ID does not have a solid basis and that the spectral feature may be spurious or the line list does not contain the correct transition for that feature. This line list should constitute one of the most detailed emission spectra of any PNe and can serve as an archetype of low-ionization spectra, similar to the spectrum of the Orion Nebula presented by Baldwin et al. (2000).

EMILI found solid identifications for 624 of the 807 observed IC 418 emission lines, and possible identifications for an additional 72 lines. Table 3 notes for each line those

TABLE 3

EMILI Line Indentifications for IC 418

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
3512.511.......	22.9	0.1026	0.1365	37.6	2 A	He I	3512.505	−0.5	3Po 1s.2p	3D 1s.12d	2.0	****	0/0
3530.499.......	24.6	0.1509	0.2002	99990.0	3 A	He I	3530.482	−1.5	3Po 1s.2p	3D 1s.11d	2.0	****	1/0
3554.417.......	23.1	0.1771	0.2340	127.5	3 A	He I	3554.389	−2.4	3Po 1s.2p	3D 1s.10d	1.0	****	2/0
3560.616.......	20.3	0.0049	0.0065	7.3	...	...	...	...	...	...	...	...	...
3562.932.......	20.7	0.0138	0.0182	11.5	4 A	He I	3562.969	3.1	3Po 1s.2p	3S 1s.10s	2.0	1.0	1/0
3574.775.......	13.5	0.0036	0.0047	7.2	6 B	O II	3574.845:	5.9	2D 2s2.2p2.(3P).3d	2Po 2s2.2p2.(3P).5p	1.5	1.5	2/0
					8 D	N II	3574.900 ?	10.5	3P 2s.2p2.(4P).3d	3Do 2s.2p2.(4P).5p	2.0	2.0	2/0
3579.402.......	23.4	0.0103	0.0135	8.1	...	...	...	...	...	...	...	...	...
3587.284.......	24.4	0.2549	0.3351	161.6	3 A	He I	3587.253	−2.6	3Po 1s.2p	3D 1s.9d	2.0	****	1/0
3590.815.......	25.3	0.0192	0.0252	21.9	5 A	C II	3590.757	−4.8	4D 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	1.5	0.5	7/0
					7 C	C II	3590.876:	5.1	4D 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	2.5	1.5	5/0
3601.327.......	14.8	0.0021	0.0027	7.2	...	...	...	...	...	...	...	...	...
3606.862.......	24.6	0.0053	0.0070	7.3	...	...	...	...	...	...	...	...	...
3613.634.......	21.7	0.4259	0.5577	293.5	2 A	He I	3613.642	0.6	1S 1s.2s	1Po 1s.5p	0.0	1.0	0/0
3616.798.......	20.7	0.0045	0.0059	11.0	3 A	S II	3616.767	−2.6	2Do 3s2.3p2.(3P).4p	2P 3s2.3p2.(3P).4d	2.5	1.5	1/0
3634.250.......	25.7	0.3883	0.5069	156.7	4 A	He I	3634.231	−1.6	3Po 1s.2p	3D 1s.8d	2.0	3.0	2/0
3649.872.......	32.6	0.0109	0.0141	7.5	...	...	...	...	...	...	...	...	...
3652.003.......	24.0	0.0254	0.0331	25.9	3 A	He I	3651.981	−1.8	3Po 1s.2p	3S 1s.8s	2.0	1.0	1/0
3654.256.......	9.3	0.0052	0.0067	7.7	...	H I	3654.266	0.8	2 2*	42 42*	****	****	...
3654.681.......	14.3	0.0107	0.0140	10.2	2 A	N II	3654.670 ?	−0.9	3F 2s.2p2.(4P).3d	3Do 2s.2p2.(2D).3p	4.0	3.0	2/1
					...	H I	3654.676	−0.4	2 2*	41 41*	****	****	...
3655.113.......	11.1	0.0114	0.0148	13.5	2 A	H I	3655.117	0.3	2 2*	40 40*	****	****	0/0
					...	N II	3655.050 ?	−5.2	3F 2s.2p2.(4P).3d	3Do 2s.2p2.(2D).3p	3.0	2.0	...
3655.588.......	11.6	0.0135	0.0176	19.0	2 A	H I	3655.593	0.4	2 2*	39 39*	****	****	0/0
					...	N II	3655.500 ?	−7.2	3F 2s.2p2.(4P).3d	3Do 2s.2p2.(2D).3p	1.0	1.0	...
3656.104.......	12.5	0.0231	0.0300	32.5	3 A	H I	3656.106	0.2	2 2*	38 38*	****	****	0/0
3656.667.......	13.5	0.0270	0.0352	44.9	2 A	H I	3656.663	−0.3	2 2*	37 37*	****	****	0/0
3657.276.......	16.2	0.0451	0.0586	54.9	2 A	H I	3657.267	−0.7	2 2*	36 36*	****	****	0/0
3657.936.......	18.1	0.0758	0.0986	96.0	2 A	H I	3657.923	−1.1	2 2*	35 35*	****	****	0/0
3658.647.......	19.9	0.0932	0.1212	102.1	2 A	H I	3658.639	−0.7	2 2*	34 34*	****	****	0/0
3659.428.......	23.5	0.1402	0.1823	126.5	2 A	H I	3659.421	−0.6	2 2*	33 33*	****	****	0/0
3660.286.......	26.3	0.1871	0.2433	152.8	2 A	H I	3660.277	−0.7	2 2*	32 32*	****	****	0/0
3661.230.......	27.9	0.2274	0.2956	193.0	2 A	H I	3661.218	−1.0	2 2*	31 31*	****	****	0/0
3662.262.......	29.1	0.2669	0.3470	266.4	2 A	H I	3662.256	−0.5	2 2*	30 30*	****	****	0/0
3663.406.......	30.7	0.3058	0.3975	267.6	2 A	H I	3663.404	−0.2	2 2*	29 29*	****	****	0/0
3664.683.......	31.3	0.3548	0.4610	353.9	2 A	H I	3664.676	−0.6	2 2*	28 28*	****	****	0/0
3666.098.......	31.4	0.3970	0.5158	364.1	2 A	H I	3666.095	−0.2	2 2*	27 27*	****	****	0/0
3669.463.......	31.4	0.5017	0.6514	456.3	3 A	H I	3669.464	0.1	2 2*	25 25*	****	****	0/0
3671.475.......	31.4	0.5339	0.6930	557.6	2 A	H I	3671.475	0.0	2 2*	24 24*	****	****	0/0
3673.757.......	32.3	0.5922	0.7684	565.0	2 A	H I	3673.758	0.1	2 2*	23 23*	****	****	0/0
3676.361.......	32.8	0.6586	0.8542	486.9	3 A	H I	3676.362	0.1	2 2*	22 22*	****	****	0/0
3679.349.......	33.2	0.7847	1.0173	464.0	3 A	H I	3679.352	0.2	2 2*	21 21*	****	****	0/0
3682.806.......	34.3	0.8182	1.0602	256.7	2 A	H I	3682.808	0.2	2 2*	20 20*	****	****	0/0
3686.830.......	32.5	0.9390	1.2159	307.2	3 A	H I	3686.830	0.0	2 2*	19 19*	****	****	0/0
3691.556.......	32.6	1.1469	1.4841	289.2	2 A	H I	3691.554	−0.2	2 2*	18 18*	****	****	0/0
3697.156.......	33.5	1.2877	1.6649	436.3	2 A	H I	3697.152	−0.3	2 2*	17 17*	****	****	0/0

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
3703.852.......	31.8	1.4822	1.9143	455.8	3 A	H I	3703.852	0.0	2 2*	16 16*	****	****	0/0
3705.017.......	22.8	0.5795	0.7483	224.3	4 A	He I	3704.996	−1.7	3Po 1s.2p	3D 1s.7d	2.0	3.0	2/0
3711.968.......	32.0	1.7773	2.2926	726.1	3 A	H I	3711.971	0.2	2 2*	15 15*	****	****	0/0
3721.895.......	36.3	2.5687	3.3082	439.6	6 B	[S III]	3721.630:	−21.4	3P 3s2.3p2	1S 3s2.3p2	1.0	0.0	0/0
					5 A	H I	3721.938:	3.5	2 2*	14 14*	****	****	0/0
3726.035.......	41.9	96.1832	123.7908	8543.0	0 A	[O II]	3726.032	−0.2	4So 2s2.2p3	2Do 2s2.2p3	1.5	1.5	1/1
3728.785.......	43.2	40.6870	52.3426	4280.0	1 A	[O II]	3728.815	2.4	4So 2s2.2p3	2Do 2s2.2p3	1.5	2.5	1/1
3734.364.......	31.0	2.3876	3.0689	614.9	3 A	H I	3734.368	0.3	2 2*	13 13*	****	****	0/0
3735.506.......	38.9	0.0461	0.0593	35.1	8 C	O II	3735.722 ?	17.3	2Po 2s2.2p2.(1D).3p	2D 2s2.2p2.(1D).4s	1.5	1.5	2/0
						O II	3735.786 ?	22.5	2Po 2s2.2p2.(1D).3p	2D 2s2.2p2.(1D).4s	1.5	2.5	2/0
3750.149.......	31.6	3.1656	4.0585	1262.0	3 A	H I	3750.151	0.2	2 2*	12 12*	****	****	0/0
3756.065.......	37.4	0.0610	0.0782	37.2	4 A	He I	3756.115	4.0	1Po 1s.2p	1D 1s.14d	1.0	2.0	0/0
3768.782.......	23.2	0.0238	0.0304	38.3	3 A	He I	3768.821	3.1	1Po 1s.2p	1D 1s.13d	1.0	2.0	0/0
3770.631.......	31.8	3.8028	4.8591	1284.0	3 A	H I	3770.630	−0.1	2 2*	11 11*	****	****	0/0
					7 B	He I	3770.750:	9.5	1Po 1s.2p	1S 1s.13s	1.0	0.0	0/0
3777.164.......	41.5	0.0039	0.0050	9.4	5 A	Ne II	3777.134:	−2.4	4P 2s2.2p4.(3P).3s	4Po 2s2.2p4.(3P).3p	0.5	1.5	6/0
3780.171.......	33.1	0.0035	0.0045	8.6	...	...	...	...	...	...	...	...	...
3784.851.......	22.5	0.0294	0.0374	71.6	3 A	He I	3784.895	3.5	1Po 1s.2p	1D 1s.12d	1.0	2.0	0/0
					9 B	O II	3784.990 ?	11.0	2Po 2s2.2p2.(3P).4p	2D 2s2.2p2.(1D).4d	1.5	2.5	2/0
3795.635.......	30.0	0.0019	0.0025	6.6	...	...	...	...	...	...	...	...	...
3797.897.......	31.5	4.4534	5.6643	1187.0	2 A	H I	3797.898	0.1	2 2*	10 10*	****	****	0/0
3801.360.......	55.5	0.0055	0.0070	10.7	...	...	...	...	...	...	...	...	...
3802.720.......	37.6	0.0057	0.0073	11.9	8	S II	3802.604 ?	−9.1	4Po 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).4d	1.5	0.5	6/0
3805.736.......	20.3	0.0331	0.0421	99.5	3 A	He I	3805.777	3.2	1Po 1s.2p	1D 1s.11d	1.0	2.0	0/0
3811.854.......	9.0	0.0015	0.0019	9.9	6 C	S II	3811.745:	−8.6	2Po 3s2.3p2.(3P).4p	2D 3s2.3p2.(3P).4d	0.5	1.5	2/0
3813.451.......	26.5	0.0026	0.0033	7.6	...	...	...	...	...	...	...	...	...
3817.159.......	25.2	0.0027	0.0035	7.7	...	...	...	...	...	...	...	...	...
3819.628.......	23.9	0.8853	1.1218	525.4	4 A	He I	3819.603	−2.0	3Po 1s.2p	3D 1s.6d	2.0	2.0	4/0
3821.849.......	26.8	0.0038	0.0049	18.3	...	...	...	...	...	...	...	...	...
3829.745.......	21.3	0.0184	0.0232	34.2	3 A	N II	3829.795	3.9	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).4s	1.0	2.0	4/2
3831.645.......	20.6	0.0237	0.0300	58.1	9	S II	3831.379 ?	−20.8	2Po 3s2.3p2.(3P).4p	2D 3s2.3p2.(3P).4d	1.5	2.5	2/0
					7 C	C II	3831.726:	6.3	2Po 2s2.4p	2D 2s.2p.(3Po).3p	1.5	2.5	2/0
3833.550.......	20.0	0.0539	0.0681	105.7	3 A	He I	3833.584	2.7	1Po 1s.2p	1D 1s.10d	1.0	2.0	0/0
3834.140.......	25.2	0.0024	0.0030	8.3	...	...	...	...	...	...	...	...	...
3835.387.......	32.0	7.5117	9.4921	2711.0	2 A	H I	3835.384	−0.2	2 2*	9 9*	****	****	0/0
3838.349.......	25.5	0.0581	0.0734	98.5	7 D	S III	3838.268:	−6.3	3Po 3s2.3p.4s	3P 3s2.3p.4p	2.0	2.0	3/1
					5 A	N II	3838.374:	1.9	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).4s	2.0	2.0	3/1
3842.183.......	19.1	0.0100	0.0126	33.6	2 A	N II	3842.187	0.3	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).4s	0.0	1.0	5/3
3848.265.......	35.0	0.0217	0.0274	56.4	3 A	Mg II	3848.212	−4.1	2D 3d	2Po 5p	2.5	1.5	2/1
					7	Mg II	3848.341:	5.9	2D 3d	2Po 5p	1.5	1.5	2/0
3850.392.......	45.2	0.0183	0.0231	46.1	2 A	Mg II	3850.386	−0.5	2D 3d	2Po 5p	1.5	0.5	2/1
3853.755.......	36.3	0.0046	0.0058	11.2	5 A	Si II	3853.664	−7.1	2D 3s.3p2	2Po 3s2.(1S).4p	1.5	1.5	2/0
3855.089.......	29.6	0.0078	0.0098	29.9	2 A	N II	3855.096	0.5	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).4s	1.0	0.0	5/3
3856.054.......	45.6	0.0805	0.1013	188.1	1 A	Si II	3856.018	−2.8	2D 3s.3p2	2Po 3s2.(1S).4p	2.5	1.5	2/2
					2 B	N II	3856.063	0.7	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).4s	2.0	1.0	4/3
					6 C	O II	3856.134:	6.2	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	0.5	9/1
3862.619.......	40.6	0.0337	0.0424	110.2	1 A	Si II	3862.596	−1.8	2D 3s.3p2	2Po 3s2.(1S).4p	1.5	0.5	2/2

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
3867.486.......	21.7	0.0677	0.0851	183.6	3 A	He I	3867.472	−1.1	3Po 1s.2p	3S 1s.6s	2.0	1.0	1/0
3868.745.......	13.6	2.4614	3.0916	805.3		[Ne III]	3869.060	24.4	3P 2s2.2p4	1D 2s2.2p4	2.0	2.0	1/1
3871.781.......	21.2	0.0606	0.0760	183.0	3 A	He I	3871.830	3.8	1Po 1s.2p	1D 1s.9d	1.0	2.0	0/0
3873.477.......	15.2	0.0014	0.0018	8.6	7	Fe I	3873.594 ?	9.0	z5Po 3d6.(5D).4s.4p.(3Po)	5D 3d6.4s.(6D).6s	3.0	3.0	4/1
3876.477.......	43.7	0.0055	0.0069	12.1	5 D	C II	3876.392	−6.6	4Fo 2s.2p.(3Po).3d	4G 2s.2p.(3Po).4f	3.5	4.5	5/0
					8	C II	3876.653	13.6	4Fo 2s.2p.(3Po).3d	4G 2s.2p.(3Po).4f	2.5	3.5	8/0
					8	C II	3876.186	−22.5	4Fo 2s.2p.(3Po).3d	4G 2s.2p.(3Po).4f	4.5	5.5	2/0
3882.178.......	13.7	0.0050	0.0063	27.4	3 A	O II	3882.194	1.2	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	3.5	3.5	3/1
						O II	3882.446	−20.7	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	1.5	7/0
3883.110.......	23.7	0.0022	0.0027	10.3	4 A	O II	3883.137	2.1	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	3.5	2.5	4/1
3884.008.......	16.9	0.0011	0.0014	8.8	6 A	C II	3883.853:	−12.0	4Fo 2s.2p.(3Po).3d	4G 2s.2p.(3Po).4f	4.5	3.5	5/1
3888.939.......	66.4	12.8101	16.0294	3433.0	5 A	H I	3889.049	8.5	2 2*	8 8*	****	****	0/0
						He I	3888.605	−25.8	3S 1s.2s	3Po 1s.3p	****	****	...
3891.462.......	25.5	0.0027	0.0034	99990.0	6 A	Ar II:	3891.401 ?	−4.7	4D 3s2.3p4.(3P).3d	4Do 3s2.3p4.(3P).4p	0.5	0.5	9/1
3892.335.......	14.0	0.0021	0.0027	8.0	5 B	S II:	3892.288	−3.6	4Po 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).4d	2.5	2.5	3/0
3892.769.......	31.0	0.0020	0.0025	13.4	...	...	...	...	...	...	...	...	...
3895.096.......	32.9	0.0032	0.0040	7.4	8	Fe I	3895.232 ?	10.5	z5Po 3d6.(5D).4s.4p.(3Po)	5D 3d6.4s.(6D).6s	2.0	2.0	7/1
3896.201.......	27.7	0.0044	0.0055	13.7	6 A	O II:	3896.303:	7.9	4Do 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	2.5	1.5	5/0
					6 A	Fe I	3896.349:	11.4	z5Po 3d6.(5D).4s.4p.(3Po)	5D 3d6.4s.(6D).6s	1.0	0.0	8/2
3899.208.......	44.9	0.0064	0.0080	15.8	7	S III	3899.028:	−13.8	3Po 3s2.3p.4s	3P 3s2.3p.4p	2.0	1.0	4/0
3907.470.......	21.9	0.0028	0.0035	13.5	3 A	O II	3907.455	−1.2	4Do 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	2.5	2.5	4/0
3909.251.......	9.6	0.0015	0.0019	7.6	...	...	...	...	...	...	...	...	...
3918.930.......	18.7	0.0858	0.1068	226.4	4 A	C II	3918.967	2.8	2Po 2s2.3p	2S 2s2.4s	0.5	0.5	1/1
3920.640.......	18.3	0.1650	0.2052	372.8	3 A	C II	3920.682	3.2	2Po 2s2.3p	2S 2s2.4s	1.5	0.5	1/1
3923.200.......	36.9	0.0035	0.0043	14.6	...	...	...	...	...	...	...	...	...
3924.007.......	36.9	0.0029	0.0036	7.9	...	...	...	...	...	...	...	...	...
3926.544.......	21.8	0.1013	0.1258	247.6	3 A	He I	3926.544	0.0	1Po 1s.2p	1D 1s.8d	1.0	2.0	0/0
					3 A	O II	3926.581	2.8	4Do 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	3.5	2.5	2/2
3929.127.......	18.5	0.0023	0.0028	5.8	5 A	C II	3928.970:	−12.0	2Fo 2s2.4f	2G 2s2.14g	****	****	...
3935.956.......	22.3	0.0119	0.0147	43.8	1 A	He I	3935.945	−0.8	1Po 1s.2p	1S 1s.8s	1.0	0.0	0/0
3962.513.......	44.8	0.0048	0.0059	9.6	...	...	...	...	...	...	...	...	...
3963.797.......	17.1	0.0012	0.0014	7.7	...	...	...	...	...	...	...	...	...
3964.727.......	22.1	0.8384	1.0336	509.9	2 A	He I	3964.729	0.1	1S 1s.2s	1Po 1s.4p	0.0	1.0	0/0
3967.457.......	14.2	0.7914	0.9751	229.6		[Ne III]	3967.790	25.2	3P 2s2.2p4	1D 2s2.2p4	1.0	2.0	1/1
3970.074.......	31.9	13.6820	16.8492	2775.0	3 A	H I	3970.072	−0.1	2 2*	7 7*	****	****	0/0
3977.342.......	25.5	0.0021	0.0026	9.6	6 A	C II	3977.250:	−6.9	4Do 2s.2p.(3Po).3d	4D 2s.2p.(3Po).4f	2.5	2.5	6/0
3979.851.......	24.8	0.0016	0.0020	10.7	...	S II	3979.824	−2.0	4So 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).4d	1.5	0.5	...
3986.459.......	30.2	0.0027	0.0034	9.7	...	...	...	...	...	...	...	...	...
3988.516.......	25.8	0.0039	0.0048	9.9	...	...	...	...	...	...	...	...	...
3992.088.......	33.4	0.0007	0.0008	7.0	...	Ar II	3992.088 ?	0.0	4D 3s2.3p4.(3P).3d	4Do 3s2.3p4.(3P).4p	1.5	2.5	...
3998.781.......	32.7	0.0073	0.0089	19.9	8	N III	3998.630 ?	−11.3	2D 2s2.4d	2Fo 2s2.5f	1.5	2.5	2/0
					1 A	S II	3998.759	−1.6	4So 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).4d	1.5	1.5	2/2
4004.939.......	33.7	0.0026	0.0032	8.2	7	Ni III	4005.180 ?	18.0	3F 3d7.(4F).4d	3Do 3d6.(5D).4s.4p	4.0	3.0	2/1
4009.256.......	21.7	0.1522	0.1860	367.9	1 A	He I	4009.256	0.0	1Po 1s.2p	1D 1s.7d	1.0	2.0	0/0
4015.931.......	20.1	0.0034	0.0041	15.3	...	...	...	...	...	...	...	...	...
4018.473.......	25.1	0.0009	0.0012	9.4	7 D	Ni III	4018.760 ?	21.4	3F 3d7.(4F).4d	3Do 3d6.(5D).4s.4p	3.0	2.0	5/2

