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A critical compilation and extended analysis of the Ne IV spectrum

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Abstract. Since Moore published her well-known tables of atomic and ionic energy levels (in 1949-1951), the number of observed lines of the light atoms and their ions has grown significantly. The lack of complete and consistent up-to-date tables of spectral lines and energy levels, particularly of the neon-ions spectra, notably reduces possibilities of interpretation of astrophysical and laboratory spectra. In the present paper, all optical spectral lines of Ne IV observed in 24 previous works have been systematised together with recent observations made by means of the beam-foil method at Liège University. As a result of our extended analysis of the whole set of available data, 35 new energy levels have been found and 90 newly classified spectral lines have been listed for the Ne IV spectrum, only a few of them having been reported previously. A complete table of observed and classified spectral lines has been built, and the list of optimised energy levels has been derived from it in a consistent way. A new, improved, ionisation potential of Ne IV has been deduced from the experimental data.

PACS. 32.30.-r Atomic spectra – 32.10.Hq Ionization potentials, electron affinities

1 History

The observed excited terms of Ne IV are formed by combination of the $1s^22s^22p^2$ ^{3}P, ^{1}D, ^{1}S, or $1s^22s2p^3$ ^{5}S^o and ^{3}D^o parent terms with the outer nl electron. The multiple parent terms give rise to multiple series of excited terms which cross each other at different values of the principal quantum number n. The configuration interactions coming into force around these crossing points cause difficulties in the interpretation of the observed spectra and account for inconsistencies in the early studies of Ne IV.

Although a few Ne IV ultraviolet lines, unclassified or wrongly attributed to Ne III at that time, were listed in early works [1,2], the first systematic study of this spectrum was made by Boyce [3]. This work was confined to a few lines in the vacuum ultraviolet region 350–550 Å belonging to the $2p^32s$–$2p^4$ transition array. An electrodeless discharge and a 2-meter normal incidence spectrograph were used in that work.

Paul and Polster [4] fundamentally extended the knowledge of the Ne IV term structure. They have used different types of discharge tubes and a 3-m grazing incidence spectrograph to obtain spectra in the range 96 to 1010 Å. Of the 115 lines listed in [4] as Ne IV lines, 25 lines were misidentified, as found by later investigators. Most of these actually belong to Ne III and Ne V or are due to impurities such as oxygen, carbon and nitrogen which were abundant in the discharge plasma [4]. In addition, six other lines listed in [4] contained misprints either in wavelength or in the identification. Despite these significant revisions, the major part of Paul and Polster's work still is the only available data source in the EUV part of the Ne IV spectrum.

Bowen [5] accurately measured the four forbidden $2s^22p^3$ ^{2}D$-^2$P transitions observed in spectra of planetary nebulae.

The next advance of the research work on multiply ionised neon was associated with invention of the toroidal discharge installations in the late 1950s. Kaufman *et al.* [6], Bockasten *et al.* [7], and Goldsmith and Kaufman [8] observed and classified the $[2s^22p^2(^3\mathrm{P})]3s$–$3p$ doublet and quartet, $[2s^22p^2(^1\mathrm{D})]3s$–$3p$ doublet, and $[2s2p^3(^5\mathrm{S}^o)]3s$–$3p$ sextet transitions in the short UV range of the spectrum.

Tilford and Giddings [9], using a condensed capillary discharge as a light source, very accurately re-measured some of the $2s^22p^3$–$2s2p^4$ and $2s^22p^3$–$2s^22p^2(^3\mathrm{P})3s$ doublet transitions.

Lindeberg [10,11] made an extended analysis of the $n = 2$–2 and $n = 3$–3 transitions, using a theta-pinch as the light source. He identified the intersystem $2s^22p^2(^3\mathrm{P})3s$–$2s^22p^2(^1\mathrm{D})3p$ combinations,

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$[2s^22p^2(^1\mathrm{S})]3s{-}3p$, $[2s^22p^2(^3\mathrm{P},{}^1\mathrm{D})]3p{-}3d$, $[2s2p^3(^5\mathrm{S}^o)]$ $3p{-}3d$ sextet transitions, and also re-measured the $[2s^2]2p^3{-}2p^2(^3\mathrm{P},{}^1\mathrm{D})3s$ quartet and doublet transitions first observed by Paul and Polster [4], as well as the $2s^22p^3{-}2s2p^4$ and $2s2p^4{-}2p^5$ doublets and quartets observed in [3,4].

With the development of lasers, as neon is a commonly used lasing medium, there arose the need for accurate wavelengths of lasing transitions. In this connection, Marling [12] performed accurate measurements of the $3s{-}3p$ transitions known from [7,8].

Not until 1977 was the first connection between the quartet and doublet systems found in the solar spectrum by Sandlin *et al.* [13]. They have observed the weak doublet at 1601.5/1601.7 Å, identified with the forbidden $^4\mathrm{S}^o_{3/2}{-}^2\mathrm{P}^o_{3/2,1/2}$ transitions within the ground configuration close to the position predicted by Edlén [14]. The later measurement of Penston *et al.* [15] yielded 1601.47 ± 0.05 Å for the wavelength of this doublet, unresolved in their spectrum. We associate this measurement with the $^4\mathrm{S}^o_{3/2}{-}^2\mathrm{P}^o_{3/2}$ component of the doublet since it must dominate in the observed intensity, according to calculations of Kastner *et al.* [16]. Another transition of the same kind, $^4\mathrm{S}^o_{3/2}{-}^2\mathrm{D}^o_{3/2}$, was observed and identified by Lutz and Seaton in the nebula spectra [17]. Later Penston *et al.* [15] re-measured this transition more accurately and found another component of the same doublet, $^4\mathrm{S}^o_{3/2}{-}^2\mathrm{D}^o_{5/2}$, in the spectrum of a slow nova.

The sextet term system has not been connected so far with the quartet and doublet terms by any observed line.

In beam-foil studies [18–24] major attention was given to measurement of radiative lifetimes, although a number of new unidentified lines were observed in the EUV [23], vacuum ultraviolet [19], UV and visible ranges [18]. Spectral resolution was too poor in these observations to permit reliable identification of the spectral lines which were usually unresolved blends of several transitions.

The recent work of Bastin *et al.* [25], although applying the same beam-foil technique to excite the spectrum, has the important advantage of greatly improved spectral resolution which was about 0.1 Å in the region 400–1100 Å. This improvement, combined with almost certain assignment of the ionisation stage using spectra obtained at different beam energies, and with careful examination of the previously reported classifications, has permitted identification of the previously unknown $[2s^22p^2(^3\mathrm{P})]3s{-}4p$, $3p{-}4d$, $3p{-}4s$, $3p{-}5s$, $3d{-}4f$, $[2s^22p^2(^1\mathrm{D})]3p{-}4d$, and $[2s2p^3(^5\mathrm{S}^o)]3d{-}4f$ transitions.

The preceding work of Churilov *et al.* [26] was based mostly on the same wavelength measurements made by Krenzer [27] at beam energy 0.8 MeV, which were partly used by Bastin *et al.* [25] and in the present analysis. The authors of [26] were unaware of Lindeberg's analysis [10,11] of the $2l{-}2l'$ and $3l{-}3l'$ transitions, so they have started from (partly) wrong or inaccurate level values for the $3s$ and $3p$ configurations. In addition, they did not have the decisive information about the ionisation-stage origin of the observed lines provided by additional spectra registered by Bastin *et al.* [25] at beam energies 1.2 and 2.5 MeV. As a result, of the 131 transitions listed in [26], only 26 line assignments, connected with 11 levels of the $2s^22p^2(^3\mathrm{P},{}^1\mathrm{D})4s$, $4d$ and $5s$ configurations, and with the $2s2p^3(^5\mathrm{S}^o)3s$ $^4\mathrm{S}^o_{3/2}$ level, have been confirmed in [25] and in the present analysis.