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4023.993.......	18.8	0.0176	0.0215	79.7	7 C	O II	4023.868:	−9.3	2F 2s2.2p2.(1D).3d	2[2]o 2s2.2p2.(1D).4f.D	3.5	2.5	...
					1 A	He I	4023.980	−1.0	1Po 1s.2p	1S 1s.7s	1.0	0.0	0/0
4026.207.......	22.9	1.7237	2.0978	412.4	8	N II	4026.078 ?	−9.6	3Fo 2s2.2p.(2Po).3d	2[9/2] 2s2.2p.(2Po<3/2>).4f.G	3.0	4.0	...
					4 B	He I	4026.186	−1.6	3Po 1s.2p	3D 1s.5d	2.0	2.0	4/0
4027.209.......	31.7	0.0280	0.0340	99999.0	3 A	Fe I	4027.098 ?	−8.3	y5Fo 3d7.(4F).4p	g5G 3d6.4s.(4D).4d	5.0	4.0	5/2
4028.221.......	12.6	0.0045	0.0055	12.2	...	...	...	...	...	...	...	...	...
4032.779.......	51.5	0.0080	0.0098	12.6	3 A	S II	4032.767	−0.9	4So 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).4d	1.5	2.5	1/1
4035.165.......	37.9	0.0059	0.0071	16.6	3 A	N II	4035.081	−6.2	3Fo 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<3/2>).4f.G	2.0	3.0	...
					4 B	O II	4035.073	−6.8	4F 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	2.5	2.5	...
4041.303.......	24.9	0.0100	0.0121	30.2	2 A	O II	4041.278	−1.9	4F 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.F	2.5	2.5	...
					3 B	N II	4041.310	0.5	3Fo 2s2.2p.(2Po).3d	2[9/2] 2s2.2p.(2Po<3/2>).4f.G	4.0	5.0	...
4043.460.......	24.3	0.0033	0.0041	8.7	4 A	N II	4043.532	5.3	3Fo 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<3/2>).4f.G	3.0	4.0	...
4058.287.......	16.8	0.0035	0.0043	10.3	4 A	N II	4058.162	−9.2	3Fo 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<3/2>).4f.G	4.0	3.0	...
4065.230.......	25.5	0.0045	0.0055	23.4	4 A	Fe III	4065.253 ?	1.7	5Ho 3d5.(4G).5p	5G 3d5.(4G).6s	4.0	5.0	8/1
4067.329.......	22.2	0.0030	0.0036	6.2	...	...	...	...	...	...	...	...	...
4068.668.......	48.8	1.4822	1.7873	900.8	0 A	[S II]	4068.600	−5.0	4So 3s2.3p3	2Po 3s2.3p3	1.5	1.5	1/1
4069.626.......	18.9	0.0169	0.0204	99999.0	1 A	O II	4069.623	−0.2	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	0.5	1.5	8/6
4069.888.......	13.0	0.0165	0.0199	99999.0	1 A	O II	4069.882	−0.4	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	1.5	2.5	8/6
4072.149.......	15.2	0.0272	0.0327	100.3	1 A	O II	4072.153	0.3	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	2.5	3.5	5/4
4074.505.......	35.9	0.0085	0.0102	19.2	5 B	N III	4074.460:	−3.3	4P 2p2.(3P).3d	4Po 2s.2p.(3Po).8d	1.5	****	2/0
					3 A	C II	4074.481	−1.8	4Do 2s.2p.(3Po).3d	4F 2s.2p.(3Po).4f	0.5	1.5	8/1
					5 B	C II	4074.544:	2.9	4Do 2s.2p.(3Po).3d	4F 2s.2p.(3Po).4f	1.5	2.5	8/0
4075.889.......	17.0	0.0368	0.0442	99999.0	2 A	O II	4075.862	−2.0	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	3.5	4.5	2/2
					5 C	C II	4075.940:	3.8	4Do 2s.2p.(3Po).3d	4F 2s.2p.(3Po).4f	2.5	2.5	7/1
4076.374.......	46.7	0.6358	0.7653	352.0	1 A	[S II]	4076.349	−1.8	4So 3s2.3p3	2Po 3s2.3p3	1.5	0.5	1/1
4078.808.......	16.3	0.0047	0.0056	23.0	2 A	O II	4078.842	2.5	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	1.5	1.5	8/5
4079.643.......	36.0	0.0021	0.0025	10.6	4 A	[Fe III]	4079.700	4.2	5D 3d6	3G 3d6	3.0	4.0	7/1
4082.319.......	36.0	0.0044	0.0053	13.3	9	Fe I	4082.107 ?	−15.6	z5Fo 3d6.(5D).4s.4p.(3Po)	g5D 3d6.4s.(4D).5s	2.0	2.0	*/1
					4 A	N II	4082.271	−3.5	3Fo 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<1/2>).4f.F	3.0	4.0	...
4083.874.......	14.3	0.0040	0.0049	17.9	3 A	[Fe II]	4083.781	−6.8	a4F 3d7	b2H 3d6.(3H).4s	4.5	4.5	3/0
					3 A	O II	4083.899	1.8	4F 2s2.2p2.(3P).3d	2[4]o 2s2.2p2.(3P).4f.G	2.5	3.5	...
4084.670.......	20.5	0.0039	0.0047	22.5	*	Fe I	4084.492 ?	−13.1	z5Fo 3d6.(5D).4s.4p.(3Po)	g5D 3d6.4s.(4D).5s	5.0	4.0	2/0
4085.101.......	16.7	0.0064	0.0076	22.5	1 A	O II	4085.112	0.8	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	2.5	2.5	7/5
4087.146.......	14.5	0.0037	0.0045	24.5	2 A	O II	4087.153	0.5	4F 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.G	1.5	2.5	...
4089.290.......	13.3	0.0095	0.0114	37.9	2 A	O II	4089.288	−0.2	4F 2s2.2p2.(3P).3d	2[5]o 2s2.2p2.(3P).4f.G	4.5	5.5	...
4092.920.......	10.8	0.0027	0.0032	16.8	1 A	O II	4092.929	0.6	4Do 2s2.2p2.(3P).3p	4F 2s2.2p2.(3P).3d	3.5	3.5	4/3
4093.921.......	39.5	0.0041	0.0049	11.0	6 C	Fe III	4093.645:	−20.2	5Go 3d5.(4G).5p	5G 3d5.(4G).5d	3.0	2.0	*/4
					5 A	N III	4093.680:	−17.7	2Do 2s.2p.(1Po).3d	2D 2s.2p.(3Po).6p	1.5	1.5	3/2
4095.648.......	19.4	0.0035	0.0042	10.5	7	N III	4095.340:	−22.6	2Do 2s.2p.(1Po).3d	2D 2s.2p.(3Po).6p	2.5	1.5	3/1
					2 A	O II	4095.644	−0.3	4F 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.G	2.5	3.5	...
4096.513.......	11.8	0.0024	0.0028	15.6	5 A	[Fe III]	4096.610:	7.1	5D 3d6	3G 3d6	2.0	3.0	8/1
4097.265.......	14.9	0.0096	0.0115	42.8	2 A	O II	4097.225	−2.9	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	0.5	1.5	7/4
					2 A	O II	4097.257	−0.6	4F 2s2.2p2.(3P).3d	2[4]o 2s2.2p2.(3P).4f.G	3.5	4.5	...
4101.739.......	31.5	20.7242	24.8041	5729.0	2 A	H I	4101.734	−0.4	2 2*	6 6*	****	****	0/0
4104.747.......	55.1	0.0134	0.0160	18.1	1 A	O II	4104.724	−1.7	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	2.5	5/4
4104.996.......	14.2	0.0038	0.0046	10.4	1 A	O II	4104.990	−0.4	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	1.5	7/3
4108.454.......	33.4	0.0046	0.0055	7.8	...	...	...	...	...	...	...	...	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4110.766.......	15.0	0.0063	0.0075	19.2	1 A	O II	4110.786	1.5	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	0.5	7/4
4113.028.......	53.6	0.0068	0.0082	16.2	5 B	Fe I	4112.912 ?	−8.5	y5Do 3d7.(4F).4p	i5D 3d6.4s.(4D).4d	3.0	3.0	6/1
4119.214.......	17.3	0.0184	0.0219	61.2	1 A	O II	4119.216	0.2	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	2.5	3.5	2/2
4120.312.......	17.4	0.0057	0.0068	99999.0	2 A	O II	4120.278	−2.5	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	2.5	2.5	4/3
						O II	4120.547	17.1	4Po 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	2.5	1.5	5/1
4120.829.......	22.8	0.1730	0.2062	351.8	3 A	He I	4120.811	−1.4	3Po 1s.2p	3S 1s.5s	2.0	1.0	1/0
4121.434.......	17.5	0.0140	0.0166	99999.0	2 A	O II	4121.462	2.1	4Po 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	0.5	0.5	6/2
4123.658.......	15.5	0.0016	0.0019	7.8	...	...	...	...	...	...	...	...	...
4128.569.......	18.6	0.0136	0.0162	7.1	7 C	Fe II	4128.748:	13.0	b4P 3d6.(3P4).4s	z4Do 3d6.(5D).4p	2.5	1.5	5/0
4131.757.......	19.8	0.0311	0.0370	92.4	8 B	Fe II	4131.870 ?	8.2	z4Ho 3d6.(3H).4p	e4G 3d6.(5D).4d	4.5	4.5	7/1
4132.789.......	11.5	0.0070	0.0083	34.8	3 A	O II	4132.800	0.8	4Po 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	0.5	1.5	6/1
4139.999.......	32.8	0.0024	0.0028	11.2	...	...	...	...	...	...	...	...	...
4143.758.......	23.1	0.2649	0.3140	226.1	4 B	O II	4143.739	−1.4	6P 2s.2p3.(5So).3p	6Do 2s.2p3.(5So).3d	2.5	3.5	5/1
					1 A	He I	4143.759	0.1	1Po 1s.2p	1D 1s.6d	1.0	2.0	0/0
4146.047.......	19.9	0.0050	0.0059	17.3	3 A	Ne II	4146.064	1.2	2P 2s2.2p4.(3P).4s	2So 2s2.2p4.(3P).5p	0.5	0.5	1/0
					4 B	O II	4146.076	2.1	6P 2s.2p3.(5So).3p	6Do 2s.2p3.(5So).3d	3.5	4.5	2/0
4153.287.......	15.1	0.0156	0.0184	75.7	3 A	O II	4153.298	0.8	4Po 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	1.5	2.5	4/1
4156.328.......	30.3	0.0134	0.0159	48.5	4 A	N II	4156.358	2.1	3Do 2s2.2p.(2Po).3d	2[3/2] 2s2.2p.(2Po<3/2>).4f.D	1.0	2.0	...
					7 D	O II	4156.530:	14.6	4Po 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	2.5	1.5	4/1
4161.141.......	29.6	0.0018	0.0022	9.5	...	...	...	...	...	...	...	...	...
4167.285.......	31.6	0.0032	0.0038	10.9	...	...	...	...	...	...	...	...	...
4168.995.......	24.3	0.0393	0.0463	140.0	1 A	He I	4168.972	−1.7	1Po 1s.2p	1S 1s.6s	1.0	0.0	0/0
					8 C	O II	4169.224:	16.4	4Po 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	2.5	2.5	3/1
4176.145.......	27.3	0.0054	0.0064	13.0	3 A	N II	4176.159	1.0	1Do 2s2.2p.(2Po).3d	2[5/2] 2s2.2p.(2Po<1/2>).4f.F	2.0	3.0	...
4185.433.......	16.2	0.0069	0.0081	22.9	1 A	O II	4185.439	0.4	2Fo 2s2.2p2.(1D).3p	2G 2s2.2p2.(1D).3d	2.5	3.5	2/1
4187.368.......	33.6	0.0029	0.0034	7.4	8	Fe II	4187.493 ?	9.0	z4Ho 3d6.(3H).4p	e4G 3d6.(5D).4d	4.5	5.5	5/0
4188.379.......	11.5	0.0010	0.0011	8.2	...	...	...	...	...	...	...	...	...
4189.783.......	21.2	0.0106	0.0124	34.0	2 A	O II	4189.788	0.3	2Fo 2s2.2p2.(1D).3p	2G 2s2.2p2.(1D).3d	3.5	4.5	2/1
					8	O II	4189.581 ?	−14.5	2Fo 2s2.2p2.(1D).3p	2G 2s2.2p2.(1D).3d	3.5	3.5	2/0
4192.167.......	48.9	0.0021	0.0024	9.8	8	O II	4192.512 ?	24.7	2Do 2s2.2p2.(1D).3p	2P 2s2.2p2.(1D).3d	2.5	1.5	2/0
4196.805.......	36.1	0.0048	0.0056	13.5	7 D	O II	4196.698:	−7.6	2Do 2s2.2p2.(1D).3p	2P 2s2.2p2.(1D).3d	1.5	0.5	2/0
4208.038.......	30.3	0.0053	0.0061	20.1	...	...	...	...	...	...	...	...	...
4211.316.......	24.5	0.0069	0.0081	32.8	7 C	[Fe II]	4211.099:	−15.5	a4F 3d7	b2H 3d6.(3H).4s	3.5	5.5	4/0
4219.753.......	19.9	0.0013	0.0015	8.0	2 A	Ne II	4219.745	−0.6	4D 2s2.2p4.(3P).3d	2[4]o 2s2.2p4.(3P<2>).4f	3.5	4.5	...
					7	Ni III	4220.070 ?	22.5	3F 3d7.(4F).4d	3Do 3d6.(5D).4s.4p	2.0	3.0	4/2
4236.926.......	14.3	0.0026	0.0030	18.0	2 A	N II	4236.927	0.1	3Do 2s2.2p.(2Po).3d	2[5/2] 2s2.2p.(2Po<1/2>).4f.F	1.0	2.0	...
					6	N II	4237.047:	8.6	3Do 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<1/2>).4f.F	2.0	3.0	...
4241.809.......	19.9	0.0060	0.0069	30.2	4 B	N II	4241.756	−3.8	3Do 2s2.2p.(2Po).3d	2[5/2] 2s2.2p.(2Po<1/2>).4f.F	2.0	3.0	...
					3 A	N II	4241.786	−1.6	3Do 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<1/2>).4f.F	3.0	4.0	...
4246.861.......	25.6	0.0027	0.0031	9.2	5 B	N II	4246.706:	−10.9	3Do 2s2.2p.(2Po).3d	2[5/2] 2s2.2p.(2Po<1/2>).4f.F	3.0	2.0	...
4253.919.......	38.7	0.0064	0.0074	15.8	2 A	O II	4253.894	−1.8	2G 2s2.2p2.(1D).3d	2[5]o 2s2.2p2.(1D).4f.H	4.5	5.5	...
					2 A	O II	4253.907	−0.8	2G 2s2.2p2.(1D).3d	2[5]o 2s2.2p2.(1D).4f.H	4.5	4.5	...
4256.128.......	23.5	0.0037	0.0043	13.5	...	...	...	...	...	...	...	...	...
4259.506.......	19.4	0.0040	0.0046	15.9	...	...	...	...	...	...	...	...	...
4267.161.......	38.7	0.4963	0.5712	536.0	8 D	C II	4267.001	−11.3	2D 2s2.3d	2Fo 2s2.4f	1.5	2.5	2/0
					5 A	C II	4267.183	1.5	2D 2s2.3d	2Fo 2s2.4f	2.5	3.5	2/0
					8 D	C II	4267.261	7.0	2D 2s2.3d	2Fo 2s2.4f	2.5	2.5	2/0

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4271.882.......	44.2	0.0050	0.0058	7.1	5 C	Fe I	4271.760 ?	−8.5	a3F 3d7.(4F).4s	z3Go 3d7.(4F).4p	4.0	5.0	2/0
4275.535.......	13.5	0.0056	0.0065	33.4	5 B	Fe II]	4275.492 ?	−3.0	z2Po 3d6.(3P4).4p	4P 3d6.(5D).4d	0.5	0.5	4/1
					2 A	O II	4275.551	1.1	4D 2s2.2p2.(3P).3d	2[4]o 2s2.2p2.(3P).4f.F	3.5	4.5	. . .
4276.820.......	44.0	0.0068	0.0079	23.5	6 B	O II	4276.749:	−5.0	4D 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	2.5	3.5	. . .
					4 A	[Fe II]	4276.829	0.7	a4F 3d7	a4G 3d6.(3G).4s	3.5	4.5	5/1
4277.481.......	24.9	0.0029	0.0033	10.7	3 A	O II	4277.426	−3.9	4D 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	3.5	2.5	. . .
					3 A	O II	4277.427	−3.8	4D 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.F	0.5	1.5	. . .
4280.548.......	48.9	0.0022	0.0026	7.4	4 B	Fe II]	4280.542 ?	−0.4	z2Po 3d6.(3P4).4p	4P 3d6.(5D).4d	1.5	0.5	4/1
4281.246.......	20.9	0.0016	0.0019	9.1	3 B	O II	4281.313	4.7	4P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	2.5	2.5	. . .
4282.957.......	16.1	0.0022	0.0026	13.4	2 A	O II	4282.961	0.3	4D 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.F	1.5	2.5	. . .
4285.699.......	13.2	0.0027	0.0031	16.5	2 A	O II	4285.684	−1.1	2F 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	2.5	3.5	. . .
					5 C	Fe II	4285.716 ?	1.2	x4Do 3d6.(3F4).4p	e4F 3d6.(5D).4d	2.5	2.5	7/1
4287.234.......	12.1	0.0048	0.0055	99999.0	7 B	[Fe II]	4287.394:	11.2	a6D 3d6.(5D).4s	a6S 3d5.4s2	4.5	2.5	1/0
4287.551.......	15.1	0.0072	0.0083	99999.0	5 A	[Co II]	4287.499 ?	−3.6	a3F 3d8	b3P 3d7.(4P).4s	3.0	1.0	5/1
					7 C	O II	4287.727:	12.3	2Po 2s2.2p2.(1D).3p	2D 2s2.2p2.(3P).4d	1.5	1.5	2/1
4292.406.......	21.2	0.0078	0.0089	35.2	6 B	O II:	4292.214 ?	−13.4	2F 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.F	2.5	2.5	. . .
					6 B	C II	4292.250:	−10.9	2Fo 2s2.2p.(3Po).3d	2G 2s2.10g	****	****	. . .
4294.777.......	27.8	0.0051	0.0059	21.1	2 A	O II	4294.782	0.3	4P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	1.5	2.5	. . .
					6 B	O II	4294.919:	9.9	4P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	1.5	1.5	. . .
4300.454.......	27.4	0.0030	0.0034	7.8	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4303.129.......	16.9	0.0009	0.0010	7.9	4 A	O II	4303.072	−4.0	2G 2s2.2p2.(1D).3d	2[4]o 2s2.2p2.(1D).4f.G	3.5	****	. . .
4303.819.......	14.6	0.0058	0.0066	34.1	2 A	O II	4303.823	0.3	4P 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.D	2.5	3.5	. . .
4306.069.......	20.1	0.0061	0.0069	20.2	7 A	[Fe II]	4305.890:	−12.5	a4F 3d7	a4G 3d6.(3G).4s	2.5	2.5	8/0
					7 A	O II	4305.965:	−7.2	2D 2s2.2p2.(1D).3d	2[1]o 2s2.2p2.(1D).4f.P	1.5	****	. . .
4307.269.......	19.5	0.0105	0.0119	45.3	3 A	O II	4307.232	−2.6	4P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	0.5	1.5	. . .
4317.119.......	16.4	0.0140	0.0159	57.8	1 A	O II	4317.139	1.4	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	0.5	1.5	6/5
					8	C II	4317.265 ?	10.1	4P 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	2.5	2.5	3/0
4318.581.......	25.2	0.0076	0.0086	32.5	5 A	C II	4318.606:	1.7	4P 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	0.5	1.5	6/1
4319.618.......	13.8	0.0073	0.0083	38.4	2 A	O II	4319.629	0.8	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	2.5	4/4
					4 B	[Fe II]	4319.620 ?	0.1	a4F 3d7	a4G 3d6.(3G).4s	2.5	3.5	8/1
					8 C	Fe II	4319.680 ?	4.3	x4Do 3d6.(3F4).4p	e4F 3d6.(5D).4d	2.5	3.5	5/1
4321.597.......	48.3	0.0070	0.0080	11.5	5 A	C II	4321.657	4.2	4P 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	1.5	1.5	6/1
4323.326.......	70.0	0.0082	0.0093	8.2	3 B	[Co II]	4323.278 ?	−3.4	a3F 3d8	b3P 3d7.(4P).4s	3.0	2.0	4/1
					8	C II	4323.106 ?	−15.3	4P 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	0.5	0.5	6/0
4325.866.......	45.0	0.0151	0.0171	49.4	8	O II	4325.761 ?	−7.3	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	0.5	0.5	6/0
					4 A	Fe I	4325.762 ?	−7.2	a3F 3d7.(4F).4s	z3Go 3d7.(4F).4p	2.0	3.0	5/1
					4 A	C II	4325.833 ?	−2.3	4P 2s.2p.(3Po).3p	4Po 2s.2p.(3Po).4s	2.5	1.5	4/0
4329.876.......	21.4	0.0062	0.0070	20.7	6 B	C II	4329.675:	−13.9	2D 2s2.4d	2Fo 2s2.9f	****	****	. . .
4335.866.......	60.2	0.0082	0.0093	8.7	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4336.830.......	11.5	0.0033	0.0037	12.2	1 A	O II	4336.859	2.0	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	1.5	6/5
4340.465.......	31.6	39.6376	44.8053	6397.0	3 A	H I	4340.464	−0.1	2 2*	5 5*	****	****	0/0
4345.546.......	15.8	0.0170	0.0192	39.6	1 A	O II	4345.560	1.0	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	0.5	6/5
4347.990.......	26.0	0.0046	0.0052	9.3	. . .	O II	4347.413 ?	−39.9	2D 2p2.(1D).3s	2Do 2s2.2p2.(1D).3p	1.5	1.5	. . .
					. . .	O II	4347.217 ?	−53.3	2D 2p2.(1D).3s	2Do 2s2.2p2.(1D).3p	2.5	1.5	. . .
4349.409.......	18.6	0.0292	0.0330	77.3	0 A	O II	4349.426	1.2	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	2.5	2.5	3/3
4351.266.......	19.2	0.0071	0.0080	16.5	5 A	O II	4351.260:	−0.4	2D 2s2.2p2.(1D).3s	2Do 2s2.2p2.(1D).3p	2.5	2.5	3/0
					9 C	O II	4351.457 ?	13.2	2D 2s2.2p2.(1D).3s	2Do 2s2.2p2.(1D).3p	1.5	2.5	3/0