In order to check the validity of several revisions of the level assignments made by different authors, we have undertaken a set of parametric calculations using Cowan's codes [28] for Ne IV and isoelectronic spectra N I through S X. In the course of these calculations, combined with analysis by means of Azarov's code IDEN [29], it was possible to find unambiguous assignments for a large number of previously unassigned or wrongly classified lines observed by previous authors. This analysis has confirmed and substantially extended the identifications made by Bastin *et al.* [25]. We have also succeeded in identifying the $4f{-}5g$ and $5g{-}6h$ transitions observed in [18,19], but not identified therein, and determining an improved value of the ionisation potential. The position of the sextet term system has been determined to $\pm\,500$ cm^{-1} on the basis of an isoelectronic extrapolation. Inclusion of the whole set of observed transitions in the level-optimisation procedure has allowed us to improve the accuracy of the known level values, including the $n = 2$ complex which is now determined with uncertainties of 1 cm^{-1} (for $2s^22p^3$) and 2–3 cm^{-1} (for $2s2p^3$ and $2p^5$). This is a slight improvement over Edlén's interpolated values [30].

2 Discussion of the observed lines and their identification

The total list of observed and classified lines of Ne IV is presented in Table 1. The line intensities reported by different authors have been converted to a uniform scale using different conversion procedures. Intensities from Paul and Polster [4] have been multiplied by 20 in order to make the scale comparable with that for the Ne V spectrum [31]. Intensities from Lindeberg's tables [10,11] have been converted with a fitted logarithmic function. Intensities of the lines from [19,23] have been estimated from the pictures of spectra presented in these papers. No account for the registration efficiency has been made, so the relative intensities are valid only for comparison of closely located lines measured in the same work.

If multiple wavelength measurements by different authors were available for a spectral line, the measurements have been averaged with weights inversely proportional to the measurement uncertainties. We have adopted 0.010 Å as an estimate of uncertainty of Paul and Polster's measurements [4] for strong isolated lines (see discussion in [31]).

In Table 1, all wavelengths below 2000 Å are in vacuum, above that in air. For computed wavelengths above 2000 Å, the calculated wavenumbers have been converted to air using the five-parameter formula of Peck and Reeder [32].

Table 1. Observed and classified lines of Ne IV.

Observed			Calculated[b]						
Intens.[a]	λ Å	unc. Å	λ Å	unc. Å	Classification[c]				Ref.[d]
60bl	140.127	0.020	140.12	0.02	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)6s$	^2D	?	[4]
			140.13	0.02	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)6s$	^2D	?	[4]
60	142.929	0.010	142.926	0.011	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)5d$	^2F		[4]
			142.935	0.011	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)5d$	^2F		[4]
40bl	144.019	0.010	144.024	0.004	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)5s$	$^4P_{5/2}$	?	[4]
40	144.151	0.010	144.150	0.005	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)5s$	$^4P_{3/2}$	?	[4]
20	144.278	0.010	-	-	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)5s$	$^4P_{1/2}$		[4]
40c	146.262	0.02	146.269	0.004	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)5s$	^2D		[4]
			146.278	0.004	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)5s$	^2D		[4]
20	148.660	0.010	-	-	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4d$	$^4P_{1/2}$		[4]
60	148.787	0.010	148.787	0.009	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4d$	$^4P_{3/2}$		[4]
80	148.942	0.010	-	-	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4d$	$^4P_{5/2}$		[4]
20	150.931	0.010	150.926	0.006	$2s^22p^3$	$^2D^o_{5/2}–2s2p^3(^3D^o)3p$	$^2F_{7/2}$	?	[4]
			150.939	0.006	$2s^22p^3$	$^2D^o_{3/2}–2s2p^3(^3D^o)3p$	$^2F_{5/2}$	?	[4]
m	-	-	151.45	0.02	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)4d$	^2P		[4]
m	-	-	151.47	0.02	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)4d$	^2P		[4]
300	151.823	0.010	151.822	0.005	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)4d$	$^2D_{5/2}$		[4]
			151.836	0.004	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)4d$	$^2D_{3/2}$		[4]
300	152.231	0.010	152.229	0.006	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)4d$	$^2F_{5/2}$		[4]
			152.240	0.006	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)4d$	$^2F_{5/2}$		[4]
			152.241	0.005	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)4d$	$^2F_{7/2}$		[4]
100w	156.480	0.02	156.48	0.02	$2s^22p^3$	$^2P^o_{1/2}–2s^22p^2(^1D)4d$	^2P		[4]
			156.48	0.02	$2s^22p^3$	$^2P^o_{3/2}–2s^22p^2(^1D)4d$	^2P		[4]
60	156.873	0.010	156.872	0.005	$2s^22p^3$	$^2P^o_{3/2}–2s^22p^2(^1D)4d$	$^2D_{5/2}$		[4]
			156.875	0.004	$2s^22p^3$	$^2P^o_{1/2}–2s^22p^2(^1D)4d$	$^2D_{3/2}$		[4]
100	157.626	0.010	157.636	0.004	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4s$	$^4P_{5/2}$		[4]
60	157.781	0.010	157.780	0.004	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4s$	$^4P_{3/2}$		[4]
40	157.862	0.010	157.870	0.004	$2s^22p^3$	$^4S^o_{3/2}–2s^22p^2(^3P)4s$	$^4P_{1/2}$		[4]
100	158.063	0.010	158.070	0.004	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^3P)4d$	$^2D_{5/2}$		[4]
40bl	158.105	0.02	158.112	0.015	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^3P)4d$	$^2D_{3/2}$		[4]
			158.12	0.02	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^3P)4d$	$^2D_{3/2}$		[4]
300	158.654	0.010	158.649	0.006	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^3P)4d$	$^2F_{7/2}$		[4]
300bl	158.822	0.010	158.824	0.007	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^3P)4d$	$^2F_{5/2}$		[4]
30bl	159.82	0.02	159.867	0.005	$2s^22p^3$	$^4S^o_{3/2}–2s2p^3(^5S^o)3p$	^4P		[34]n
200	160.471	0.010	160.478	0.004	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^1D)4s$	$^2D_{5/2}$	?	[4]
			160.491	0.004	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^1D)4s$	$^2D_{3/2}$	?	[4]
240	163.562	0.010	163.552	0.005	$2s^22p^3$	$^2P^o_{3/2}–2s^22p^2(^3P)4d$	$^2D_{5/2}$		[4]
40bl	163.602	0.02	163.60	0.02	$2s^22p^3$	$^2P^o_{1/2}–2s^22p^2(^3P)4d$	$^2D_{3/2}$		[4]
			163.60	0.02	$2s^22p^3$	$^2P^o_{3/2}–2s^22p^2(^3P)4d$	$^2D_{3/2}$		[4]
m	-	-	166.131	0.004	$2s^22p^3$	$^2P^o_{1/2}–2s^22p^2(^1D)4s$	$^2D_{3/2}$		[4]
m	-	-	166.132	0.004	$2s^22p^3$	$^2P^o_{3/2}–2s^22p^2(^1D)4s$	$^2D_{5/2}$		[4]
m	-	-	167.789	0.004	$2s^22p^3$	$^2D^o_{5/2}–2s^22p^2(^3P)4s$	$^2P_{3/2}$		-
m	-	-	167.801	0.004	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^3P)4s$	$^2P_{3/2}$		-
m	-	-	168.006	0.004	$2s^22p^3$	$^2D^o_{3/2}–2s^22p^2(^3P)4s$	$^2P_{1/2}$		-