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4359.380.......	42.0	0.0080	0.0090	27.9	3 A	[Fe II]	4359.333	−3.2	a6D 3d6.(5D).4s	a6S 3d5.4s2	3.5	2.5	2/0
					5 B	O II	4359.395:	1.0	2Do 2s2.2p2.(3P).3p	2D 2s2.2p2.(3P).3d	1.5	2.5	3/0
4363.191.......	15.6	0.8321	0.9353	606.3	1 A	[O III]	4363.210	1.3	1D 2s2.2p2	1S 2s2.2p2	2.0	0.0	0/0
4366.875.......	13.4	0.0121	0.0136	53.0	1 A	O II	4366.895	1.3	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	2.5	1.5	4/4
4368.264.......	54.9	0.0858	0.0964	291.3	2 A	O I	4368.193	−4.9	3So 2s2.2p3.(4So).3s	3P 2s2.2p3.(4So).4p	****	****	. . .
4376.580.......	12.6	0.0014	0.0016	11.0	4 A	C II	4376.582	0.1	4Po 2s.2p.(3Po).3d	4D 2s.2p.(3Po).4f	1.5	2.5	5/0
4387.930.......	21.5	0.4889	0.5462	291.0	1 A	He I	4387.929	−0.1	1Po 1s.2p	1D 1s.5d	1.0	2.0	0/0
4390.550.......	47.1	0.0053	0.0059	32.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4391.963.......	15.8	0.0020	0.0022	7.4	3 A	Ne II	4391.991	1.9	4F 2s2.2p4.(3P).3d	2[5]o 2s2.2p4.(3P<2>).4f	4.5	5.5	. . .
					3 A	Ne II	4391.995	2.2	4F 2s2.2p4.(3P).3d	2[5]o 2s2.2p4.(3P<2>).4f	4.5	4.5	. . .
4393.483.......	33.9	0.0041	0.0045	15.0	4 A	O II	4393.435	−3.3	2Po 2s2.2p2.(1D).3p	2P 2s2.2p2.(3P).4d	1.5	0.5	3/0
4396.586.......	20.4	0.0014	0.0016	7.7	4 A	O I	4396.560 ?	−1.8	3P 2s2.2p3.(4So).4p	3Do 2s2.2p3.(2Do).4s	2.0	3.0	2/0
4411.172.......	13.3	0.0015	0.0016	12.5	4 A	C II	4411.152	−1.4	2Do 2s.2p.(3Po).3d	2F 2s.2p.(3Po).4f	1.5	2.5	2/0
4413.609.......	12.4	0.0025	0.0027	99999.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
4413.942.......	10.4	0.0019	0.0021	99999.0	3 A	[Fe II]	4413.781	−10.9	a6D 3d6.(5D).4s	a6S 3d5.4s2	2.5	2.5	3/2
4414.888.......	15.0	0.0273	0.0303	113.7	1 A	O II	4414.898	0.7	2P 2s2.2p2.(3P).3s	2Do 2s2.2p2.(3P).3p	1.5	2.5	2/1
4416.090.......	11.0	0.0015	0.0016	99999.0	6 A	[Fe II]	4416.266:	12.0	a6D 3d6.(5D).4s	b4F 3d6.(3F4).4s	4.5	4.5	3/1
4416.515.......	17.4	0.0024	0.0026	99999.0	7 B	[Fe II]	4416.266:	−16.9	a6D 3d6.(5D).4s	b4F 3d6.(3F4).4s	4.5	4.5	3/0
4416.969.......	15.5	0.0178	0.0197	92.2	3 A	O II	4416.975	0.4	2P 2s2.2p2.(3P).3s	2Do 2s2.2p2.(3P).3p	0.5	1.5	2/1
4418.945.......	35.3	0.0029	0.0032	11.1	5 C	O II	4418.870:	−5.1	2Po 2s2.2p2.(1S).3p	2P 2s2.2p2.(1D).4d	0.5	1.5	1/0
					3 A	Fe II	4418.958 ?	0.9	y4Go 3d6.(3F4).4p	e4F 3d6.(5D).4d	2.5	1.5	8/1
4432.692.......	22.1	0.0032	0.0036	11.4	6 B	[Fe II]	4432.447:	−16.6	a6D 3d6.(5D).4s	b4F 3d6.(3F4).4s	3.5	2.5	7/1
					5 A	N II	4432.735:	2.9	3Po 2s2.2p.(2Po).3d	2[5/2] 2s2.2p.(2Po<3/2>).4f.D	2.0	3.0	. . .
4433.769.......	23.6	0.0025	0.0028	11.9	6	N II	4433.475:	−19.9	3Po 2s2.2p.(2Po).3d	2[3/2] 2s2.2p.(2Po<3/2>).4f.D	0.0	1.0	. . .
4437.552.......	22.0	0.0718	0.0792	211.5	1 A	He I	4437.554	0.1	1Po 1s.2p	1S 1s.5s	1.0	0.0	0/0
4447.060.......	16.5	0.0035	0.0039	19.7	2 A	N II	4447.030	−2.0	1P 2s2.2p.(2Po).3p	1Do 2s2.2p.(2Po).3d	1.0	2.0	0/0
4448.253.......	12.8	0.0008	0.0009	9.0	5 A	O II	4448.191:	−4.2	2Fo 2s2.2p2.(1D).3p	2F 2s2.2p2.(1D).3d	3.5	3.5	3/0
4448.825.......	9.5	0.0009	0.0010	9.2	2 A	O II	4448.850	1.7	2P 2s2.2p2.(1D).3d	2[1]o 2s2.2p2.(1D).4f.P	1.5	****	. . .
4452.262.......	43.9	0.0080	0.0088	34.1	4 A	[Fe II]	4452.098 ?	−11.1	a6D 3d6.(5D).4s	a6S 3d5.4s2	1.5	2.5	4/2
					8 C	O II	4452.378	7.8	2P 2s2.2p2.(3P).3s	2Do 2s2.2p2.(3P).3p	1.5	1.5	2/0
4453.475.......	16.3	0.0051	0.0056	29.1	7 D	Fe II	4453.205 ?	−18.2	y6Po 3d5.(6S).4s.4p.(3Po)	6P 3d6.(5D).4d	1.5	1.5	6/1
4454.107.......	21.5	0.0015	0.0017	6.5	8	O II	4453.966 ?	−9.5	4P 2s2.2p2.(3P).3d	4So 2s.2p3.(5So).3s	1.5	1.5	2/0
4457.091.......	20.9	0.0122	0.0134	59.4	3 A	Ne II	4457.050	−2.8	2D 2s2.2p4.(3P).3d	2[2]o 2s2.2p4.(3P<2>).4f	1.5	2.5	. . .
					6 C	Ne II	4457.239:	10.0	4P 2s2.2p4.(3P).3d	2[3]o 2s2.2p4.(3P<1>).4f	2.5	2.5	. . .
					6 C	Ne II	4457.265:	11.7	2D 2s2.2p4.(3P).3d	2[2]o 2s2.2p4.(3P<2>).4f	1.5	1.5	. . .
4457.725.......	26.0	0.0026	0.0028	99999.0	6 A	[Fe II]	4457.945:	14.8	a6D 3d6.(5D).4s	b4F 3d6.(3F4).4s	3.5	3.5	6/1
4459.898.......	17.2	0.0022	0.0025	14.3	6 A	N II	4459.937:	2.6	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	0.0	5/1
4465.404.......	14.8	0.0054	0.0059	32.4	1 A	O II	4465.408	0.3	6So 2s.2p3.(5So).3s	6P 2s.2p3.(5So).3p	2.5	3.5	1/1
					8	N II	4465.529 ?	8.4	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	1.0	5/0
4466.390.......	25.1	0.0027	0.0029	9.9	3 A	O II	4466.435	3.0	2P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	1.5	2.5	. . .
					6 D	O II	4466.583:	13.0	2P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	1.5	1.5	. . .
4467.919.......	14.7	0.0038	0.0041	22.6	1 A	O II	4467.924	0.3	6So 2s.2p3.(5So).3s	6P 2s.2p3.(5So).3p	2.5	2.5	2/2
					5 B	Fe II	4467.931:	0.8	y4Go 3d6.(3F4).4p	e4F 3d6.(5D).4d	3.5	3.5	7/0
4469.375.......	13.5	0.0020	0.0022	12.1	1 A	O II	4469.378	0.2	6So 2s.2p3.(5So).3s	6P 2s.2p3.(5So).3p	2.5	1.5	2/2
					4 B	O II	4469.462	5.8	2P 2s2.2p2.(3P).3d	2[1]o 2s2.2p2.(3P).4f.D	0.5	0.5	. . .
4471.499.......	23.7	4.1046	4.4921	1935.0	4 A	He I	4471.474	−1.7	3Po 1s.2p	3D 1s.4d	2.0	3.0	2/0
4474.689.......	20.9	0.0024	0.0026	5.8	4 A	[Fe II]	4474.904	14.4	a6D 3d6.(5D).4s	a6S 3d5.4s2	0.5	2.5	4/2

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4477.745.......	25.1	0.0055	0.0061	29.9	4 A	N II	4477.682	−4.2	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	2.0	1.0	5/1
4481.213.......	30.6	0.0176	0.0193	81.2	7 A	Mg II	4481.126:	−5.8	2D 3d	2Fo 4f	2.5	3.5	2/0
					7 A	Mg II	4481.150:	−4.2	2D 3d	2Fo 4f	2.5	2.5	2/0
					8 C	Mg II	4481.325 ?	7.5	2D 3d	2Fo 4f	1.5	2.5	2/0
4483.494.......	15.7	0.0018	0.0020	8.6	5 C	S II	4483.427:	−4.5	4Do 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).5s	2.5	1.5	5/0
4485.231.......	34.2	0.0020	0.0021	10.5	7 B	Fe III	4485.575:	23.0	3G 3d5.(2G3).4s	3Fo 3d5.(a2F).4p	5.0	4.0	2/1
4487.744.......	17.4	0.0008	0.0009	99999.0	7	Fe II	4487.497:	−16.5	y6Po 3d5.(6S).4s.4p.(3Po)	6P 3d6.(5D).4d	2.5	2.5	6/1
					2 A	O II	4487.712	−2.2	2P 2s2.2p2.(1D).3d	2[2]o 2s2.2p2.(1D).4f.D	0.5	1.5	...
4488.194.......	18.9	0.0022	0.0024	9.7	4 D	N II	4488.095	−6.6	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	2.0	2.0	4/1
					2 A	O II	4488.184	−0.7	2P 2s2.2p2.(1D).3d	2[2]o 2s2.2p2.(1D).4f.D	1.5	2.5	...
					2 A	O II	4488.198	0.3	2P 2s2.2p2.(1D).3d	2[2]o 2s2.2p2.(1D).4f.D	1.5	1.5	...
					3 C	S II	4488.188	−0.4	2D 3s2.3p2.(3P).4d	2[2]o 3s2.3p2.(1D<2>).5f	1.5	****	...
4489.468.......	23.0	0.0007	0.0007	7.0	3 A	O II	4489.461	−0.5	2P 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	0.5	1.5	...
4491.278.......	19.6	0.0115	0.0125	56.5	5 B	C II	4491.130:	−9.9	2Fo 2s2.4f	2G 2s2.9g	****	****	...
					4 A	O II	4491.222	−3.7	2P 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.D	1.5	2.5	...
4503.289.......	17.4	0.0014	0.0015	10.3	...	...	...	...	...	...	...	...	...
4507.554.......	13.1	0.0047	0.0051	25.8	5 B	N II	4507.560:	0.4	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	3.0	2.0	2/0
4530.404.......	16.7	0.0039	0.0042	21.6	3 A	N II	4530.410	0.4	1Fo 2s2.2p.(2Po).3d	2[9/2] 2s2.2p.(2Po<3/2>).4f.G	3.0	4.0	...
4545.218.......	23.6	0.0023	0.0024	11.8	...	...	...	...	...	...	...	...	...
4552.505.......	22.1	0.0024	0.0026	11.3	3 A	N II	4552.522	1.1	1Fo 2s2.2p.(2Po).3d	2[7/2] 2s2.2p.(2Po<3/2>).4f.G	3.0	4.0	...
4562.637.......	57.5	0.0387	0.0414	168.8	...	...	...	...	...	...	...	...	...
4571.161.......	52.8	0.4017	0.4291	173.0	2 A	Mg I]	4571.096	−4.3	1S 3s2	3Po 3s.3p	0.0	1.0	0/0
4590.959.......	16.5	0.0135	0.0143	73.2	2 A	O II	4590.974	1.0	2D 2s2.2p2.(1D).3s	2Fo 2s2.2p2.(1D).3p	2.5	3.5	2/1
4596.171.......	15.5	0.0089	0.0094	37.8	8	O II	4595.957	−14.0	2D 2s2.2p2.(1D).3s	2Fo 2s2.2p2.(1D).3p	2.5	2.5	2/0
					2 A	O II	4596.176	0.3	2D 2s2.2p2.(1D).3s	2Fo 2s2.2p2.(1D).3p	1.5	2.5	2/1
4601.471.......	17.3	0.0248	0.0263	104.0	2 A	N II	4601.478	0.4	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	1.0	2.0	4/4
4602.121.......	12.6	0.0020	0.0022	12.5	2 A	O II	4602.129	0.5	2D 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	1.5	2.5	...
4607.140.......	17.5	0.0243	0.0257	96.0	4 A	[Fe III]	4607.030	−7.2	5D 3d6	3F4 3d6	4.0	3.0	4/1
					...	N II	4607.153	0.8	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	0.0	1.0	...
4609.436.......	15.3	0.0057	0.0060	23.7	2 A	O II	4609.436	0.0	2D 2s2.2p2.(3P).3d	2[4]o 2s2.2p2.(3P).4f.F	2.5	3.5	...
4611.738.......	41.4	0.0057	0.0061	8.1	5 B	O II	4611.582:	−10.1	4F 2s2.2p2.(3P).4d	2[2]o 2s2.2p2.(1D).4f.D	2.5	2.5	...
					5 B	O II	4611.597:	−9.1	4F 2s2.2p2.(3P).4d	2[2]o 2s2.2p2.(1D).4f.D	2.5	1.5	...
4613.858.......	19.6	0.0172	0.0182	59.1	6 D	O II	4613.681:	−11.5	2D 2s2.2p2.(3P).3d	2[3]o 2s2.2p2.(3P).4f.F	2.5	3.5	...
					2 A	N II	4613.868	0.7	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	1.0	1.0	5/5
4620.348.......	21.5	0.0101	0.0107	41.7	7 A	C II	4620.185	−10.6	2D 2s2.4d	2Fo 2s2.8f	****	****	...
4621.384.......	18.0	0.0250	0.0264	103.9	3 A	N II	4621.393	0.6	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	1.0	0.0	5/5
					7 D	Si II	4621.419:	2.3	2D 3s2.(1S).4d	2Fo 3s2.(1S).7f	1.5	2.5	2/0
					6 B	[C I]	4621.570:	12.1	3P 2s2.2p2	1S 2s2.2p2	1.0	0.0	0/0
4627.940.......	16.0	0.0013	0.0013	7.0	8	[Ni II]	4628.046 ?	6.9	2D 3d9	4P 3d8.(3P).4s	1.5	2.5	3/0
4630.531.......	16.8	0.0765	0.0805	217.7	2 A	N II	4630.539	0.5	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	2.0	2.0	3/3
4634.079.......	18.8	0.0024	0.0026	16.6	2 A	N III	4634.120	2.7	2Po 2s2.3p	2D 2s2.3d	0.5	1.5	2/1
4637.456.......	23.2	0.0053	0.0056	19.5	8 C	C II	4637.630	11.2	2Po 2s2.4p	2D 2s2.6d	0.5	1.5	2/0
4638.816.......	18.4	0.0283	0.0297	125.4	2 A	O II	4638.856	2.6	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	0.5	1.5	7/7
4640.604.......	15.4	0.0049	0.0052	23.4	3 A	N III	4640.640	2.3	2Po 2s2.3p	2D 2s2.3d	1.5	2.5	2/1
4641.802.......	15.1	0.0407	0.0428	156.1	1 A	O II	4641.810	0.5	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	1.5	2.5	5/5
					2 B	N III	4641.850	3.1	2Po 2s2.3p	2D 2s2.3d	1.5	1.5	2/2
4643.078.......	17.0	0.0327	0.0344	140.5	1 A	N II	4643.086	0.5	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	2.0	1.0	4/4

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4649.128.......	15.6	0.0639	0.0670	210.8	1 A	O II	4649.135	0.4	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	2.5	3.5	2/2
4650.826.......	15.5	0.0207	0.0217	99.3	1 A	O II	4650.838	0.8	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	0.5	0.5	7/7
4651.559.......	24.6	0.0005	0.0005	6.0	6 A	O II	4651.326:	−15.0	4F 2s2.2p2.(3P).4d	2[3]o 2s2.2p2.(1D).4f.F	2.5	****	...
					6 A	C III	4651.473 ?	−5.5	3S 2s.3s	3Po 2s.3p	1.0	0.0	2/0
4654.475.......	19.6	0.0030	0.0031	14.7	6 A	O I:	4654.556	5.2	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).8d	2.0	1.0	8/0
					6 A	O I	4654.557:	5.3	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).8d	2.0	2.0	7/0
					6 A	O I	4654.559:	5.4	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).8d	2.0	3.0	5/0
4658.174.......	31.1	0.0262	0.0274	116.9	5 A	[Fe III]	4658.050:	−8.0	5D 3d6	3F4 3d6	4.0	4.0	3/1
4661.625.......	15.6	0.0221	0.0231	115.0	1 A	O II	4661.632	0.5	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	1.5	1.5	7/7
4667.255.......	25.2	0.0027	0.0028	15.6	6 A	[Fe III]	4667.010:	−15.8	5D 3d6	3F4 3d6	3.0	2.0	6/1
4669.227.......	57.3	0.0073	0.0076	34.3	2 A	O II	4669.260	2.1	2D 2s2.2p2.(3P).3d	2[2]o 2s2.2p2.(3P).4f.D	1.5	2.5	...
4673.725.......	16.4	0.0039	0.0041	22.8	1 A	O II	4673.733	0.5	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	1.5	0.5	7/7
4674.903.......	16.7	0.0020	0.0021	16.1	...	...	...	...	...	...	...	...	...
4676.225.......	16.2	0.0152	0.0158	77.3	1 A	O II	4676.235	0.6	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	2.5	2.5	4/4
4678.137.......	24.3	0.0013	0.0014	5.8	2 A	N II	4678.135	−0.2	1Po 2s2.2p.(2Po).3d	2[3/2] 2s2.2p.(2Po<3/2>).4f.D	1.0	2.0	...
4681.881.......	63.8	0.0021	0.0021	6.2	6 B	O II	4681.963:	5.3	2P 2s2.2p2.(3P).4s	2Do 2s2.2p2.(3P).5p	1.5	2.5	2/0
4696.335.......	14.7	0.0026	0.0027	14.4	1 A	O II	4696.353	1.2	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	2.5	1.5	5/5
4699.129.......	38.9	0.0128	0.0133	42.0	7	O II	4699.011:	−7.5	2Do 2s2.2p2.(1D).3p	2F 2s2.2p2.(1D).3d	2.5	3.5	2/0
					6 B	O II	4699.218:	5.7	2Do 2s2.2p2.(3P).3p	2F 2s2.2p2.(3P).3d	1.5	2.5	2/0
4703.145.......	16.4	0.0021	0.0021	7.1	4 A	O II	4703.161	1.0	2Do 2s2.2p2.(1D).3p	2F 2s2.2p2.(1D).3d	1.5	2.5	2/0
4705.344.......	14.6	0.0176	0.0183	61.4	4 A	O II	4705.346	0.1	2Do 2s2.2p2.(3P).3p	2F 2s2.2p2.(3P).3d	2.5	3.5	2/0
4710.015.......	20.7	0.0065	0.0067	21.7	...	...	...	...	...	...	...	...	...
4711.352.......	13.9	0.0029	0.0030	10.3	0 A	[Ar IV]	4711.370	1.2	4So 3s2.3p3	2Do 3s2.3p3	1.5	2.5	1/1
4713.174.......	24.2	0.5902	0.6098	233.5	3 A	He I	4713.139	−2.2	3Po 1s.2p	3S 1s.4s	2.0	1.0	1/0
4716.325.......	18.8	0.0036	0.0037	8.9	3 A	[Fe III]	4716.330	0.3	3F4 3d6	1F 3d6	3.0	3.0	2/0
4726.961.......	30.2	0.0026	0.0027	5.8	...	...	...	...	...	...	...	...	...
4733.956.......	34.5	0.0046	0.0048	18.6	0 A	[Fe III]	4733.910	−2.9	5D 3d6	3F4 3d6	2.0	2.0	7/2
4740.205.......	12.7	0.0035	0.0036	19.6	1 A	[Ar IV]	4740.160	−2.8	4So 3s2.3p3	2Do 3s2.3p3	1.5	1.5	1/1
4752.893.......	27.3	0.0168	0.0172	77.0	...	...	...	...	...	...	...	...	...
4754.741.......	35.8	0.0046	0.0047	23.3	3 A	[Fe III]	4754.690	−3.2	5D 3d6	3F4 3d6	3.0	4.0	4/0
4756.449.......	29.4	0.0233	0.0239	82.9	...	...	...	...	...	...	...	...	...
4757.232.......	17.1	0.0009	0.0010	8.6	...	...	...	...	...	...	...	...	...
4769.653.......	59.7	0.0061	0.0062	20.4	6 A	[Fe III]	4769.430:	−14.0	5D 3d6	3F4 3d6	2.0	3.0	7/1
4772.109.......	33.6	0.0024	0.0025	14.0	4 A	[Fe II]	4772.062 ?	−2.9	a6D 3d6.(5D).4s	b4P 3d6.(3P4).4s	1.5	1.5	7/0
4774.263.......	13.5	0.0022	0.0022	15.0	1 A	N II	4774.244	−1.2	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	1.0	2.0	6/3
4777.788.......	33.2	0.0032	0.0032	12.5	3 A	[Fe III]	4777.680	−6.8	5D 3d6	3F4 3d6	1.0	2.0	7/4
4779.715.......	17.8	0.0176	0.0179	88.9	2 A	N II	4779.723	0.5	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	1.0	1.0	6/4
4781.311.......	28.9	0.0013	0.0013	7.9	6 A	N II	4781.190:	−7.6	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	2.0	3.0	4/0
4788.127.......	15.6	0.0192	0.0195	101.9	2 A	N II	4788.137	0.6	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	2.0	2.0	6/3
4789.589.......	34.7	0.0268	0.0272	112.1	...	...	...	...	...	...	...	...	...
4792.040.......	19.2	0.0016	0.0017	7.8	5 C	S II	4792.007:	−2.1	4Po 3s2.3p2.(3P).4p	4P 3s2.3p2.(3P).5s	2.5	2.5	3/0
					3 A	O II	4792.083 ?	2.7	4D 2s2.2p2.(3P).4d	2[3]o 2s2.2p2.(1D).4f.F	3.5	****	...
4802.454.......	19.5	0.0181	0.0183	72.8	6 B	C II	4802.740:	17.9	2Fo 2s2.4f	2G 2s2.8g	****	****	...
4803.276.......	16.9	0.0258	0.0261	76.5	4 A	N II	4803.286	0.6	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	3.0	3.0	3/1
4810.209.......	49.2	0.0039	0.0040	12.9	4 A	Ne II	4810.214 ?	0.3	4Do 2s2.2p4.(3P).4p	4P 2s2.2p4.(3P).5d	1.5	0.5	7/0
					6	N II	4810.299:	5.6	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	3.0	2.0	4/0
4814.688.......	44.6	0.0079	0.0080	14.8	5 A	[Fe II]	4814.534:	−9.6	a4F 3d7	b4F 3d6.(3F4).4s	4.5	4.5	3/0

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
4815.483.......	60.5	0.0168	0.0170	13.7	6 B	S II	4815.552:	4.3	4P 3s2.3p2.(3P).4s	4So 3s2.3p2.(3P).4p	2.5	1.5	1/0
					8	N II	4815.617 ?	8.4	5Do 2s.2p2.(4P).3p	5P 2s.2p2.(4P).3d	1.0	1.0	8/0
4861.327.......	32.5	100.0000	100.0000	13680.0	3 A	H I	4861.325	−0.1	2 2*	4 4*	****	****	0/0
4869.377.......	23.0	0.0052	0.0052	19.4	...	...	...	...	...	...	...	...	...
4881.140.......	33.4	0.0155	0.0154	56.9	...	[Fe III]	4881.000	−8.6	5D 3d6	3H 3d6	4.0	4.0	...
4890.905.......	33.5	0.0138	0.0137	50.5	5 A	O II	4890.856:	−3.0	4So 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	1.5	0.5	2/0
4906.809.......	13.1	0.0043	0.0042	22.5	3 A	O II	4906.830	1.3	4So 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	1.5	1.5	2/1
4921.933.......	22.0	1.2341	1.2186	385.1	2 A	He I	4921.931	−0.1	1Po 1s.2p	1D 1s.4d	1.0	2.0	0/0
4924.524.......	16.4	0.0091	0.0089	25.1	1 A	O II	4924.529	0.3	4So 2s2.2p2.(3P).3p	4P 2s2.2p2.(3P).3d	1.5	2.5	1/1
					...	[Fe III]	4924.500 ?	−1.5	5D 3d6	3H 3d6	4.0	5.0	...
4931.229.......	18.8	0.0298	0.0294	85.6	0 A	[O III]	4931.226	−0.2	3P 2s2.2p2	1D 2s2.2p2	0.0	2.0	2/2
4953.007.......	16.8	0.0038	0.0037	14.0	3 A	O II	4952.940 ?	−4.1	2[4] 2s2.2p2.(3P<1>).5g	2[5]o 2s2.2p2.(1D).5f.H	3.5	****	...
					3 A	O II	4952.950 ?	−3.4	2[4] 2s2.2p2.(3P<1>).5g	2[5]o 2s2.2p2.(1D).5f.H	4.5	****	...
4958.915.......	16.0	74.1985	72.7233	9084.0	0 A	[O III]	4958.911	−0.2	3P 2s2.2p2	1D 2s2.2p2	1.0	2.0	1/1
4964.751.......	32.7	0.0216	0.0211	29.6	3 A	C II	4964.736	−0.9	2P 2s.2p.(3Po).3p	2Po 2s.2p.(3Po).3d	1.5	1.5	3/0
4987.360.......	19.4	0.0170	0.0165	71.1	3 A	C II	4987.300 ?	−3.6	4P 2s.2p.(3Po).4p	4Do 2s.2p.(3Po).6d	2.5	3.5	0/0
					5 C	N II	4987.377:	1.0	3S 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	0.0	2/0
					...	[Fe III]	4987.200	−9.6	a5D	a3H	3.0	4.0	...
4994.374.......	18.6	0.0435	0.0423	146.2	...	N II	4994.371	−0.2	3S 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	1.0	...
5006.845.......	15.6	221.3740	214.9350	9892.0	0 A	[O III]	5006.843	−0.1	3P 2s2.2p2	1D 2s2.2p2	2.0	2.0	1/1
5015.679.......	21.3	2.4681	2.3922	651.7	1 A	He I	5015.678	−0.1	1S 1s.2s	1Po 1s.3p	0.0	1.0	0/0
5031.963.......	19.3	0.0449	0.0434	69.0	6 B	C II	5032.128:	9.8	2Po 2p3	2D 2s.2p.(3Po).3p	1.5	2.5	2/1
5035.808.......	21.7	0.0577	0.0558	75.7	8 C	[Fe II]	5035.484 ?	−19.3	a6D 3d6.(5D).4s	b4P 3d6.(3P4).4s	0.5	2.5	8/0
					8 C	C II	5035.943 ?	8.0	2Po 2p3	2D 2s.2p.(3Po).3p	0.5	1.5	2/1
5041.022.......	44.7	0.0751	0.0725	199.7	4 A	Si II	5041.024	0.1	2Po 3s2.(1S).4p	2D 3s2.(1S).4d	0.5	1.5	2/0
5045.095.......	18.1	0.0300	0.0289	112.9	2 A	O II	5045.119 ?	1.4	2[4] 2s2.2p2.(3P<2>).5g	2[4]o 2s2.2p2.(1D).5f.G	****	4.5	...
					3 B	N II	5045.099	0.2	3Po 2s2.2p.(2Po).3s	3S 2s2.2p.(2Po).3p	2.0	1.0	1/0
5047.741.......	23.1	0.1958	0.1887	167.0	1 A	He I	5047.738	−0.2	1Po 1s.2p	1S 1s.4s	1.0	0.0	0/0
5056.067.......	51.6	0.1247	0.1200	323.6	5 B	Si II	5055.984	−4.9	2Po 3s2.(1S).4p	2D 3s2.(1S).4d	1.5	2.5	2/0
					8	Si II	5056.316 ?	14.8	2Po 3s2.(1S).4p	2D 3s2.(1S).4d	1.5	1.5	2/0
5080.619.......	43.0	0.0015	0.0014	7.1	...	...	...	...	...	...	...	...	...
5099.390.......	49.2	0.0009	0.0009	7.7	...	...	...	...	...	...	...	...	...
5121.850.......	20.8	0.0282	0.0268	103.7	1 A	C II	5121.828	−1.3	2Po 2s2.4p	2P 2s.2p.(3Po).3p	1.5	1.5	3/2
5125.232.......	14.9	0.0061	0.0058	29.6	1 A	C II	5125.208	−1.4	2Po 2s2.4p	2P 2s.2p.(3Po).3p	0.5	0.5	3/2
5126.960.......	16.9	0.0032	0.0030	12.7	1 A	C II	5126.963	0.2	2Po 2s2.4p	2P 2s.2p.(3Po).3p	1.5	0.5	3/2
5131.705.......	57.3	0.0173	0.0164	47.1	...	...	...	...	...	...	...	...	...
5133.114.......	39.5	0.0047	0.0044	14.9	6 B	C II	5132.947	−9.8	4Po 2s.2p.(3Po).3s	4P 2s.2p.(3Po).3p	0.5	1.5	6/0
					8 D	C II	5133.282	9.8	4Po 2s.2p.(3Po).3s	4P 2s.2p.(3Po).3p	1.5	2.5	4/0
5143.424.......	51.8	0.0100	0.0095	19.6	3 A	[Fe III]	5143.290 ?	−7.8	3D 3d6	3F2 3d6	3.0	3.0	4/1
					5 B	C II	5143.494:	4.1	4Po 2s.2p.(3Po).3s	4P 2s.2p.(3Po).3p	1.5	0.5	6/1
5145.165.......	14.8	0.0042	0.0040	12.3	3 B	C II	5145.165	0.0	4Po 2s.2p.(3Po).3s	4P 2s.2p.(3Po).3p	2.5	2.5	3/1
5146.692.......	54.1	0.0297	0.0281	90.1	8	O I	5146.462 ?	−13.4	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).9s	1.0	1.0	2/0
					4 B	O I	5146.610 ?	−4.8	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).9s	2.0	1.0	1/0
					4 B	O I	5146.652 ?	−2.3	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).9s	0.0	1.0	2/0
					3 A	O I	5146.700 ?	0.5	1F 2s2.2p3.(2Do).3p	1Do 2s2.2p3.(2Do<3/2>).7s	3.0	2.0	0/0
5151.117.......	20.5	0.0049	0.0046	16.4	2 A	C II	5151.085	−1.9	4Po 2s.2p.(3Po).3s	4P 2s.2p.(3Po).3p	2.5	1.5	4/2
5158.858.......	53.3	0.0108	0.0102	36.2	1 A	[Fe II]	5158.777	−4.7	a4F 3d7	a4H 3d6.(3H).4s	4.5	6.5	2/1

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
5167.180.......	40.6	0.0052	0.0049	9.9	5 A	O I	5167.300:	6.9	1D 2s2.2p3.(2Po).3p	1Po 2s2.2p3.(2Po).8s	2.0	1.0	0/0
5172.786.......	56.4	0.0052	0.0049	99999.0	6 A	[Fe III]	5172.640:	−8.5	3D 3d6	3F2 3d6	3.0	2.0	4/1
					*	N II	5172.973 ?	10.8	5Do 2s.2p2.(4P).3p	5F 2s.2p2.(4P).3d	0.0	1.0	*/0
5173.564.......	30.7	0.0048	0.0045	99999.0	8 D	N II	5173.385 ?	−10.4	5Do 2s.2p2.(4P).3p	5F 2s.2p2.(4P).3d	2.0	3.0	8/0
5175.862.......	14.0	0.0019	0.0018	8.1	5 C	N II	5175.889:	1.6	5Do 2s.2p2.(4P).3p	5F 2s.2p2.(4P).3d	3.0	4.0	5/1
5179.521.......	18.6	0.0036	0.0033	18.4	7	N II	5179.344:	−10.2	5Po 2s.2p2.(4P).3p	5D 2s.2p2.(4P).3d	3.0	4.0	2/0
					2 A	N II	5179.520	−0.1	5Do 2s.2p2.(4P).3p	5F 2s.2p2.(4P).3d	4.0	5.0	2/1
5183.806.......	45.7	0.0053	0.0050	29.0	...	...	...	...	...	...	...	...	...
5191.702.......	18.8	0.0411	0.0386	186.5	5 A	[Ar III]	5191.820	6.8	1D 3s2.3p4	1S 3s2.3p4	2.0	0.0	0/0
5198.012.......	53.5	0.2145	0.2011	238.0	1 A	[N I]	5197.901	−6.4	4So 2s2.2p3	2Do 2s2.2p3	1.5	1.5	1/1
5200.329.......	53.2	0.1252	0.1173	238.8	0 A	[N I]	5200.257	−4.1	4So 2s2.2p3	2Do 2s2.2p3	1.5	2.5	1/1
5217.986.......	17.8	0.0011	0.0010	9.3	...	...	...	...	...	...	...	...	...
5258.999.......	24.3	0.0034	0.0031	7.6	4 B	C II	5259.055	3.2	4Fo 2s.2p.(3Po).3d	4D 2s.2p.(3Po).4p	3.5	2.5	5/1
5259.664.......	28.9	0.0034	0.0032	7.2	3 A	C II	5259.664	0.0	4Fo 2s.2p.(3Po).3d	4D 2s.2p.(3Po).4p	1.5	0.5	8/1
					5 C	C II	5259.758	5.3	4Fo 2s.2p.(3Po).3d	4D 2s.2p.(3Po).4p	2.5	1.5	8/1
5261.726.......	49.0	0.0067	0.0062	25.6	3 A	[Fe II]	5261.621	−6.0	a4F 3d7	a4H 3d6.(3H).4s	3.5	5.5	5/1
5270.562.......	30.7	0.0163	0.0151	53.9	6 B	[Fe III]	5270.400:	−9.2	5D 3d6	3P4 3d6	3.0	2.0	2/0
5273.346.......	49.8	0.0019	0.0018	8.1	4 A	[Fe II]	5273.346	0.0	a4F 3d7	b4P 3d6.(3P4).4s	4.5	2.5	2/0
5275.155.......	58.6	0.0201	0.0186	41.0	3 A	O I	5275.123	−1.8	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).7d	2.0	****	1/0
					5 B	O I	5275.167	0.7	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).7d	0.0	****	2/0
5284.920.......	26.9	0.0020	0.0019	5.6	...	...	...	...	...	...	...	...	...
5299.059.......	53.3	0.0402	0.0371	180.2	9	O I	5298.887 ?	−9.7	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).8s	1.0	1.0	2/0
					4 A	O I	5299.044	−0.8	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).8s	2.0	1.0	1/0
					6 C	O I	5299.088	1.7	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).8s	0.0	1.0	2/0
5330.516.......	33.1	0.0025	0.0023	8.2	8 D	O I	5330.726 ?	11.8	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).5d	3.0	2.0	5/0
					8 D	O I	5330.735 ?	12.3	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).5d	3.0	3.0	4/0
					8 D	O I	5330.741 ?	12.7	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).5d	3.0	4.0	2/0
5332.771.......	19.5	0.0061	0.0056	20.8	5 A	C II	5332.889	6.6	2Po 2s2.4p	2S 2s2.6s	0.5	0.5	1/1
5334.647.......	20.7	0.0069	0.0063	42.4	5 A	C II	5334.789	8.0	2Po 2s2.4p	2S 2s2.6s	1.5	0.5	1/1
5342.392.......	18.4	0.0302	0.0277	153.2	4 A	C II	5342.370	−1.2	2Fo 2s2.4f	2G 2s2.7g	****	****	...
5345.943.......	16.3	0.0038	0.0035	20.5	...	...	...	...	...	...	...	...	...
5368.205.......	20.7	0.0063	0.0057	27.9	6 D	C II	5368.340:	7.5	2D 2s2.4d	2Po 2s2.7p	1.5	1.5	2/0
					8	C II	5368.460 ?	14.2	2D 2s2.4d	2Po 2s2.7p	1.5	0.5	2/0
5374.845.......	14.8	0.0015	0.0014	7.3	...	...	...	...	...	...	...	...	...
5376.691.......	70.0	0.0058	0.0053	9.1	6 B	[Fe II]	5376.452:	−13.3	a4F 3d7	a4H 3d6.(3H).4s	1.5	3.5	9/0
5380.882.......	78.3	0.0079	0.0072	13.6	8	O II	5380.640 ?	−13.5	4F 2s2.2p2.(3P).4d	4Do 2s2.2p2.(3P).7p	2.5	3.5	5/0
5400.553.......	50.4	0.0031	0.0029	9.6	...	...	...	...	...	...	...	...	...
5412.255.......	16.2	0.0006	0.0006	11.2	7 A	[Fe III]	5411.980:	−15.2	5D 3d6	3P4 3d6	1.0	2.0	5/0
5432.799.......	24.8	0.0021	0.0019	12.9	7 A	[Fe II]	5433.129:	18.3	a4F 3d7	b4P 3d6.(3P4).4s	3.5	2.5	4/0
					...	S II	5432.797	−0.1	4P 3s2.3p2.(3P).4s	4Do 3s2.3p2.(3P).4p	1.5	2.5	...
5452.063.......	20.2	0.0046	0.0042	25.9	3 A	N II	5452.071	0.4	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	0.0	1.0	5/4
5454.035.......	43.2	0.0092	0.0083	46.8	8	S II	5453.855 ?	−9.9	4P 3s2.3p2.(3P).4s	4Do 3s2.3p2.(3P).4p	2.5	3.5	2/0
					8	N II	5454.215 ?	9.9	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	0.0	5/0
5462.568.......	26.2	0.0050	0.0045	36.4	2 A	N II	5462.581	0.7	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	1.0	5/4
5463.566.......	45.1	0.0018	0.0016	9.5	...	...	...	...	...	...	...	...	...
5473.624.......	42.0	0.0023	0.0021	17.3	3 B	S II	5473.614	−0.6	4P 3s2.3p2.(3P).4s	4Do 3s2.3p2.(3P).4p	0.5	0.5	7/1
5478.087.......	16.6	0.0033	0.0030	19.6	2 A	N II	5478.086	−0.1	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	1.0	2.0	4/4