Table 1. *Continued.*

Observed			Calculated[b]						
Intens.[a]	λ Å	unc. Å	λ Å	unc. Å	Classification[c]				Ref.[d]
800	172.492	0.010	172.489	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{1/2}$		[4]
1000	172.525	0.010	172.532	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$		[4]
1600	172.620	0.010	172.614	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{5/2}$		[4]
m	-	-	173.14	0.03	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{S})3d$	$^2\mathrm{D}$		-
m	-	-	173.14	0.03	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{S})3d$	$^2\mathrm{D}$		-
m	-	-	173.264	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$		-
m	-	-	173.267	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$		-
m	-	-	173.977	0.004	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$		[4]
m	-	-	173.979	0.004	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$		[4]
60	174.303	0.010	-	-	$2s2p^4$	$^4\mathrm{P}_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3d$	$^4\mathrm{P}^o_{5/2}$	?	[4]n
200	174.880	0.010	174.8762	0.0011	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
m	-	-	174.8898	0.0012	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
160	174.920	0.010	174.923	0.010	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{1/2}$		[4]
1000	176.007	0.010	176.000	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$		[4]
			176.031	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$		[4]
m	-	-	176.013	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$		[4]
m	-	-	176.017	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$		[4]
m	-	-	177.133	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{5/2}$		[4]
1600	177.161	0.010	177.147	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{5/2}$		[4]
			177.178	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{7/2}$		[4]
300	180.402	0.010	180.395	0.002	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{S}_{1/2}$		[4]
			180.397	0.002	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{S}_{1/2}$		[4]
400	181.614	0.010	181.6092	0.0013	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
			181.6113	0.0013	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
400	181.651	0.010	181.645	0.011	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{1/2}$		[4]
			181.648	0.011	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{1/2}$		[4]
m	-	-	182.823	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$		[4]
m	-	-	182.840	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$		[4]
m	-	-	182.842	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$		[4]
300	183.165	0.010	183.163	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$		[4]
m	-	-	183.178	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$		[4]
m	-	-	183.235	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$		[4]
240	183.247	0.010	183.250	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$		[4]
400	185.479	0.010	185.477	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{7/2}$		[4]
m	-	-	185.722	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$		[4]
bl	185.730	0.02	185.737	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$		[4]
3000	186.575	0.010	186.580	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$	?	[4]
100	186.787	0.010	186.792	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{1/2}$		[4]
300	186.915	0.010	186.909	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{3/2}$		[4]
			186.925	0.003	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{3/2}$		[4]
500	190.565	0.010	190.565	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$		[4]
300	190.645	0.010	190.641	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$		[4]
			190.643	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$		[4]
m	-	-	194.247	0.003	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$	?	[4]n
m	-	-	194.249	0.004	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$	?	[4]n

Table 1. *Continued.*

Observed			Calculated^b		Classification^c				Ref.^{d}
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å					
2000	194.276	0.030	194.285	0.004	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^3P)3d$	$^4D_{3/2}$	?	[4]n
			194.287	0.004	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^3P)3d$	$^4D_{3/2}$	?	[4]n
800	194.477	0.010	194.477	0.003	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^3P)3d$	$^2P_{1/2}$		[4]
			194.479	0.003	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^3P)3d$	$^2P_{1/2}$		[4]
1000	194.623	0.010	194.621	0.003	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^3P)3d$	$^2P_{3/2}$		[4]
			194.623	0.003	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^3P)3d$	$^2P_{3/2}$		[4]
300	197.6	0.2	197.56	0.02	$2s2p^4$	$^4P_{5/2}$–$2s2p^3(^3P^o)3s$	$^4P^o_{5/2}$	?	[23]n
300	204.270	0.020	204.249	0.006	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)4f$	$0[3]^o_{7/2}$		[4]n
			204.287	0.007	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)4f$	$0[3]^o_{5/2}$		[4]n
500	204.531	0.010	204.525	0.010	$2s2p^4$	$^4P_{5/2}$–$2s2p^3(^5S^o)3d$	$^4D^o$		[4]
300	204.786	0.010	204.782	0.010	$2s2p^4$	$^4P_{3/2}$–$2s2p^3(^5S^o)3d$	$^4D^o$		[4]
100	204.908	0.010	204.918	0.010	$2s2p^4$	$^4P_{1/2}$–$2s2p^3(^5S^o)3d$	$^4D^o$		[4]
200	206.7	0.2	206.7	0.2	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^1S)3s$	$^2S_{1/2}$		[23]n
			206.7	0.2	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^1S)3s$	$^2S_{1/2}$		[23]n
2000	208.485	0.010	208.485	0.004	$2s^22p^3$	$^4S^o_{3/2}$–$2s^22p^2(^3P)3s$	$^4P_{5/2}$		[10,4]
2000	208.734	0.007	208.737	0.004	$2s^22p^3$	$^4S^o_{3/2}$–$2s^22p^2(^3P)3s$	$^4P_{3/2}$		[10,4]
1600	208.899	0.009	208.903	0.004	$2s^22p^3$	$^4S^o_{3/2}$–$2s^22p^2(^3P)3s$	$^4P_{1/2}$		[10,4]
3000	212.552	0.006	212.547	0.004	$2s^22p^3$	$^2D^o_{5/2}$–$2s^22p^2(^1D)3s$	$^2D_{5/2}$		[10,4]
			212.564	0.004	$2s^22p^3$	$^2D^o_{3/2}$–$2s^22p^2(^1D)3s$	$^2D_{3/2}$		[10,4]
60bl	214.8	0.4	214.510	0.010	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)4p$	$^4P^o_{3/2}$		[23]n
			214.618	0.012	$2s2p^4$	$^4P_{3/2}$–$2s^22p^2(^3P)4p$	$^4P^o_{5/2}$		[23]n
			214.84	0.02	$2s2p^4$	$^4P_{3/2}$–$2s^22p^2(^3P)4p$	$^4P^o_{1/2}$		[23]n
			214.943	0.010	$2s2p^4$	$^4P_{1/2}$–$2s^22p^2(^3P)4p$	$^4P^o_{3/2}$		[23]n
800	222.600	0.010	222.573	0.004	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^1D)3s$	$^2D_{3/2}$		[4]
			222.576	0.004	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^1D)3s$	$^2D_{3/2}$		[4]
			222.579	0.004	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^1D)3s$	$^2D_{5/2}$		[4]
500	223.235	0.007	223.228	0.004	$2s^22p^3$	$^2D^o_{5/2}$–$2s^22p^2(^3P)3s$	$^2P_{3/2}$		[9]
500	223.601	0.006	223.603	0.004	$2s^22p^3$	$^2D^o_{3/2}$–$2s^22p^2(^3P)3s$	$^2P_{1/2}$		[9]
500	234.319	0.006	234.317	0.004	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^3P)3s$	$^2P_{3/2}$		[9,10,4]
			234.320	0.005	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^3P)3s$	$^2P_{3/2}$		[9,10,4]
500	234.703	0.006	234.706	0.004	$2s^22p^3$	$^2P^o_{1/2}$–$2s^22p^2(^3P)3s$	$^2P_{1/2}$		[9,10,4]
			234.709	0.005	$2s^22p^3$	$^2P^o_{3/2}$–$2s^22p^2(^3P)3s$	$^2P_{1/2}$		[9,10,4]
250bl	241.9	0.2	241.79	0.02	$2s2p^4$	$^2D_{3/2}$–$2s2p^3(^3D^o)3s$	$^2D^o_{3/2}$		[23]n
			241.81	0.02	$2s2p^4$	$^2D_{5/2}$–$2s2p^3(^3D^o)3s$	$^2D^o_{5/2}$		[23]n
200	247.422	0.010	247.426	0.008	$2s2p^4$	$^4P_{5/2}$–$2s2p^3(^5S^o)3s$	$^4S^o_{3/2}$		[4]
160	247.807	0.010	247.803	0.009	$2s2p^4$	$^4P_{3/2}$–$2s2p^3(^5S^o)3s$	$^4S^o_{3/2}$		[4]
160	248.004	0.010	248.002	0.008	$2s2p^4$	$^4P_{1/2}$–$2s2p^3(^5S^o)3s$	$^4S^o_{3/2}$		[4]
300	286.448	0.010	286.431	0.008	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)3p$	$^4S^o_{3/2}$		[4]
300	286.934	0.010	286.935	0.008	$2s2p^4$	$^4P_{3/2}$–$2s^22p^2(^3P)3p$	$^4S^o_{3/2}$		[4]
200	287.206	0.010	287.202	0.008	$2s2p^4$	$^4P_{1/2}$–$2s^22p^2(^3P)3p$	$^4S^o_{3/2}$		[4]
300	293.123	0.010	293.127	0.008	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)3p$	$^4P^o_{5/2}$		[4]
200	293.429	0.010	293.424	0.009	$2s2p^4$	$^4P_{5/2}$–$2s^22p^2(^3P)3p$	$^4P^o_{3/2}$		[4]
100	293.649	0.010	293.655	0.009	$2s2p^4$	$^4P_{3/2}$–$2s^22p^2(^3P)3p$	$^4P^o_{5/2}$		[4]
20	293.947	0.010	293.954	0.008	$2s2p^4$	$^4P_{3/2}$–$2s^22p^2(^3P)3p$	$^4P^o_{3/2}$		[4]