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta) = 100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta) = 100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
5480.050.......	17.0	0.0062	0.0056	34.9	1 A	N II	5480.050	0.0	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	2.0	1.0	4/3
5495.655.......	19.1	0.0165	0.0148	87.5	3 A	N II	5495.655	0.0	3P 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).3d	2.0	2.0	3/3
					7 C	[Fe II]	5495.824:	9.2	a4F 3d7	a2D2 3d7	1.5	1.5	4/0
5512.790.......	60.9	0.0350	0.0313	95.3	8	O I	5512.602	−10.2	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).6d	1.0	****	2/0
					3 A	O I	5512.772	−1.0	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).6d	2.0	****	1/0
					5 B	O I	5512.820	1.6	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).6d	0.0	****	2/0
5517.686.......	24.3	0.2038	0.1819	313.3	2 A	[Cl III]	5517.720	1.9	4So 3s2.3p3	2Do 3s2.3p3	1.5	2.5	1/1
5526.212.......	25.8	0.0017	0.0015	7.1	2 A	N II	5526.234	1.2	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	1.0	2.0	7/5
					2 A	S II	5526.243 ?	1.7	4F 3s2.3p2.(3P).3d	4Do 3s2.3p2.(3P).4p	3.5	3.5	4/2
5530.215.......	19.2	0.0023	0.0021	10.8	2 A	N II	5530.242	1.5	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	2.0	3.0	5/3
5535.359.......	16.9	0.0056	0.0050	26.4	1 A	N II	5535.347	−0.6	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	3.0	4.0	2/2
					3 C	C II	5535.353	−0.3	2S 2s2.4s	2Po 2s2.5p	0.5	1.5	1/0
					2 B	N II	5535.384	1.3	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	1.0	1.0	8/4
5537.853.......	36.1	0.4000	0.3560	216.6	3 A	[Cl III]	5537.890	2.0	4So 3s2.3p3	2Do 3s2.3p3	1.5	1.5	1/1
5543.517.......	27.6	0.0050	0.0045	15.3	1 A	N II	5543.471	−2.5	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	2.0	2.0	7/4
5545.933.......	18.8	0.0017	0.0015	10.7	4 A	[Fe II]	5545.900 ?	−1.8	a4D 3d6.(5D).4s	a4G 3d6.(3G).4s	3.5	3.5	6/0
5547.994.......	36.1	0.0024	0.0022	7.7	...	...	...	...	...	...	...	...	...
5551.930.......	12.0	0.0007	0.0006	7.5	2 A	N II	5551.922	−0.4	5P 2s.2p2.(4P).3s	5Do 2s.2p2.(4P).3p	3.0	3.0	4/2
5554.983.......	56.0	0.0179	0.0159	84.5	7	O I	5554.832	−8.1	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).7s	1.0	1.0	2/0
					4 B	O I	5555.004	1.2	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).7s	2.0	1.0	1/0
					7	O I	5555.053	3.8	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).7s	0.0	1.0	2/0
5567.469.......	19.8	0.0013	0.0012	7.2	...	...	...	...	...	...	...	...	...
5577.389.......	48.6	0.0297	0.0263	143.2	1 A	[O I]	5577.339	−2.7	1D 2s2.2p4	1S 2s2.2p4	2.0	0.0	0/0
5587.863.......	10.7	0.0013	0.0011	8.9	...	...	...	...	...	...	...	...	...
5595.511.......	35.5	0.0015	0.0014	8.7	7	Fe III	5595.329:	−9.8	5Fo 3d5.(4D).5p	5F 3d5.(4G).5d	1.0	2.0	*/1
5606.134.......	34.0	0.0015	0.0013	10.4	7 A	[Fe II]	5606.246:	6.0	a4D 3d6.(5D).4s	b2P 3d6.(3P4).4s	3.5	1.5	2/0
					...	S II	5606.151	0.9	4F 3s2.3p2.(3P).3d	4Do 3s2.3p2.(3P).4p	4.5	3.5	...
5627.804.......	22.0	0.0021	0.0018	14.8	4 A	N II	5627.760	−2.4	3P 2s2.2p.(2Po).4p	3Po 2s2.2p.(2Po).5d	0.0	1.0	5/0
5640.188.......	24.4	0.0023	0.0020	10.5	6	S II	5640.345:	8.4	4F 3s2.3p2.(3P).3d	4Do 3s2.3p2.(3P).4p	3.5	2.5	5/0
5648.066.......	24.5	0.0016	0.0014	10.1	4 A	C II	5648.070	0.2	4Po 2s.2p.(3Po).3s	4S 2s.2p.(3Po).3p	1.5	1.5	2/0
					5 B	N II	5648.137:	3.8	3P 2s2.2p.(2Po).4p	3Po 2s2.2p.(2Po).5d	1.0	2.0	4/0
5662.337.......	27.3	0.0029	0.0025	8.3	...	...	...	...	...	...	...	...	...
5664.519.......	20.5	0.0017	0.0015	4.5	7 D	S II	5664.773:	13.4	4F 3s2.3p2.(3P).3d	4Do 3s2.3p2.(3P).4p	1.5	0.5	8/1
5666.630.......	17.1	0.0473	0.0414	176.9	1 A	N II	5666.629	−0.1	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	1.0	2.0	5/5
5676.023.......	17.6	0.0225	0.0197	123.4	1 A	N II	5676.017	−0.3	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	0.0	1.0	5/5
5679.552.......	20.7	0.0771	0.0674	170.8	2 A	N II	5679.558	0.3	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	2.0	3.0	2/2
5686.199.......	18.5	0.0145	0.0127	70.1	2 A	N II	5686.212	0.7	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	1.0	1.0	5/5
5705.318.......	24.2	0.0020	0.0017	9.5	4 B	N II	5705.316	−0.1	3P 2s.2p2.(4P).3s	3Do 2s.2p2.(4P).3p	1.0	1.0	5/0
5708.910.......	43.1	0.0022	0.0019	3.7	...	...	...	...	...	...	...	...	...
5710.763.......	18.7	0.0156	0.0136	75.9	1 A	N II	5710.766	0.2	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	2.0	2.0	4/4
5711.604.......	30.6	0.0009	0.0008	99999.0	*	Fe III	5711.414 ?	−10.0	5Fo 3d5.(4D).5p	5F 3d5.(4G).5d	5.0	5.0	3/0
					8 D	S II	5711.450 ?	−8.1	4Po 3s2.3p2.(3P).5p	4P 3s2.3p2.(3P).6d	1.5	0.5	6/0
					9	Fe I	5711.849 ?	12.8	y5Fo 3d7.(4F).4p	g5D 3d6.4s.(4D).5s	2.0	2.0	*/1
5724.956.......	32.9	0.0029	0.0025	10.9	9 D	N II	5724.752 ?	−10.7	3D 2s2.2p.(2Po).4p	3Fo 2s2.2p.(2Po).5d	3.0	2.0	4/0
5730.637.......	17.5	0.0015	0.0013	8.9	2 A	N II	5730.656	1.0	3Po 2s2.2p.(2Po).3s	3D 2s2.2p.(2Po).3p	2.0	1.0	4/4
5739.757.......	18.7	0.0045	0.0039	21.8	2 A	Si III	5739.734	−1.2	1S 3s.4s	1Po 3s.4p	0.0	1.0	0/0
5744.476.......	46.3	0.0080	0.0069	20.4	...	...	...	...	...	...	...	...	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
5747.287.......	17.1	0.0038	0.0033	29.3	7 B	[Fe II]	5746.966:	−16.7	a4D 3d6.(5D).4s	b2P 3d6.(3P4).4s	2.5	1.5	2/0
					3 A	O II	5747.330	2.2	2Do 2s2.2p2.(3P).4p	2F 2s2.2p2.(3P).5d	2.5	3.5	0/0
5754.629.......	47.5	3.1908	2.7615	1907.0	2 A	[N II]	5754.644	0.8	1D 2s2.2p2	1S 2s2.2p2	2.0	0.0	0/0
5759.785.......	48.3	0.0023	0.0020	7.0	...	...	...	...	...	...	...	...	...
5764.485.......	59.9	0.0030	0.0026	16.2	6 B	S II	5764.596 ?	5.8	4Po 3s2.3p2.(3P).5p	4P 3s2.3p2.(3P).6d	0.5	1.5	6/0
5766.223.......	25.1	0.0025	0.0022	10.4	...	...	...	...	...	...	...	...	...
5767.459.......	15.4	0.0015	0.0013	9.5	5 A	S II	5767.416:	−2.2	4Do 3s2.3p2.(3P).5p	4P 3s2.3p2.(3P).6d	3.5	2.5	2/0
					6 B	[Fe II]	5767.539:	4.1	b4P 3d6.(3P4).4s	c2D 3d6.(1D4).4s	2.5	2.5	3/0
5790.942.......	13.5	0.0012	0.0011	4.4	...	...	...	...	...	...	...	...	...
5793.201.......	16.7	0.0014	0.0012	4.9	6 B	C II	5793.300:	5.1	4Fo 2s.2p.(3Po).4d	4G 2s.2p.(3Po).6f	1.5	2.5	8/0
5826.540.......	43.9	0.0022	0.0019	9.3	7 C	S II	5826.360:	−9.3	4Do 3s2.3p2.(3P).5p	4P 3s2.3p2.(3P).7s	1.5	2.5	5/0
5832.961.......	18.6	0.0033	0.0028	15.8	...	...	...	...	...	...	...	...	...
5846.704.......	20.6	0.0150	0.0129	75.2	...	...	...	...	...	...	...	...	...
5852.354.......	37.1	0.0031	0.0027	10.0	...	...	...	...	...	...	...	...	...
5855.143.......	61.6	0.0049	0.0042	12.3	...	...	...	...	...	...	...	...	...
5859.582.......	26.0	0.0015	0.0013	9.8	...	...	...	...	...	...	...	...	...
5867.726.......	16.4	0.0041	0.0035	22.3	6 D	Al II	5867.640:	−4.4	3D 3s.4d	3Fo 3s.6f	3.0	2.0	4/0
					7	Al II	5867.780:	2.7	3D 3s.4d	3Fo 3s.6f	2.0	2.0	5/0
					9	Al II	5867.890 ?	8.4	3D 3s.4d	3Fo 3s.6f	1.0	2.0	5/0
5875.650.......	25.9	16.0305	13.6746	5395.0	4 A	He I	5875.615	−1.8	3Po 1s.2p	3D 1s.3d	2.0	3.0	2/0
5879.032.......	23.3	0.0023	0.0020	8.5	3 A	N II	5879.080 ?	2.4	3Fo 2s2.2p.(2Po).4d	2[5/2] 2s2.2p.(2Po<3/2>).6f.D	2.0	2.0	...
5889.960.......	44.8	0.0931	0.0793	301.5	7	C II	5889.780:	−9.2	2D 2s2.3d	2Po 2s2.4p	2.5	1.5	2/0
					4 B	Na I	5889.951	−0.4	2S 3s	2Po 3p	0.5	1.5	1/0
5891.565.......	18.6	0.0213	0.0181	99.2	5 A	C II	5891.600:	1.8	2D 2s2.3d	2Po 2s2.4p	1.5	0.5	2/0
5896.024.......	35.6	0.0405	0.0344	134.2	5 C	Na I	5895.924:	−5.1	2S 3s	2Po 3p	0.5	0.5	1/0
5915.611.......	56.5	0.0040	0.0034	16.0	...	...	...	...	...	...	...	...	...
5927.802.......	17.4	0.0225	0.0191	113.8	2 A	N II	5927.820	0.9	3P 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	0.0	1.0	5/4
5931.773.......	16.7	0.0322	0.0273	156.7	2 A	N II	5931.790	0.9	3P 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	1.0	2.0	5/4
5940.264.......	18.2	0.0164	0.0139	63.0	1 A	N II	5940.240	−1.2	3P 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	1.0	1.0	5/4
5941.663.......	16.0	0.0372	0.0315	137.3	1 A	N II	5941.650	−0.7	3P 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	2.0	3.0	2/2
5944.925.......	10.0	0.0009	0.0008	6.2	3 A	N II	5944.960 ?	1.8	3Fo 2s2.2p.(2Po).4d	2[7/2] 2s2.2p.(2Po<3/2>).6f.G	4.0	3.0	...
5952.385.......	13.8	0.0061	0.0052	33.7	2 A	N II	5952.390	0.3	3P 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).3d	2.0	2.0	4/3
5957.653.......	34.0	0.0161	0.0136	99999.0	2 A	Si II	5957.560	−4.7	2Po 3s2.(1S).4p	2S 3s2.(1S).5s	0.5	0.5	1/1
5958.625.......	56.2	0.0563	0.0475	99999.0	8	O I	5958.385	−12.1	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).5d	1.0	****	2/0
					3 A	O I	5958.584	−2.1	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).5d	2.0	****	1/0
					5 C	O I	5958.640	0.8	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).5d	0.0	****	2/0
5979.018.......	49.5	0.0282	0.0238	182.4	2 A	Si II	5978.930	−4.4	2Po 3s2.(1S).4p	2S 3s2.(1S).5s	1.5	0.5	1/1
5991.093.......	20.0	0.0011	0.0009	6.2	4 A	C I	5990.980 ?	−5.6	3D 2s2.2p.(2Po).3p	3Do 2s2.2p.(2Po).5d	2.0	3.0	4/0
6013.010.......	35.7	0.0034	0.0028	13.4	8	C I	6013.160 ?	7.5	3D 2s2.2p.(2Po).3p	3Po 2s2.2p.(2Po).6s	3.0	2.0	2/0
					8	C I	6013.210 ?	10.0	3D 2s2.2p.(2Po).3p	3Fo 2s2.2p.(2Po).5d	3.0	4.0	2/0
6019.822.......	40.3	0.0046	0.0039	19.4	7	C I	6019.890 ?	3.4	3D 2s2.2p.(2Po).3p	3Fo 2s2.2p.(2Po).5d	2.0	2.0	5/0
6046.471.......	60.9	0.1053	0.0881	153.2	8	O I	6046.233 ?	−11.8	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).6s	1.0	1.0	2/0
					3 A	O I	6046.438	−1.6	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).6s	2.0	1.0	1/0
					5 B	O I	6046.495	1.2	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).6s	0.0	1.0	2/0
6074.324.......	19.0	0.0019	0.0015	12.0	3A	Ne I	6074.338	0.7	3/2[3/2]o 2p5.(2Po<3/2>).3s	3/2[1/2] 2p5.(2Po<3/2>).3p	1	0	...
6096.195.......	20.7	0.0017	0.0014	12.7	4 A	[Fe III]	6096.300 ?	5.2	3P4 3d6	1D4 3d6	2.0	2.0	1/0
					9 C	N II	6096.320	6.2	3Do 2s.2p2.(4P).3p	3F 2s.2p2.(4P).3d	3.0	4.0	2/0

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta) = 100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta) = 100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
6098.538.......	21.5	0.0014	0.0011	9.0	4 A	C II	6098.510	−1.4	2P 2s.2p.(3Po).3p	2Do 2s.2p.(3Po).3d	1.5	2.5	2/0
6130.475.......	41.7	0.0034	0.0028	11.2	...	...	...	...	...	...	...	...	...
6147.234.......	17.7	0.0023	0.0019	12.1	...	...	...	...	...	...	...	...	...
6151.336.......	26.7	0.0306	0.0253	127.3	3 A	C II	6151.270	−3.2	2D 2s2.4d	2Fo 2s2.6f	1.5	****	1/0
					7 D	C II	6151.540	10.0	2D 2s2.4d	2Fo 2s2.6f	2.5	****	1/0
6154.406.......	24.5	0.0040	0.0033	21.5	...	...	...	...	...	...	...	...	...
6155.983.......	18.9	0.0021	0.0018	7.0	1 A	O I	6155.961	−1.1	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	1.0	0.0	8/5
					1 A	O I	6155.970	−0.6	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	1.0	1.0	8/4
					1 A	O I	6155.989	0.3	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	1.0	2.0	7/4
6156.785.......	29.2	0.0043	0.0036	19.9	1 A	O I	6156.737	−2.4	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	2.0	1.0	8/6
					1 A	O I	6156.778	−0.4	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	2.0	3.0	5/3
6158.143.......	35.3	0.0051	0.0042	19.9	1 A	O I	6158.150	0.3	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	3.0	2.0	5/3
					2 B	O I	6158.172	1.4	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	3.0	3.0	4/2
					3 C	O I	6158.188	2.2	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).4d	3.0	4.0	2/1
6161.778.......	41.1	0.0048	0.0039	21.1	5 B	[Cl II]	6161.830:	2.5	1D 3s2.3p4	1S 3s2.3p4	2.0	0.0	0/0
6167.678.......	36.4	0.0030	0.0025	15.0	6 D	N II	6167.750:	3.5	3Fo 2s2.2p.(2Po).3d	3D 2s2.2p.(2Po).4p	4.0	3.0	2/0
6170.170.......	15.5	0.0011	0.0009	8.7	1 A	N II	6170.160	−0.5	3Fo 2s2.2p.(2Po).3d	3D 2s2.2p.(2Po).4p	2.0	1.0	5/2
6173.331.......	13.6	0.0027	0.0023	20.1	1 A	N II	6173.310	−1.0	3Fo 2s2.2p.(2Po).3d	3D 2s2.2p.(2Po).4p	3.0	2.0	5/2
6176.066.......	15.0	0.0014	0.0012	8.2	2 A	N II	6176.050 ?	−0.8	3Do 2s2.2p.(2Po).4d	2[7/2] 2s2.2p.(2Po<1/2>).6f.F	3.0	3.0	...
6250.704.......	14.6	0.0018	0.0015	15.6	5 B	C II	6250.760:	2.7	2Do 2s.2p.(3Po).3d	2P 2s.2p.(3Po).4p	2.5	1.5	2/0
6257.117.......	19.9	0.0063	0.0052	99999.0	4 A	C II	6257.180	3.0	2Po 2s2.4p	2D 2s2.5d	0.5	1.5	2/1
6259.482.......	17.8	0.0102	0.0084	63.7	4 A	C II	6259.560	3.7	2Po 2s2.4p	2D 2s2.5d	1.5	2.5	2/1
6300.405.......	56.2	2.6718	2.1753	1977.0	0 A	[O I]	6300.304	−4.8	3P 2s2.2p4	1D 2s2.2p4	2.0	2.0	1/1
6312.107.......	23.6	1.0534	0.8566	590.2	1 A	[S III]	6312.100	−0.3	1D 3s2.3p2	1S 3s2.3p2	2.0	0.0	0/0
6325.191.......	22.2	0.0032	0.0026	8.7	7 A	[Fe II]	6325.501:	14.7	b4P 3d6.(3P4).4s	c2D 3d6.(1D4).4s	0.5	1.5	4/0
6332.889.......	19.5	0.0047	0.0038	21.1	...	...	...	...	...	...	2	2	...
6334.480.......	22.0	0.0032	0.0026	14.4	2A	Ne I	6334.429	−2.4	3/2[3/2]o 2p5.(2Po<3/2>).3s	3/2[5/2] 2p5.(2Po<3/2>).3p	...	...	...
6347.193.......	47.7	0.0634	0.0513	83.3	2 A	Si II	6347.110	−3.9	2S 3s2.(1S).4s	2Po 3s2.(1S).4p	0.5	1.5	1/1
6363.886.......	56.7	0.9389	0.7594	485.2	0 A	[O I]	6363.777	−5.2	3P 2s2.2p4	1D 2s2.2p4	1.0	2.0	1/1
6371.418.......	31.0	0.0537	0.0434	198.3	1 A	Si II	6371.370	−2.3	2S 3s2.(1S).4s	2Po 3s2.(1S).4p	0.5	0.5	1/1
6379.649.......	25.5	0.0011	0.0009	10.7	3 A	O II	6379.584 ?	−3.1	2[3]o 2s2.2p2.(3P).4f.D	2[2] 2s2.2p2.(3P<2>).6g	2.5	****	...
6382.988.......	44.1	0.0024	0.0020	16.1	2A	Ne I	6382.992	0.2	3/2[3/2]o 2p5.(2Po<3/2>).3s	3/2[3/2] 2p5.(2Po<3/2>).3p	1	1	...
6392.496.......	17.6	0.0012	0.0009	6.2	7 A	[Fe II]	6392.698:	9.5	a2G 3d7	b4D 3d6.(3D).4s	4.5	3.5	3/0
					9 C	C II	6393.000 ?	23.6	4D 2s.2p.(3Po).4p	4Fo 2s.2p.(3Po).5d	2.5	2.5	7/0
6402.269.......	21.9	0.0133	0.0107	75.5	3 A	Ne I	6402.249 ?	−1.0	2[3/2]o 2p5.(2Po<3/2>).3s	2[5/2] 2p5.(2Po<3/2>).3p	2.0	3.0	...
6454.393.......	22.4	0.0013	0.0010	5.4	3 A	O I	6454.444	2.4	5P 2s2.2p3.(4So).3p	5So 2s2.2p3.(4So).5s	2.0	2.0	2/1
6455.997.......	19.3	0.0016	0.0013	8.7	2 A	O I	6455.977	−0.9	5P 2s2.2p3.(4So).3p	5So 2s2.2p3.(4So).5s	3.0	2.0	1/1
6461.848.......	18.6	0.0730	0.0584	93.5	6 C	C II	6461.950:	4.7	2Fo 2s2.4f	2G 2s2.6g	****	****	...
6527.257.......	29.3	0.0358	0.0285	70.6	0 A	[N II]	6527.240	−0.8	3P 2s2.2p2	1D 2s2.2p2	0.0	2.0	2/2
6548.096.......	39.8	67.5573	53.6007	10430.0	0 A	[N II]	6548.040	−2.6	3P 2s2.2p2	1D 2s2.2p2	1.0	2.0	1/1
6562.804.......	31.3	393.8931	312.0430	14100.0	3 A	H I	6562.800	−0.2	2 2*	3 3*	****	****	0/0
6578.050.......	18.3	0.6794	0.5374	870.5	2 A	C II	6578.050	0.0	2S 2s2.3s	2Po 2s2.3p	0.5	1.5	1/0
6583.467.......	40.2	206.1069	162.9287	11370.0	0 A	[N II]	6583.460	−0.3	3P 2s2.2p2	1D 2s2.2p2	2.0	2.0	1/1
6610.650.......	25.0	0.0035	0.0028	11.7	2 A	N II	6610.560	−4.1	1D 2s2.2p.(2Po).3p	1Fo 2s2.2p.(2Po).3d	2.0	3.0	0/0
6678.153.......	21.6	4.9466	3.8721	2346.0	2 A	He I	6678.152	0.0	1Po 1s.2p	1D 1s.3d	1.0	2.0	0/0
6699.344.......	20.1	0.0016	0.0013	7.7	...	He I	6699.315	−1.3	3S 1s.3s	3Po 1s.27p	****	****	...
6704.604.......	43.8	0.0026	0.0020	7.8	...	He I	6704.653	2.2	3S 1s.3s	3Po 1s.26p	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
6710.658.......	54.0	0.0030	0.0023	9.0	...	He I	6710.656	−0.1	3S 1s.3s	3Po 1s.25p	****	****	...
6716.523.......	52.0	2.6718	2.0831	1437.0	0 A	[S II]	6716.440	−3.7	4So 3s2.3p3	2Do 3s2.3p3	1.5	2.5	1/1
6723.459.......	22.3	0.0092	0.0071	99999.0	8	C II	6723.130	−14.7	2D 2s2.4d	2Po 2s2.6p	1.5	1.5	2/0
					6 C	C II	6723.320	−6.2	2D 2s2.4d	2Po 2s2.6p	1.5	0.5	2/0
					4 A	C II	6723.450	−0.4	2D 2s2.4d	2Po 2s2.6p	2.5	1.5	2/0
6724.226.......	18.0	0.0040	0.0031	99999.0	6 A	C II	6724.300	3.3	4Do 2s.2p.(3Po).4d	4D 2s.2p.(3Po).6p	1.5	0.5	9/0
					8 D	C II	6724.560 ?	14.9	4D 2s.2p.(3Po).3p	4Do 2s.2p.(3Po).3d	0.5	1.5	9/0
6725.248.......	17.2	0.0020	0.0015	99999.0	...	...	...	...	...	...	...	...	...
6730.893.......	52.7	5.6794	4.4215	2317.0	0 A	[S II]	6730.810	−3.7	4So 3s2.3p3	2Do 3s2.3p3	1.5	1.5	1/1
6744.386.......	52.3	0.0064	0.0050	27.0	...	He I	6744.098 ?	−12.8	3S 1s.3s	3Po 1s.21p	****	****	...
6755.955.......	18.2	0.0028	0.0022	16.5	...	He I	6755.847	−4.8	3S 1s.3s	3Po 1s.20p	****	****	...
6769.672.......	21.3	0.0033	0.0026	21.6	...	He I	6769.548	−5.5	3S 1s.3s	3Po 1s.19p	****	****	...
6779.954.......	17.9	0.0141	0.0109	99999.0	1 A	C II	6779.940	−0.6	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	1.5	2.5	5/4
6780.626.......	17.7	0.0071	0.0055	99999.0	0 A	C II	6780.600	−1.1	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	0.5	1.5	7/4
6783.937.......	19.1	0.0028	0.0022	12.4	4 A	C II	6783.910	−1.2	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	2.5	3.5	2/0
6785.783.......	20.8	0.0047	0.0037	25.9	...	He I	6785.676	−4.7	3S 1s.3s	3Po 1s.18p	****	****	...
6787.361.......	46.1	0.0095	0.0073	45.5	6 D	C II	6787.210:	−6.7	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	0.5	0.5	7/0
6791.466.......	19.2	0.0085	0.0066	51.5	1 A	C II	6791.470	0.2	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	1.5	1.5	7/4
6800.678.......	17.7	0.0065	0.0050	33.1	0 A	C II	6800.680	0.1	4Po 2s.2p.(3Po).3s	4D 2s.2p.(3Po).3p	2.5	2.5	4/3
6804.950.......	19.8	0.0043	0.0033	29.2	...	He I	6804.840	−4.9	3S 1s.3s	3Po 1s.17p	****	****	...
6809.953.......	24.6	0.0027	0.0021	12.6	4 A	N II	6809.970	0.8	3Po 2s2.2p.(2Po).3d	3S 2s2.2p.(2Po).4p	2.0	1.0	1/0
6821.403.......	22.5	0.0027	0.0021	13.9	3 A	N II	6821.410 ?	0.3	5Fo 2s.2p2.(4P).4f	5F 2s.2p2.(4P).6d	4.0	****	1/0
6826.875.......	21.1	0.0429	0.0331	99999.0	...	...	...	...	...	...	...	...	...
6829.900.......	16.6	0.0014	0.0010	3.4	7 A	[Fe II]	6830.033:	5.9	a4D 3d6.(5D).4s	a6S 3d5.4s2	1.5	2.5	3/0
6834.197.......	31.9	0.0021	0.0016	6.5	5 B	N II	6834.090:	−4.7	3Po 2s2.2p.(2Po).3d	3S 2s2.2p.(2Po).4p	1.0	1.0	2/0
6836.444.......	33.5	0.0014	0.0011	3.5	...	...	...	...	...	...	...	...	...
6856.005.......	20.0	0.0065	0.0050	46.7	2 A	He I	6855.883	−5.3	3S 1s.3s	3Po 1s.15p	1.0	****	0/0
6929.430.......	20.4	0.0024	0.0019	17.7	3A	Ne I	6929.468	1.6	1/2[1/2]o 2p5.(2Po<1/2>).3s	3/2[3/2] 2p5.(2Po<3/2>).3p	1	2	...
6930.769.......	18.0	0.0044	0.0034	25.8	...	...	...	...	...	...	...	...	...
6934.033.......	16.4	0.0095	0.0072	55.3	8 C	[Fe II]	6933.660 ?	−16.1	a4D 3d6.(5D).4s	b4F 3d6.(3F4).4s	2.5	3.5	5/0
					4 A	He I	6933.890	−6.2	3S 1s.3s	3Po 1s.13p	1.0	****	0/0
6989.531.......	21.9	0.0154	0.0117	72.5	1 A	He I	6989.450	−3.5	3S 1s.3s	3Po 1s.12p	1.0	****	0/0
7002.204.......	56.5	0.1122	0.0849	14.2	8	O I	7001.899	−13.1	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	1.0	1.0	5/0
					7	O I	7001.922	−12.1	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	1.0	2.0	5/0
					4 A	O I	7002.173	−1.3	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	2.0	1.0	4/0
					4 A	O I	7002.196	−0.4	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	2.0	2.0	4/0
					5 D	O I	7002.230	1.1	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	2.0	3.0	2/0
					5 D	O I	7002.250	2.0	3P 2s2.2p3.(4So).3p	3Do 2s2.2p3.(4So).4d	0.0	1.0	5/0
7032.469.......	24.2	0.0048	0.0036	29.9	2 A	Ne I	7032.413 ?	−2.4	2[3/2]o 2p5.(2Po<3/2>).3s	2[1/2] 2p5.(2Po<3/2>).3p	2.0	1.0	...
7050.047.......	53.3	0.0064	0.0048	38.5	...	...	...	...	...	...	...	...	...
7062.334.......	19.2	0.0163	0.0123	63.3	1 A	He I	7062.260	−3.2	3S 1s.3s	3Po 1s.11p	1.0	****	0/0
7065.228.......	27.3	9.3893	7.0593	3291.0	3 A	He I	7065.179	−2.1	3Po 1s.2p	3S 1s.3s	2.0	1.0	1/0
					4 B	He I	7065.217	−0.5	3Po 1s.2p	3S 1s.3s	1.0	1.0	2/0
7080.387.......	42.4	0.0058	0.0043	31.4	...	...	...	...	...	...	...	...	...
7099.927.......	63.0	0.0033	0.0024	14.7	...	...	...	...	...	...	...	...	...
7102.675.......	21.2	0.0037	0.0028	16.4	3 A	[Ni II]	7102.650 ?	−1.1	2F 3d8.(3F).4s	2P 3d8.(3P).4s	2.5	1.5	1/0
7112.965.......	35.4	0.0069	0.0052	34.6	5 B	C II	7113.040:	3.2	4D 2s.2p.(3Po).3p	4Fo 2s.2p.(3Po).3d	1.5	2.5	8/1