Table 1. *Continued.*

Observed			Calculated^b		Classification^c				
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å					Ref.^{d}
60	294.100	0.010	294.100	0.009	$2s2p^4$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$		[4]
60	294.390	0.010	294.380	0.008	$2s2p^4$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$		[4]
1000	357.839	0.01	357.832	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^2\mathrm{P}_{1/2}$		[11,4]
4000	358.693	0.01	358.694	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s2p^4$	$^2\mathrm{P}_{3/2}$		[11]
m	-	-	358.751	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^2\mathrm{P}_{3/2}$		[11]
2500	387.143	0.01	387.139	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s2p^4$	$^2\mathrm{P}_{1/2}$		[11,4]
			387.149	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^2\mathrm{P}_{1/2}$		[11,4]
2000	388.219	0.01	388.215	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s2p^4$	$^2\mathrm{P}_{3/2}$		[11,4]
			388.225	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^2\mathrm{P}_{3/2}$		[11,4]
p	393.538	0.01	393.540	0.003	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s2p^4$	$^2\mathrm{D}_{3/2}$		[30]
3000	421.606	0.01	421.598	0.006	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s2p^4$	$^2\mathrm{S}_{1/2}$		[11,4]
			421.609	0.006	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^2\mathrm{S}_{1/2}$		[11,4]
500	431.474	0.01	431.476	0.006	$2s2p^4$	$^2\mathrm{D}_{3/2}$–$2p^5$	$^2\mathrm{P}^o_{1/2}$		[11,4]
1000	433.236	0.01	433.234	0.006	$2s2p^4$	$^2\mathrm{D}_{5/2}$–$2p^5$	$^2\mathrm{P}^o_{3/2}$		[11,4]
m	-	-	433.276	0.006	$2s2p^4$	$^2\mathrm{D}_{3/2}$–$2p^5$	$^2\mathrm{P}^o_{3/2}$		[11]
50	461.17	0.15	461.26	0.02	$2s2p^4$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$		[35]n
40	462.99	0.10	463.04	0.02	$2s2p^4$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{1/2}$		[35]n
400	469.775	0.007	469.777	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s2p^4$	$^2\mathrm{D}_{3/2}$		[11,9]
4000	469.822	0.010	469.825	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s2p^4$	$^2\mathrm{D}_{5/2}$		[11,9]
4000	469.868	0.009	469.875	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^2\mathrm{D}_{3/2}$		[11,9,4]
400	469.924	0.007	469.924	0.004	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^2\mathrm{D}_{5/2}$		[11,9]
60	475.30	0.10	475.31	0.10	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s2p^3(^3\mathrm{P}^o)3s$	$^4\mathrm{P}^o_{5/2}$	?	[35]n
500	521.741	0.006	521.738	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s2p^4$	$^2\mathrm{D}_{3/2}$		[11,9,4]
			521.755	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^2\mathrm{D}_{3/2}$		[11,9,4]
500	521.816	0.007	521.815	0.005	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^2\mathrm{D}_{5/2}$		[11,9,4]
20	536.960	0.01	536.952	0.009	$2s2p^4$	$^2\mathrm{S}_{1/2}$–$2p^5$	$^2\mathrm{P}^o_{1/2}$		[11]
60	539.731	0.010	539.741	0.008	$2s2p^4$	$^2\mathrm{S}_{1/2}$–$2p^5$	$^2\mathrm{P}^o_{3/2}$		[4]
1600	541.129	0.01	541.126	0.010	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{1/2}$		[11,4]
2000	542.072	0.01	542.076	0.010	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{3/2}$		[11,4]
3000	543.891	0.01	543.886	0.010	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{5/2}$		[11,4]
130	558.07	0.10	558.07	0.10	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s2p^3(^3\mathrm{D}^o)3s$	$^2\mathrm{D}^o_{3/2}$		[35]n
150	559.16	0.10	559.02	0.05	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{D}_{3/2}$		[35]n
190	560.48	0.10	560.47	0.10	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3s$	$^2\mathrm{D}^o_{5/2}$		[35]n
100	563.38	0.10	563.36	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{3/2}$		[35]n
90	564.03	0.10	563.97	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{5/2}$		[35]n
			564.03	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{3/2}$		[35]n
120	565.06	0.10	564.96	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{7/2}$		[35]n
			565.09	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{5/2}$		[35]n
40	565.18	0.15	565.15	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{3/2}$		[35]n
150	566.51	0.10	566.50	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{7/2}$		[35]n
m	-	-	574.67	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{3/2}$		[35]n
150	575.12	0.10	575.16	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{5/2}$		[35]n
			575.23	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{3/2}$		[35]n
220	576.13	0.10	576.17	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{7/2}$		[35]n
70	577.58	0.15	577.44	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^2\mathrm{F}_{5/2}$	?	[35]n