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
7115.642.......	21.1	0.0057	0.0043	30.8	3 B	C II	7115.630	−0.5	4D 2s.2p.(3Po).3p	4Fo 2s.2p.(3Po).3d	2.5	3.5	5/1
7120.052.......	42.1	0.0093	0.0070	41.5	8	C II	7119.760	−12.3	4D 2s.2p.(3Po).3p	4Fo 2s.2p.(3Po).3d	1.5	1.5	8/0
					5 B	C II	7119.910	−6.0	4D 2s.2p.(3Po).3p	4Fo 2s.2p.(3Po).3d	3.5	4.5	2/0
7135.744.......	28.9	11.0687	8.2608	2973.0	2 A	[Ar III]	7135.800	2.3	3P 3s2.3p4	1D 3s2.3p4	2.0	2.0	1/1
7155.557.......	27.9	0.0072	0.0054	99999.0	7 A	[Fe II]	7155.160:	−16.6	a4F 3d7	a2G 3d7	4.5	4.5	3/0
7156.637.......	20.9	0.0045	0.0034	99999.0	3 A	O I	7156.701 ?	2.7	1Do 2s2.2p3.(2Do).3s	1D 2s2.2p3.(2Do).3p	2.0	2.0	0/0
7160.559.......	21.3	0.0295	0.0219	141.7	2 A	He I	7160.580	0.9	3S 1s.3s	3Po 1s.10p	1.0	****	0/0
7231.329.......	23.6	0.2290	0.1692	255.3	3 A	C II	7231.340	0.4	2Po 2s2.3p	2D 2s2.3d	0.5	1.5	2/1
7236.414.......	21.1	0.6328	0.4673	99999.0	2 A	C II	7236.420	0.2	2Po 2s2.3p	2D 2s2.3d	1.5	2.5	2/1
7237.145.......	16.6	0.0663	0.0489	15.5	...	C II	7237.170	1.0	2Po 2s2.3p	2D 2s2.3d	1.5	1.5	...
7252.759.......	31.3	0.0182	0.0135	99999.0	4 A	O II	7252.717	−1.7	4P 2s2.2p2.(3P).3d	4Po 2s2.2p2.(3P).4p	1.5	0.5	6/0
7254.380.......	69.3	0.2122	0.1564	15.0	7 D	O I	7254.154	−9.3	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).5s	1.0	1.0	2/0
					4 B	O I	7254.448	2.8	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).5s	2.0	1.0	1/0
					7 D	O I	7254.531	6.2	3P 2s2.2p3.(4So).3p	3So 2s2.2p3.(4So).5s	0.0	1.0	2/0
7281.348.......	26.1	1.0763	0.7911	323.1	2 A	He I	7281.351	0.1	1Po 1s.2p	1S 1s.3s	1.0	0.0	0/0
7291.573.......	34.6	0.0168	0.0123	77.8	2 A	[Ca II]	7291.470 ?	−4.2	2S 3p6.(1S).4s	2D 3p6.(1S).3d	0.5	2.5	1/0
7298.019.......	24.3	0.0288	0.0211	116.9	2 A	He I	7298.030	0.4	3S 1s.3s	3Po 1s.9p	1.0	****	0/0
7319.087.......	34.7	5.0382	3.6886	2161.0	4 A	[O II]	7318.920	−6.8	2Do 2s2.2p3	2Po 2s2.2p3	2.5	0.5	3/1
7320.135.......	27.4	13.7405	10.0586	6483.0	4 A	[O II]	7319.990	−5.9	2Do 2s2.2p3	2Po 2s2.2p3	2.5	1.5	2/0
7329.679.......	28.9	8.0153	5.8617	3856.0	1 A	[O II]	7329.660	−0.8	2Do 2s2.2p3	2Po 2s2.2p3	1.5	0.5	2/1
7330.754.......	27.3	7.7099	5.6377	3856.0	1 A	[O II]	7330.730	−1.0	2Do 2s2.2p3	2Po 2s2.2p3	1.5	1.5	2/1
7378.035.......	66.3	0.0067	0.0049	21.5	3 A	[Ni II]	7377.830	−8.3	2D 3d9	2F 3d8.(3F).4s	2.5	3.5	1/0
7391.385.......	36.1	0.0018	0.0013	99999.0	...	...	...	...	...	...	...	...	...
7423.733.......	58.3	0.0215	0.0156	119.4	1 A	N I	7423.641	−3.7	4P 2s2.2p2.(3P).3s	4So 2s2.2p2.(3P).3p	0.5	1.5	2/2
7442.351.......	57.7	0.0502	0.0363	219.9	1 A	N I	7442.298	−2.1	4P 2s2.2p2.(3P).3s	4So 2s2.2p2.(3P).3p	1.5	1.5	2/2
7452.706.......	58.8	0.0041	0.0029	16.4	4 A	[Fe II]	7452.540	−6.7	a4F 3d7	a2G 3d7	3.5	4.5	4/0
7459.251.......	21.1	0.0065	0.0047	26.7	...	...	...	...	...	...	...	...	...
7468.457.......	59.2	0.0809	0.0583	99999.0	3 A	N I	7468.312	−5.8	4P 2s2.2p2.(3P).3s	4So 2s2.2p2.(3P).3p	2.5	1.5	1/1
7469.554.......	21.5	0.0114	0.0082	99999.0	2 A	O II	7469.530 ?	−1.0	2G 2s2.2p2.(1D).3d	2[3]o 2s2.2p2.(3P).5f.F	4.5	3.5	...
7499.977.......	21.7	0.0587	0.0422	38.7	2 A	He I	7499.846	−5.2	3S 1s.3s	3Po 1s.8p	****	****	...
7505.008.......	17.5	0.0066	0.0048	45.9	6 B	O II	7504.960 ?	−1.9	2G 2s2.2p2.(1D).3d	2[5] 2s2.2p2.(3P).5f.G	3.5	4.5	...
					6 C	C II	7505.260 ?	10.1	2Po 2s2.5p	2D 2s.2p.(3Po).3p	1.5	2.5	2/1
7505.392.......	47.3	0.0311	0.0224	122.7	5 A	C II	7505.260 ?	−5.3	2Po 2s2.5p	2D 2s.2p.(3Po).3p	1.5	2.5	2/0
7507.456.......	43.2	0.0169	0.0122	41.5	5 A	[Ni I]	7507.380 ?	−3.0	3D 3d9.(2D).4s	1D 3d8.(1D).4s2	3.0	2.0	1/0
7509.767.......	16.6	0.0046	0.0033	23.9	...	...	...	...	...	...	...	...	...
7513.379.......	43.5	0.0076	0.0055	15.7	...	He I	7513.340 ?	−1.6	1S 1s.3s	1Po 1s.28p	****	****	...
7519.431.......	19.0	0.0144	0.0103	128.2	2 A	C II	7519.490	2.4	2Po 2p3	2P 2s.2p.(3Po).3p	1.5	1.5	3/2
					...	He I	7519.299 ?	−5.3	1S 1s.3s	1Po 1s.27p	****	****	...
7519.948.......	17.3	0.0129	0.0092	128.2	3 A	C II	7519.930	−0.7	2Po 2p3	2P 2s.2p.(3Po).3p	0.5	0.5	3/1
					5	C II	7520.200:	10.1	2Po 2s2.5p	2D 2s.2p.(3Po).3p	0.5	1.5	2/2
7524.101.......	17.8	0.0014	0.0010	7.5	4 A	C II	7524.370	10.7	2Po 2s2.5p	2D 2s.2p.(3Po).3p	1.5	1.5	2/2
7525.791.......	45.6	0.0020	0.0015	8.6	...	He I	7525.969	7.1	1S 1s.3s	1Po 1s.26p	****	****	...
7530.460.......	35.9	0.0053	0.0038	19.0	6 A	C II	7530.570:	4.4	2Po 2p3	2P 2s.2p.(3Po).3p	1.5	0.5	3/1
7533.509.......	42.8	0.0037	0.0026	10.0	...	He I	7533.469	−1.6	1S 1s.3s	1Po 1s.25p	****	****	...
7542.126.......	44.1	0.0079	0.0057	36.6	...	He I	7541.944 ?	−7.2	1S 1s.3s	1Po 1s.24p	****	****	...
7551.525.......	42.1	0.0033	0.0024	18.2	...	He I	7551.571	1.8	1S 1s.3s	1Po 1s.23p	****	****	...
7562.471.......	31.9	0.0042	0.0030	17.2	...	He I	7562.569	3.9	1S 1s.3s	1Po 1s.22p	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
7569.057.......	40.5	0.0022	0.0015	99999.0	...	...	...	...	...	...	...	...	...
7574.071.......	15.3	0.0051	0.0036	40.7	...	...	...	...	...	...	...	...	...
7575.264.......	41.1	0.0036	0.0026	9.4	...	He I	7575.214	2.0	1S 1s.3s	1Po 1s.21p	****	****	...
7589.851.......	33.1	0.0047	0.0033	20.2	...	He I	7589.854	0.1	1S 1s.3s	1Po 1s.20p	****	****	...
7679.594.......	28.4	0.0036	0.0025	37.7	...	He I	7679.627	1.3	1S 1s.3s	1Po 1s.16p	****	****	...
7751.074.......	28.3	3.1374	2.1967	1789.0	1 A	[Ar III]	7751.100	1.0	3P 3s2.3p4	1D 3s2.3p4	1.0	2.0	1/1
7757.635.......	23.2	0.0096	0.0067	99999.0	1 A	He I	7757.620	−0.6	1S 1s.3s	1Po 1s.14p	0.0	1.0	0/0
7771.921.......	38.4	0.0504	0.0352	157.4	2 A	O I	7771.944	0.9	5So 2s2.2p3.(4So).3s	5P 2s2.2p3.(4So).3p	2.0	3.0	1/1
7774.170.......	27.1	0.0308	0.0215	148.9	1 A	O I	7774.166	−0.2	5So 2s2.2p3.(4So).3s	5P 2s2.2p3.(4So).3p	2.0	2.0	2/2
7775.372.......	28.6	0.0185	0.0130	148.9	1 A	O I	7775.387	0.6	5So 2s2.2p3.(4So).3s	5P 2s2.2p3.(4So).3p	2.0	1.0	2/2
7811.659.......	23.1	0.0088	0.0061	45.3	2 A	He I	7811.680	0.8	1S 1s.3s	1Po 1s.13p	0.0	1.0	0/0
7816.122.......	20.1	0.0901	0.0627	80.5	2 A	He I	7816.122	0.0	3S 1s.3s	3Po 1s.7p	****	****	...
7860.551.......	54.2	0.0052	0.0036	28.7	3 A	C II	7860.500 ?	−1.9	2D 2s2.5d	2Fo 2s2.9f	2.5	****	1/0
7876.089.......	26.5	0.0418	0.0289	99999.0	1 A	[P II]	7875.990	−3.8	1D 3s2.3p2	1S 3s2.3p2	2.0	0.0	0/0
7877.066.......	53.8	0.0194	0.0134	99999.0	2 A	Mg II	7877.050	−0.6	2Po 4p	2D 4d	0.5	1.5	2/1
7880.901.......	21.0	0.0053	0.0037	21.8	1 A	He I	7880.890	−0.4	1S 1s.3s	1Po 1s.12p	0.0	1.0	0/0
7890.641.......	21.7	0.0013	0.0009	21.7		[Ni III]	7889.900	−28.2	3F 3d8	1D 3d8	3.0	2.0	1/0
7896.364.......	56.8	0.0324	0.0224	158.7	* C	Mg II	7896.040 ?	−12.3	2Po 4p	2D 4d	1.5	1.5	2/0
					3 A	Mg II	7896.370	0.2	2Po 4p	2D 4d	1.5	2.5	2/1
7902.149.......	20.0	0.0019	0.0013	9.6	...	...	...	...	...	...	...	...	...
7906.002.......	29.5	0.0049	0.0034	11.2	...	...	...	...	...	...	...	...	...
7924.546.......	16.0	0.0019	0.0013	16.3	...	He I	7924.521	−0.9	3Po 1s.3p	3D 1s.29d	****	****	...
7932.977.......	22.8	0.0025	0.0017	7.7	...	...	...	...	...	...	...	...	...
7944.564.......	18.7	0.0033	0.0022	18.0	...	He I	7944.580	0.6	3Po 1s.3p	3D 1s.26d	****	****	...
7950.773.......	26.2	0.0052	0.0035	39.5	5 B	O I	7950.803:	1.1	3Do 2s2.2p3.(2Do).3s	3F 2s2.2p3.(2Do).3p	2.0	3.0	5/0
					6 D	Fe I	7950.786 ?	0.5	w5Fo 3d6.(3F).4s.4p.(3Po)	5F 3d6.4s.(6D).5d	3.0	4.0	7/1
					6 D	Fe I	7950.814 ?	1.5	w5Fo 3d6.(3F).4s.4p.(3Po)	5F 3d6.4s.(6D).5d	1.0	2.0	*/1
7952.826.......	30.6	0.0039	0.0027	33.3	...	He I	7952.953	4.8	3Po 1s.3p	3D 1s.25d	****	****	...
7971.645.......	22.4	0.0047	0.0032	33.2	1 A	He I	7971.620	−0.9	1S 1s.3s	1Po 1s.11p	0.0	1.0	0/0
7973.190.......	26.1	0.0040	0.0028	22.2	...	He I	7973.166	−0.9	3Po 1s.3p	3D 1s.23d	****	****	...
7985.473.......	26.5	0.0057	0.0039	18.5	...	He I	7985.452	−0.8	3Po 1s.3p	3D 1s.22d	****	****	...
7995.554.......	39.8	0.0009	0.0006	9.1	...	...	...	...	...	...	...	...	...
7999.722.......	38.6	0.0079	0.0054	31.4	...	He I	7999.583 ?	−5.2	3Po 1s.3p	3D 1s.21d	****	****	...
8015.967.......	19.5	0.0063	0.0043	28.0	...	He I	8015.948	−0.7	3Po 1s.3p	3D 1s.20d	****	****	...
8035.090.......	17.6	0.0066	0.0045	34.5	...	He I	8035.047	−1.6	3Po 1s.3p	3D 1s.19d	****	****	...
8057.497.......	21.2	0.0086	0.0059	43.1	...	He I	8057.551	2.0	3Po 1s.3p	3D 1s.18d	****	****	...
8064.893.......	16.1	0.0011	0.0007	8.0	...	...	...	...	...	...	...	...	...
8084.272.......	22.6	0.0121	0.0082	56.7	...	He I	8084.292	0.7	3Po 1s.3p	3D 1s.17d	****	****	...
8093.881.......	67.6	0.0086	0.0058	36.9	5 A	He I	8094.080:	7.4	1S 1s.3s	1Po 1s.10p	0.0	1.0	0/0
8115.313.......	37.0	0.0117	0.0079	99999.0	5 B	Mg II	8115.230:	−3.1	2D 4d	2Po 6p	2.5	1.5	2/0
					6 D	Mg II	8115.570:	9.5	2D 4d	2Po 6p	1.5	1.5	2/1
8116.451.......	18.5	0.0098	0.0067	99999.0	4 A	O II	8116.490	1.4	2P 2s2.2p2.(3P).4d	2Po 2s2.2p2.(1D).4p	1.5	1.5	3/0
					...	He I	8116.426	−0.9	3Po 1s.3p	3D 1s.16d	****	****	...
8120.188.......	19.7	0.0039	0.0026	21.4	3 A	Fe I	8120.045 ?	−5.3	w5Fo 3d6.(3F).4s.4p.(3Po)	5F 3d6.4s.(6D).5d	4.0	3.0	7/1
					8	Mg II	8120.440 ?	9.3	2D 4d	2Po 6p	1.5	0.5	2/0
8140.560.......	13.0	0.0053	0.0036	36.2	...	...	...	...	...	...	...	...	...
8155.505.......	19.3	0.0197	0.0133	82.9	4 A	He I	8155.590	3.1	3Po 1s.3p	3D 1s.15d	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta) = 100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta) = 100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
8185.270.......	20.8	0.0227	0.0152	168.0	7 D	N I	8184.862:	−15.0	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	2.5	4/1
8188.451.......	51.1	0.0567	0.0381	152.9	7 D	N I	8188.012:	−16.1	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	0.5	1.5	6/1
					4 A	O II	8188.520	2.5	2P 2s2.2p2.(3P).4d	2Po 2s2.2p2.(1D).4p	0.5	1.5	3/1
8200.503.......	51.5	0.0195	0.0131	138.6	2 A	N I	8200.357	−5.3	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	0.5	0.5	6/3
8203.844.......	22.9	0.0204	0.0137	93.3	3 A	He I	8203.850	0.2	3Po 1s.3p	3D 1s.14d	****	****	. . .
8210.965.......	45.4	0.0295	0.0198	92.0	2 A	Fe I	8210.920 ?	−1.6	w5Fo 3d6.(3F).4s.4p.(3Po)	5F 3d6.4s.(6D).5d	3.0	3.0	8/2
					6	N I	8210.715:	−9.1	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	1.5	6/1
8213.890.......	47.3	0.0039	0.0026	37.9	4 A	[Fe III]	8213.900 ?	0.4	3D 3d6	1F 3d6	1.0	3.0	2/0
8216.298.......	62.2	0.0893	0.0598	304.1	5 B	N I	8216.336:	1.4	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	2.5	2.5	3/0
8223.218.......	50.4	0.0931	0.0623	347.8	1 A	N I	8223.128	−3.3	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	1.5	0.5	6/2
8233.205.......	18.5	0.0175	0.0117	73.5	3 A	Mg II	8233.190 ?	−0.5	2G 5g	2Ho 9h	****	****	0/0
8234.505.......	27.7	0.0363	0.0243	143.6	4 B	C II	8234.300 ?	−7.5	2G 2s2.5g	2Fo 2s2.9f	****	****	0/0
					3 A	Mg II	8234.640 ?	4.9	2Po 4p	2S 5s	1.5	0.5	1/1
8235.769.......	18.2	0.0181	0.0121	67.5	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8237.116.......	17.2	0.0221	0.0147	134.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8238.620.......	15.6	0.0184	0.0123	116.1	4 B	S II	8238.590	−1.1	2D 3s2.3p2.(1D).3d	2Po 3s2.3p2.(1S).4p	1.5	1.5	2/0
8240.199.......	21.0	0.0337	0.0225	147.6	5 A	Fe III	8240.720 ?	18.9	5D 3d5.(6S).5d	5Do 3d5.(4D).5p	2.0	2.0	9/2
8241.366.......	6.5	0.0010	0.0006	99999.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8242.031.......	8.1	0.0402	0.0269	99999.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8242.508.......	53.9	0.0824	0.0551	99999.0	4 B	N I	8242.389	−4.3	4P 2s2.2p2.(3P).3s	4Po 2s2.2p2.(3P).3p	2.5	1.5	4/1
8243.704.......	12.6	0.0635	0.0424	99999.0	. . .	H I	8243.698	−0.2	3 3*	43 43*	****	****	. . .
8245.639.......	25.7	0.0643	0.0429	250.2	. . .	H I	8245.641	0.1	3 3*	42 42*	****	****	. . .
8247.727.......	26.8	0.0683	0.0456	266.5	. . .	H I	8247.730	0.1	3 3*	41 41*	****	****	. . .
8249.995.......	27.9	0.0779	0.0520	260.3	2 A	H I	8249.973	−0.8	3 3*	40 40*	****	****	0/0
8252.396.......	30.0	0.0947	0.0632	351.0	3 A	H I	8252.398	0.1	3 3*	39 39*	****	****	0/0
8254.352.......	7.7	0.0024	0.0016	99999.0	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
8255.102.......	22.5	0.0687	0.0458	372.5	1 A	H I	8255.018	−3.1	3 3*	38 38*	****	****	0/0
8256.551.......	13.4	0.0018	0.0012	99999.0	. . .	He I	8256.492 ?	−2.1	3D 1s.3d	3Fo 1s.33f	****	****	. . .
8257.581.......	18.9	0.0321	0.0214	99999.0	5 A	H I	8257.855	10.0	3 3*	37 37*	****	****	0/0
8258.116.......	20.6	0.0455	0.0303	99999.0	3 A	H I	8257.855	−9.5	3 3*	37 37*	****	****	0/0
8260.907.......	28.3	0.1061	0.0707	404.4	3 A	H I	8260.934	1.0	3 3*	36 36*	****	****	0/0
8264.339.......	32.8	0.1405	0.0936	22.6	2 A	H I	8264.284	−2.0	3 3*	35 35*	****	****	0/0
					7 B	He I	8264.530:	6.9	3Po 1s.3p	3D 1s.13d	****	****	. . .
8265.723.......	18.0	0.0112	0.0075	67.0	1 A	He I	8265.710	−0.5	1S 1s.3s	1Po 1s.9p	0.0	1.0	0/0
8267.938.......	31.0	0.1176	0.0783	21.2	2 A	H I	8267.936	−0.1	3 3*	34 34*	****	****	0/0
8271.803.......	35.7	0.1130	0.0752	22.6	5 A	H I	8271.930	4.6	3 3*	33 33*	****	****	0/0
8276.325.......	44.5	0.1397	0.0930	26.4	2 A	H I	8276.308	−0.6	3 3*	32 32*	****	****	0/0
8281.148.......	47.8	0.1336	0.0889	22.9	2 A	H I	8281.122	−1.0	3 3*	31 31*	****	****	0/0
8283.315.......	22.7	0.0061	0.0041	99999.0	. . .	He I	8283.306	−0.3	3D 1s.3d	3Fo 1s.28f	****	****	. . .
8285.688.......	22.2	0.0152	0.0101	99999.0	4 A	He I	8285.360	−11.9	3Po 1s.3p	3S 1s.13s	****	****	. . .
8286.579.......	34.7	0.1038	0.0691	99999.0	1 A	H I	8286.431	−5.4	3 3*	30 30*	****	****	0/0
8290.520.......	19.5	0.0046	0.0031	16.8	7 B	C II	8290.800:	10.1	2Po 2s2.5p	2D 2s2.7d	1.5	****	1/0
					. . .	He I	8290.559	1.4	3D 1s.3d	3Fo 1s.27f	****	****	. . .
8298.882.......	28.5	0.1916	0.1273	40.8	2 A	H I	8298.834	−1.7	3 3*	28 28*	****	****	0/0
					. . .	He I	8298.680	−7.3	3D 1s.3d	3Fo 1s.26f	****	****	. . .
8306.064.......	30.5	0.2481	0.1647	234.7	4 A	H I	8306.112	1.7	3 3*	27 27*	****	****	0/0
8307.803.......	18.5	0.0057	0.0038	99999.0	. . .	He I	8307.814	0.4	3D 1s.3d	3Fo 1s.25f	****	****	. . .

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
8314.233.......	34.0	0.2595	0.1722	292.4	3 A	H I	8314.260	1.0	3 3*	26 26*	****	****	0/0
8318.141.......	20.0	0.0075	0.0050	44.1	...	He I	8318.137	−0.1	3D 1s.3d	3Fo 1s.24f	****	****	...
8320.490.......	22.6	0.0031	0.0020	21.5	7 D	Fe I	8320.169 ?	−11.6	c3F 3d8	y3Go 3d6.(3H).4s.4p.(3Po)	3.0	4.0	4/1
8323.418.......	31.7	0.3053	0.2025	446.1	3 A	H I	8323.424	0.2	3 3*	25 25*	****	****	0/0
8329.838.......	21.1	0.0083	0.0055	51.4	...	He I	8329.867	1.0	3D 1s.3d	3Fo 1s.23f	****	****	...
8333.773.......	32.1	0.3183	0.2109	532.0	3 A	H I	8333.783	0.4	3 3*	24 24*	****	****	0/0
8339.344.......	25.7	0.0079	0.0052	27.0	4 A	Ca I	8339.210 ?	−4.8	1D 4s.4d	1Po 4s.77p	2.0	1.0	0/0
8342.203.......	21.3	0.0228	0.0151	99999.0	6 C	He I	8342.330	4.6	3Po 1s.3p	3D 1s.12d	****	****	...
8343.190.......	30.9	0.0108	0.0072	99999.0	...	He I	8343.273	3.0	3D 1s.3d	3Fo 1s.22f	****	****	...
8345.556.......	31.6	0.3710	0.2455	217.8	2 A	H I	8345.552	−0.1	3 3*	23 23*	****	****	0/0
8350.233.......	19.9	0.0090	0.0060	99999.0	...	...	...	...	...	...	...	...	...
8352.471.......	16.5	0.0015	0.0010	7.3	...	...	...	...	...	...	...	...	...
8358.975.......	32.0	0.4328	0.2861	101.2	3 A	H I	8359.003	1.0	3 3*	22 22*	****	****	0/0
					...	He I	8358.692 ?	−10.2	3D 1s.3d	3Fo 1s.21f	****	****	...
8361.738.......	27.8	0.1847	0.1221	405.4	1 A	He I	8361.711	−1.0	3S 1s.3s	3Po 1s.6p	****	****	...
8374.487.......	32.2	0.4359	0.2877	527.8	2 A	H I	8374.475	−0.5	3 3*	21 21*	****	****	0/0
8376.548.......	17.9	0.0100	0.0066	63.8	...	He I	8376.553	0.2	3D 1s.3d	3Fo 1s.20f	****	****	...
8382.927.......	21.1	0.0019	0.0012	10.3	...	He I	8382.921	−0.2	1Po 1s.3p	1D 1s.25d	****	****	...
8392.397.......	31.5	0.4863	0.3205	275.1	2 A	H I	8392.396	0.0	3 3*	20 20*	****	****	0/0
8399.830.......	19.6	0.0048	0.0031	36.8	...	He I	8399.811	−0.7	1D 1s.3d	1Fo 1s.19f	****	****	...
8405.417.......	28.5	0.0015	0.0010	10.8	...	He I	8405.379	−1.4	1Po 1s.3p	1D 1s.23d	****	****	...
8413.317.......	31.3	0.5649	0.3717	383.7	4 B	H I	8413.317	0.0	3 3*	19 19*	****	****	0/0
8419.009.......	24.3	0.0021	0.0014	9.4	...	He I	8419.032	0.8	1Po 1s.3p	1D 1s.22d	****	****	...
8421.969.......	21.4	0.0180	0.0118	94.5	...	He I	8421.959	−0.4	3D 1s.3d	3Fo 1s.18f	****	****	...
8424.347.......	24.4	0.0070	0.0046	43.6	...	He I	8424.379	1.1	1D 1s.3d	1Fo 1s.18f	****	****	...
8433.723.......	22.4	0.0095	0.0062	67.5	7 B	C II	8433.900:	6.3	4Fo 2s.2p.(3Po).4d	4G 2s.2p.(3Po).5f	4.5	4.5	4/0
					6 A	[Cl III]	8434.000:	9.9	2Do 3s2.3p3	2Po 3s2.3p3	1.5	1.5	2/1
8437.908.......	31.5	0.6618	0.4345	789.5	3 A	H I	8437.955	1.7	3 3*	18 18*	****	****	0/0
8444.441.......	20.6	0.0353	0.0232	99999.0	3 A	He I	8444.440	0.0	3Po 1s.3p	3D 1s.11d	****	****	...
8446.549.......	68.1	1.7405	1.1419	99999.0	*	O I	8446.247	−10.7	3So 2s2.2p3.(4So).3s	3P 2s2.2p3.(4So).3p	1.0	0.0	2/0
					7 B	O I	8446.359	−6.7	3So 2s2.2p3.(4So).3s	3P 2s2.2p3.(4So).3p	1.0	2.0	1/0
					9 C	O I	8446.758	7.4	3So 2s2.2p3.(4So).3s	3P 2s2.2p3.(4So).3p	1.0	1.0	2/0
8451.153.......	21.0	0.0207	0.0136	99999.0	...	He I	8451.158	0.2	3D 1s.3d	3Fo 1s.17f	****	****	...
8453.496.......	25.8	0.0091	0.0060	38.8	...	He I	8453.596	3.5	1D 1s.3d	1Fo 1s.17f	****	****	...
8467.251.......	32.0	0.7710	0.5050	486.8	2 A	H I	8467.253	0.1	3 3*	17 17*	****	****	0/0
8474.190.......	19.4	0.0019	0.0013	11.6	...	He I	8474.172	−0.6	1Po 1s.3p	1D 1s.19d	****	****	...
8480.830.......	27.9	0.0165	0.0108	82.7	1 A	He I	8480.670	−5.7	3Po 1s.3p	3S 1s.11s	****	****	...
					7 B	[Cl III]	8481.200:	13.1	2Do 3s2.3p3	2Po 3s2.3p3	2.5	1.5	2/1
8486.261.......	21.7	0.0247	0.0162	118.4	...	He I	8486.269	0.3	3D 1s.3d	3Fo 1s.16f	****	****	...
8488.736.......	21.4	0.0104	0.0068	49.9	...	He I	8488.727	−0.3	1D 1s.3d	1Fo 1s.16f	****	****	...
8495.350.......	27.5	0.0035	0.0023	15.2	...	...	...	...	...	...	...	...	...
8499.216.......	8.1	0.0028	0.0019	99999.0	...	He I	8499.187	−1.0	1Po 1s.3p	1D 1s.18d	****	****	...
8500.039.......	27.1	0.0068	0.0044	99999.0	8 C	[Cl III]	8500.200 ?	5.7	2Do 3s2.3p3	2Po 3s2.3p3	1.5	0.5	2/0
8502.482.......	32.4	0.9160	0.5983	226.3	3 A	H I	8502.483	0.0	3 3*	16 16*	****	****	0/0
8518.027.......	19.1	0.0262	0.0171	147.4	2 A	He I	8518.036	0.3	1S 1s.3s	1Po 1s.8p	0.0	1.0	0/0
8529.022.......	21.0	0.0324	0.0211	195.2	...	He I	8528.967	−1.9	1Po 1s.3p	1D 1s.17d	****	****	...
					...	He I	8529.025	0.1	3D 1s.3d	3Fo 1s.15f	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta)=100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
8531.522.......	24.1	0.0102	0.0066	66.5	5 A	He I	8530.930:	−20.8	1D 1s.3d	1Po 1s.15p	2.0	1.0	0/0
					...	He I	8531.508	−0.5	1D 1s.3d	1Fo 1s.15f	****	****	...
8545.389.......	31.9	1.0458	0.6807	839.9	2 A	H I	8545.382	−0.2	3 3*	15 15*	****	****	0/0
8548.026.......	21.3	0.0019	0.0013	99999.0	3 A	[Cl III]	8548.200	6.1	2Do 3s2.3p3	2Po 3s2.3p3	2.5	0.5	3/2
8564.691.......	21.8	0.0041	0.0027	34.7	...	He I	8564.763	2.5	1Po 1s.3p	1D 1s.16d	****	****	...
8567.730.......	48.7	0.0019	0.0012	15.7	3 A	N I	8567.735	0.2	2P 2s2.2p2.(3P).3s	2Po 2s2.2p2.(3P).3p	0.5	1.5	3/1
8578.795.......	52.4	0.4382	0.2844	620.0	1 A	[Cl II]	8578.690	−3.7	3P 3s2.3p4	1D 3s2.3p4	2.0	2.0	1/1
8581.867.......	23.0	0.0405	0.0263	99999.0	...	He I	8581.856	−0.4	3D 1s.3d	3Fo 1s.14f	****	****	...
8582.627.......	21.3	0.0491	0.0319	99999.0	1 A	He I	8582.510	−4.1	3Po 1s.3p	3D 1s.10d	****	****	...
8584.378.......	21.1	0.0121	0.0078	65.8	...	He I	8584.369	0.3	1D 1s.3d	1Fo 1s.14f	****	****	...
8598.379.......	32.5	1.2901	0.8362	663.8	3 A	H I	8598.392	0.4	3 3*	14 14*	****	****	0/0
8608.294.......	25.3	0.0056	0.0036	29.8	...	He I	8608.312	0.6	1Po 1s.3p	1D 1s.15d	****	****	...
8617.062.......	54.2	0.0145	0.0094	84.3	3 A	[Fe II]	8616.952	−3.8	a4F 3d7	a4P 3d7	4.5	2.5	2/0
8629.244.......	34.0	0.0046	0.0030	99999.0	3 A	N I	8629.236	−0.3	2P 2s2.2p2.(3P).3s	2Po 2s2.2p2.(3P).3p	1.5	1.5	3/1
8632.937.......	40.7	0.0076	0.0049	99999.0	2 A	He I	8632.710	−7.9	3Po 1s.3p	3S 1s.10s	****	****	...
8648.270.......	20.7	0.0450	0.0291	271.6	...	He I	8648.258	−0.4	3D 1s.3d	3Fo 1s.13f	****	****	...
8650.793.......	20.7	0.0140	0.0091	83.9	6 A	O II	8650.920:	4.4	2Fo 2s2.2p2.(1D).4p	2D 2s2.2p2.(1D).5s	3.5	2.5	2/0
					...	He I	8650.811	0.6	1D 1s.3d	1Fo 1s.13f	****	****	...
8653.417.......	19.0	0.0026	0.0017	99999.0	3 A	He I	8653.240	−6.1	3D 1s.3d	3Po 1s.13p	****	****	...
8665.022.......	31.2	1.4733	0.9501	1255.0	3 A	H I	8665.018	−0.2	3 3*	13 13*	****	****	0/0
8675.887.......	32.3	0.0018	0.0012	4.9	5 A	N II	8676.090:	7.0	3D 2s2.2p.(2Po).4p	3Po 2s2.2p.(2Po).5s	3.0	2.0	2/1
8680.370.......	56.8	0.0597	0.0385	396.1	1 A	N I	8680.282	−3.0	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	2.5	3.5	2/2
8683.525.......	57.6	0.0647	0.0417	382.0	3 A	N I	8683.403	−4.2	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	1.5	2.5	5/4
8686.267.......	52.3	0.0342	0.0220	99999.0	2 A	N I	8686.149	−4.0	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	0.5	1.5	7/5
8698.894.......	18.4	0.0012	0.0008	11.3	5 D	N II	8698.990:	3.3	3D 2s2.2p.(2Po).4p	3Po 2s2.2p.(2Po).5s	2.0	1.0	5/1
8703.334.......	54.0	0.0417	0.0268	254.2	1 A	N I	8703.247	−3.0	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	0.5	0.5	7/5
8711.778.......	52.8	0.0425	0.0273	234.7	1 A	N I	8711.703	−2.6	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	1.5	1.5	7/5
8718.959.......	53.4	0.0211	0.0135	143.9	2 A	N I	8718.837	−4.2	4P 2s2.2p2.(3P).3s	4Do 2s2.2p2.(3P).3p	2.5	2.5	4/3
8727.289.......	58.3	0.0521	0.0334	136.6	1 A	[C I]	8727.120	−5.8	1D 2s2.2p2	1S 2s2.2p2	2.0	0.0	0/0
8729.674.......	36.4	0.0079	0.0050	99999.0	5 A	He I	8730.090:	14.3	1Po 1s.3p	1D 1s.13d	1.0	2.0	0/0
8733.415.......	22.1	0.0595	0.0382	263.2	...	He I	8733.434	0.7	3D 1s.3d	3Fo 1s.12f	****	****	...
8736.001.......	22.2	0.0212	0.0136	104.4	...	He I	8736.037	1.2	1D 1s.3d	1Fo 1s.12f	****	****	...
8740.119.......	25.2	0.0047	0.0030	15.2	3 A	He I	8739.960	−5.5	3D 1s.3d	3Po 1s.12p	****	****	...
8750.463.......	32.3	2.0458	1.3112	556.5	3 A	H I	8750.473	0.3	3 3*	12 12*	****	****	0/0
8776.749.......	19.7	0.0620	0.0397	99999.0	1 A	He I	8776.650	−3.4	3Po 1s.3p	3D 1s.9d	****	****	...
8780.667.......	19.5	0.0014	0.0009	11.7	...	...	...	...	...	...	...	...	...
8806.901.......	42.0	0.0064	0.0041	47.0	2 A	Mg I	8806.757	−4.9	1Po 3s.3p	1D 3s.3d	1.0	2.0	0/0
8816.619.......	19.8	0.0092	0.0058	59.1	5 A	He I	8816.820:	6.8	1Po 1s.3p	1D 1s.12d	1.0	2.0	0/0
					9 B	O II	8817.110 ?	16.7	2F 2s2.2p2.(3P).4d	2Do 2s2.2p2.(1D).4p	2.5	2.5	2/0
8820.439.......	27.3	0.0037	0.0024	22.7	2 A	O I	8820.423	−0.6	1Do 2s2.2p3.(2Do).3s	1F 2s2.2p3.(2Do).3p	2.0	3.0	0/0
8829.753.......	24.2	0.0075	0.0048	99999.0	4 A	[S III]	8829.400	−12.0	3P 3s2.3p2	1D 3s2.3p2	0.0	2.0	1/1
8843.375.......	26.9	0.0009	0.0006	7.4	8	S II	8842.920 ?	−15.4	2Po 3s2.3p2.(1S).4p	2D 3s2.3p2.(1D).4d	0.5	1.5	2/0
					4 A	[Ni I]	8843.374 ?	0.0	3F 3d8.(3F).4s2	1D 3d8.(1D).4s2	2.0	2.0	1/0
8845.337.......	21.7	0.0786	0.0501	311.6	5 A	He I	8845.000:	−11.4	3D 1s.3d	3Fo 1s.11f	****	****	...
8847.902.......	26.2	0.0301	0.0191	99999.0	3 A	He I	8847.700	−6.9	1D 1s.3d	1Fo 1s.11f	2.0	3.0	0/0
8849.082.......	27.4	0.0112	0.0071	99999.0	4 A	He I	8849.145	2.1	3Po 1s.3p	3S 1s.9s	****	****	...
8853.998.......	26.0	0.0179	0.0114	38.7	3 A	He I	8854.100	3.4	3D 1s.3d	3Po 1s.11p	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(H\beta)$ ($F(H\beta)=100$) (3)	$I(\lambda)/I(H\beta)$ ($I(H\beta)=100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
8862.752.......	32.6	2.5496	1.6217	464.6	3 A	H I	8862.783	1.1	3 3*	11 11*	****	****	0/0
8873.451.......	29.2	0.0051	0.0032	21.0	2 A	C I	8873.360 ?	−3.1	1D 2s2.2p.(2Po).3p	1Po 2s2.2p.(2Po).5s	2.0	1.0	0/0
8886.539.......	15.3	0.0011	0.0007	8.0	...	...	...	...	...	...	...	...	...
8892.237.......	49.0	0.0046	0.0030	26.6	5 A	[Fe II]	8891.913:	−10.9	a4F 3d7	a4P 3d7	3.5	1.5	5/1
8914.751.......	21.3	0.0361	0.0229	131.9	2 A	He I	8914.771	0.7	1S 1s.3s	1Po 1s.7p	0.0	1.0	0/0
8930.778.......	24.2	0.0142	0.0090	51.2	5 A	He I	8930.970:	6.4	1Po 1s.3p	1D 1s.11d	1.0	2.0	0/0
8949.241.......	15.3	0.0028	0.0017	16.5	1 A	He I	8949.200	−1.4	1Po 1s.3p	1S 1s.11s	1.0	0.0	0/0
8996.949.......	24.3	0.1260	0.0795	371.1	4 A	He I	8996.700	−8.3	3D 1s.3d	3Fo 1s.10f	****	****	...
8999.590.......	40.7	0.0435	0.0274	99999.0	3 A	He I	8999.400	−6.3	1D 1s.3d	1Fo 1s.10f	2.0	3.0	0/0
9009.026.......	19.9	0.0111	0.0070	36.5	4 A	He I	9009.180	5.1	3D 1s.3d	3Po 1s.10p	****	****	...
9015.048.......	51.9	2.0076	1.2652	755.9	1 A	H I	9014.910	−4.6	3 3*	10 10*	****	****	0/0
9052.447.......	18.8	0.0027	0.0017	5.7	...	...	...	...	...	...	...	...	...
9063.275.......	21.5	0.0878	0.0552	144.4	2 A	He I	9063.282	0.2	3Po 1s.3p	3D 1s.8d	****	****	...
9068.905.......	31.2	28.3206	17.7936	3977.0	3 A	[S III]	9068.600	−10.1	3P 3s2.3p2	1D 3s2.3p2	1.0	2.0	1/1
9085.516.......	15.8	0.0132	0.0083	51.1	3 A	He I	9085.630	3.8	1Po 1s.3p	1D 1s.10d	1.0	2.0	0/0
9094.797.......	80.8	0.0165	0.0103	127.4	6 C	C I	9094.830:	1.1	3Po 2s2.2p.(2Po).3s	3P 2s2.2p.(2Po).3p	2.0	2.0	3/0
9111.130.......	18.7	0.0014	0.0009	27.1	2 A	He I	9111.000	−4.3	1Po 1s.3p	1S 1s.10s	1.0	0.0	0/0
9123.737.......	40.4	0.1229	0.0770	441.8	0 A	[Cl II]	9123.600	−4.5	3P 3s2.3p4	1D 3s2.3p4	1.0	2.0	1/1
9143.128.......	27.1	0.0036	0.0022	7.5	...	...	...	...	...	...	...	...	...
9174.224.......	24.8	0.0108	0.0067	33.2	5 A	He I	9174.488:	8.7	3Po 1s.3p	3S 1s.8s	****	****	...
9210.290.......	22.0	0.1412	0.0880	342.7	2 A	He I	9210.260	−1.0	3D 1s.3d	3Fo 1s.9f	****	****	...
					8 C	Fe II	9210.720 ?	14.0	c4F 3d6.(3F2).4s	z4Go 3d6.(3H).4p	3.5	2.5	7/1
9213.218.......	20.4	0.0438	0.0273	127.0	2 A	He I	9213.200	−0.6	1D 1s.3d	1Fo 1s.9f	2.0	3.0	0/0
9218.313.......	46.0	0.0718	0.0448	256.4	1 A	Mg II	9218.250 ?	−2.1	2S 4s	2Po 4p	0.5	1.5	1/1
9223.637.......	18.3	0.0102	0.0064	99990.0	...	...	...	...	...	...	...	...	...
9228.996.......	32.5	4.5115	2.8092	1894.0	2 A	H I	9229.014	0.6	3 3*	9 9*	****	****	0/0
9236.263.......	16.4	0.0219	0.0136	86.9	...	...	...	...	...	...	...	...	...
9244.407.......	50.0	0.0340	0.0211	150.2	3 A	Mg II	9244.260 ?	−4.8	2S 4s	2Po 4p	0.5	0.5	1/1
					5 B	Fe II	9244.739 ?	10.8	c4F 3d6.(3F2).4s	z4Go 3d6.(3H).4p	2.5	3.5	8/2
9250.959.......	22.5	0.0039	0.0024	17.9	5 A	C II	9251.010:	1.6	2Po 2s.2p.(3Po).3s	2D 2s.2p.(3Po).3p	0.5	1.5	2/0
9260.917.......	43.8	0.0076	0.0047	99999.0	1 A	O I	9260.806	−3.6	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	1.0	0.0	8/3
					1 A	O I	9260.848	−2.2	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	1.0	1.0	8/2
					2 C	O I	9260.937	0.6	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	1.0	2.0	7/4
9262.666.......	43.7	0.0156	0.0097	99999.0	1 A	O I	9262.582	−2.7	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	2.0	1.0	8/5
					1 A	O I	9262.670	0.1	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	2.0	2.0	7/4
					3 C	O I	9262.776	3.6	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	2.0	3.0	5/3
9265.934.......	27.8	0.0202	0.0125	99.0	1 A	O I	9265.826	−3.5	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	3.0	2.0	5/2
					1 A	O I	9265.932	−0.1	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	3.0	3.0	4/2
					3 C	O I	9266.005	2.3	5P 2s2.2p3.(4So).3p	5Do 2s2.2p3.(4So).3d	3.0	4.0	2/1
9268.114.......	19.2	0.0012	0.0007	8.5	9 B	C II	9267.270 ?	−27.3	2Po 2s.2p.(3Po).3s	2D 2s.2p.(3Po).3p	1.5	1.5	2/0
					6 A	[Fe II]	9267.563:	−17.8	a4F 3d7	a4P 3d7	1.5	0.5	7/1
9303.057.......	20.0	0.0213	0.0132	99999.0	5 A	He I	9303.420:	11.7	1Po 1s.3p	1D 1s.9d	1.0	2.0	0/0
9318.089.......	22.5	0.0184	0.0114	86.5	...	...	...	...	...	...	...	...	...
9387.009.......	55.1	0.0236	0.0146	135.5	7	N I	9386.805:	−6.5	2P 2s2.2p2.(3P).3s	2Do 2s2.2p2.(3P).3p	0.5	1.5	2/0
					5 C	[Fe I]	9386.985:	−0.7	a5F 3d7.(4F).4s	a3P 3d6.4s2	3.0	2.0	2/0
9393.159.......	40.0	0.0086	0.0053	31.6	*	N I	9392.793 ?	−11.7	2P 2s2.2p2.(3P).3s	2Do 2s2.2p2.(3P).3p	1.5	2.5	2/0
9463.585.......	23.3	0.2244	0.1380	473.9	1 A	He I	9463.534	−1.6	3S 1s.3s	3Po 1s.5p	****	****	...

TABLE 3—*Continued*

λ_0 (Å) (1)	FWHM (km s^{-1}) (2)	$F(\lambda)/F(\mathrm{H}\beta)$ ($F(\mathrm{H}\beta) = 100$) (3)	$I(\lambda)/I(\mathrm{H}\beta)$ ($I(\mathrm{H}\beta) = 100$) (4)	S/N (5)	IDI (6)	ID (7)	λ (Å) (8)	δV (km s^{-1}) (9)	Lower Term/Config (10)	Upper Term/Config (11)	J_l (12)	J_u (13)	Multi. (14)
9516.592.......	35.7	0.1321	0.0810	247.1	1 A	He I	9516.562	−0.9	3Po 1s.3p	3D 1s.7d	****	****	...
9530.929.......	42.8	68.9313	42.2567	5092.0	3 A	[S III]	9530.600	−10.4	3P 3s2.3p2	1D 3s2.3p2	2.0	2.0	1/1
9545.854.......	32.6	5.8626	3.5913	1107.0	4 A	H I	9545.972	3.7	3 3*	8 8*	****	****	0/0
9552.904.......	24.7	0.0227	0.0139	66.5	2 A	He I	9552.890	−0.5	3D 1s.3d	3Po 1s.8p	****	****	...
9603.397.......	16.0	0.0277	0.0169	116.9	3 A	He I	9603.440	1.3	1S 1s.3s	1Po 1s.6p	0.0	1.0	0/0
9625.445.......	30.3	0.0374	0.0228	103.1	7	O I	9625.261:	−5.8	3Do 2s2.2p3.(4So).4d	3D 2s2.2p3.(2Do).3p	3.0	2.0	4/0
					7	O I	9625.296:	−4.7	3Do 2s2.2p3.(4So).4d	3D 2s2.2p3.(2Do).3p	3.0	3.0	3/0
					6 C	O I	9625.325:	−3.7	3Do 2s2.2p3.(4So).4d	3D 2s2.2p3.(2Do).3p	2.0	2.0	6/0
					5 A	O I	9625.360:	−2.6	3Do 2s2.2p3.(4So).4d	3D 2s2.2p3.(2Do).3p	2.0	3.0	4/0
					6 C	O I	9625.367:	−2.4	3Do 2s2.2p3.(4So).4d	3D 2s2.2p3.(2Do).3p	1.0	2.0	6/0
					5 A	He I	9625.697:	7.9	1Po 1s.3p	1D 1s.8d	1.0	2.0	0/0
9702.529.......	29.6	0.0198	0.0120	51.4	4 A	He I	9702.614	2.6	3Po 1s.3p	3S 1s.7s	****	****	...
9778.841.......	68.4	0.0072	0.0044	25.6	2 A	[Fe I]	9778.731 ?	−3.4	a5F 3d7.(4F).4s	a3P 3d6.4s2	1.0	2.0	2/1
9794.186.......	29.3	0.0027	0.0016	9.0	2 A	N II	9794.050 ?	−4.2	1Fo 2s2.2p.(2Po).4d	2[9/2] 2s2.2p.(2Po<3/2>).5f.G	3.0	4.0	...
9797.660.......	35.4	0.0177	0.0107	70.4	...	...	...	...	...	...	...	...	...
9805.383.......	71.6	0.0086	0.0052	22.6	...	...	...	...	...	...	...	...	...
9809.767.......	57.5	0.0136	0.0082	40.5	7	N I	9810.010:	7.4	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	1.5	0.5	7/0
9822.279.......	40.6	0.0126	0.0076	99999.0	9	N I	9822.750 ?	14.4	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	2.5	2.5	4/0
9824.092.......	56.2	0.0731	0.0442	99999.0	3 A	[C I]	9824.130	1.2	3P 2s2.2p2	1D 2s2.2p2	1.0	2.0	0/0
9834.627.......	51.5	0.0135	0.0082	14.7	5 C	N I	9834.610:	−0.5	4Do 2s2.2p2.(3P).3p	4D 2s2.2p2.(3P).3d	2.5	1.5	5/0

NOTES.—(Col. [1]) Observed wavelength corrected for $+68.6$ km s^{-1} nebular proper motion. (Col. [2]) FWHM of line. (Col. [3]) Observed intensity of line with respect to the observed intensity of Hβ ($F(\mathrm{H}\beta) = 1.31 \times 10^{-11}$ ergs cm^{-3} s^{-1}). (Col. [4]) Dereddened intensity of line with respect to Hβ ($I(\mathrm{H}\beta) = 2.87 \times 10^{-11}$ ergs cm^{-3} s^{-1}). (Col. [5]) S/N of line; "99999.0" indicates indeterminate. (Col. [6]) EMILI IDI value/rank (A, B, C, D) where applicable. Asterisk (*) denotes that IDI > 9. No IDI value/rank for manual IDs. (Col. [7]) Source ion of line. (Col. [8]) Tabulated wavelength of transition. Colon and asterisk are as indicated in text. (Col. [9]) Difference in wavelength between observed and tabulated wavelength, $\delta V = c * (\lambda - \lambda_o)/\lambda$ km s^{-1}. (Col. [10]) Lower level term/configuration. Coupling schemes used are *LS*, *LK*, J_1K. (Col. [11]) Upper level term/configuration. (Col. [12]) Lower level *J* value, Asterisks indicate that *J* is indeterminate (line from blended level). (Col. [13]) Upper level *J* value. (Col. [14]) EMILI multiplet check statistics for *LS* coupled levels only; (A/B), where *A* is number of lines expected and *B* is the number considered found. Not used for manual IDs. Asterisk indicates that $A > 9$. Table 3 is also available in machine-readable form in the electronic edition of the *Astrophysical Journal Supplement*.

identifications that are not rated as questionable. There are a total of 754 such line identifications, for 480 observed lines for which there was only one suggested identification and for a further 144 observed lines for which there is more than one possible identification. The dereddened strengths of these identified lines range down to slightly below 10^{-5} the intensity of Hβ.

5. COMPARISON OF EMILI RESULTS WITH PREVIOUS STUDIES

The correctness of spectral line identifications, especially for fainter lines that are not frequently observed, is difficult to ascertain. There is no absolute benchmark of correct IDs with which to compare the results of EMILI, except possibly for the stronger lines in spectra which have been observed in many objects and for which there is universal agreement. We will therefore undertake to compare EMILI results with those of previous studies done traditionally as an indication of their reliability.

We are currently engaged in a program to obtain high S/N spectra of a sample of emission-line objects to which we can apply EMILI. At present we have excellent data for IC 418 (Paper II), and we have access to high-resolution spectra of the Orion Nebula (Baldwin et al. 2000), for which detailed traditional line identifications have also been made. For IC 418 we compare the EMILI identifications from this study with those made by Hyung, Aller, & Feibelman (1994) from their Lick Observatory echelle data.

We have taken the spectra of IC 418 and the Orion Nebula and have generated the necessary line characterization and wavelength error tables from *rdgen*. This information has been fed into EMILI using our updated version 2.04 of the line database and standard nebular parameters with solar abundances. Line identifications have been made, and when the lowest value of the IDI has been shared by more than one line all of those lines are assigned as IDs. The resulting identifications have then been compared with the published IDs for the Orion Nebula and IC 418. The comparison of EMILI IDs with those assigned traditionally for these nebulae is given in Table 4. The EMILI ID rankings A, B, C, and D refer to the first, second, third, and fourth highest ranked IDs from the algorithm. The comparison shows that the EMILI identifications ranked as "A" agree with the traditional manual ID for about 85% of all lines. Furthermore, 90%–98% of all manual IDs are ranked as A, B, C, or D by EMILI. The agreement with those ranked A can be improved upon easily by optimizing the way in which the IDI is defined. We have taken a close look at some of the disagreements between the manual IDs and those ranked A by EMILI, and we believe that EMILI is more likely to be correct than the traditional line identifications in a majority of cases. This raises the question as to which identification process, traditional or software, yields more correct results. This question can only be answered after a larger sample of objects have been studied at fainter flux levels so that some consensus emerges as to the correct identification of the weakest lines.

TABLE 4
COMPARISON OF EMILI VS. MANUAL LINE IDENTIFICATIONS

	IC 418		ORION NEBULA	
RANK	*N*	%	*N*	%
A	178	88	329	85
B	4	2	34	9
C	5	2	12	3
D	0	0	5	1
Unranked	16	8	8	2
Total	203		388	

6. SUMMARY AND FUTURE PROSPECTS

The time- and labor-intensive method of traditional identification of spectral lines has acted as a deterrent to obtaining very high S/N, high-resolution spectra of astronomical objects. The task of making manual identifications for large numbers of lines has required such effort that the focus has been on utilizing only well-known stronger lines as diagnostics to determine physical conditions. Yet, modern spectrographs and detectors make very faint lines observable with only a modest investment of telescope time, and the large amount of new information that is certain to be contained in previously unstudied weak lines can now be tapped.

Even with its current simple logic EMILI works well in identifying lines in nebular spectra, and certainly well enough to justify continued improvement. It would benefit from new features such as the ability to interrogate multiple line databases, and using additional criteria to evaluate candidate IDs, including a more sophisticated way to deconvolve line blends. Also, it should be applied to the spectra of additional types of emission-line objects. One of the eventual goals is to include very heavy elements in the line lists so that *s*- and *r*-process elements can be identified when lines from these elements are detected in spectra. This may require detecting lines down to 10^{-6} the intensity of Hβ. This flux level is 100 times fainter than the nebular continuum of the emitting gas upon which the lines are superposed; however, the requisite S/N is achievable. The very large numbers of emission lines that would be revealed in such spectra are precisely the situation that requires an automated line identification aid such as EMILI.

The logic incorporated into EMILI is based upon traditional procedures used by spectroscopists for making manual line identifications in astronomical spectra. There are a number of uncertainties involved in the application of EMILI to spectra, and a number of areas in which improvements should eventually be made. One of the major difficulties of spectral line identification is accurately characterizing blends of multiple lines. It is often difficult to prove whether a feature is or is not a blend, and what the component wavelengths and line widths are when it is a blend. Emission-line objects can have a complex kinematical structure that results in complicated line profiles which differ from ion to ion of the same element. For example, a line of sight that passes through an expanding shell, as is the case for the object IC 418, produces a distinct double-peaked profile that is easily misinterpreted as two separate lines rather than a single feature. The stronger signature lines in the spectrum easily remove this uncertainty because they generally do not suffer significant blending and can therefore be used to characterize the different line profiles. For the current version of EMILI only a cursory effort was made to use differing intrinsic line widths and profiles as identification discriminants because of the complexity involved in doing proper line deconvolutions for large numbers of lines. However, these criteria should be developed further in future versions of EMILI.

One of the most important aspects of faint line detection is the use of spectral resolution that can resolve the narrowest lines in the spectrum, which is set by the thermal widths of the lines (typically, of order 10 km s^{-1}) and bulk motions in the gas. Higher spectral resolution increases the accuracy of measured line wavelengths, which is the most important criterion in making line IDs, and it serves to increase the contrast between peak line intensity and the surrounding continuum. The detectability of emission lines is further enhanced by low bulk velocities of the gas and by the faintest possible continuum against which the lines are detected. One cannot escape the bound-free and 2-photon continuum emitted by the ionized gas, but one can select objects of low dust content in order to minimize the contribution of the scattered continuum from the ionizing star.

The number density of lines increases at fainter intensity levels and the proper identification of the weakest lines becomes increasingly uncertain due to the less well-determined wavelengths of these features and the higher fraction of associated multiplet lines that are not observed because their S/N is below the threshold of detection. This is inevitable, and there will always be a substantial fraction of lines at the threshold of detection for which the criteria for confirmation are not well determined. Line IDs for the faintest lines are generally less certain, and further progress can be made by pressing for spectra with yet higher S/N, since the faintest flux levels we have achieved do not approach a line density that is so high that weak lines blend into each other to form a pseudo-continuum.

Finally, the v2.04 Atomic Line List is the only database that we have interrogated in searching for potential identifications in the present version of EMILI, and its wavelengths are accepted as valid for each transition. A more thorough search process should eventually interrogate multiple line lists and should include molecular lines, especially those that are known to be present in the night sky spectrum (Osterbrock et al. 1996). Imperfect sky subtraction inevitably results in night sky lines being present in the spectra of many objects, and even though these lines are not intrinsic to the object, they do require proper identification.

The current line identification software is still in a rudimentary form, yet it is already shown to be reliable and efficient in making an arduous process consistent and tractable. EMILI produces the largest gains over the traditional method in situations where there are large numbers of lines to be identified, as in our deep echelle spectra of IC 418. For spectra of lower resolution the current version of EMILI is likely to be less successful because of the importance that it assigns to wavelength accuracy. We are experimenting with making the relative weights given to the identification criteria variable and dependent upon the resolution and S/N of the spectrum. Further refinement of the software logic and steady progress in compiling more complete transition databases should produce a reliable product and have a dramatic impact on high S/N spectroscopy in the next decade.

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