Table 1. *Continued.*

Observed			Calculated^b						
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å	Classification^c				Ref.^{d}
80	579.65	0.10	579.69	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{3/2}$		[35]n
			579.77	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^2\mathrm{F}_{7/2}$	?	[35]n
130	580.52	0.10	580.44	0.06	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{5/2}$		[25]
110	580.92	0.10	580.88	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{3/2}$		[25]
130	583.61	0.10	583.60	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{3/2}$		[25]
			583.61	0.09	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{5/2}$		[25]
30	584.87	0.10	584.91	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{3/2}$		[35]n
60	585.30	0.15	585.28	0.15	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{1/2}$		[25]
160	585.61	0.10	585.58	0.09	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{5/2}$		[25]
140bl	586.92	0.10	586.89	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{3/2}$		[25]
70	589.50	0.10	589.40	0.06	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{5/2}$		[35]n
			589.65	0.05	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$		[35]n
130	590.29	0.10	590.13	0.06	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$		[35]n
6	590.58	0.15	590.60	0.06	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{5/2}$		[25]
60	591.54	0.10	591.52	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{3/2}$		[35]n
170	592.67	0.10	592.70	0.09	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{3/2}$		[25]
320	593.18	0.10	593.12	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{1/2}$		[25]
			593.16	0.08	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{5/2}$		[25]
530	593.92	0.10	593.93	0.10	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{7/2}$		[25]
120	594.05	0.15	594.04	0.09	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{3/2}$		[25]
30	594.36	0.10	594.47	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{1/2}$		[25]
110	595.18	0.10	595.20	0.08	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{5/2}$		[25]
250	602.985	0.01	602.989	0.010	$2s2p^4$	$^2\mathrm{P}_{3/2}$–$2p^5$	$^2\mathrm{P}^o_{1/2}$		[11]
420	605.594	0.01	605.604	0.010	$2s2p^4$	$^2\mathrm{P}_{1/2}$–$2p^5$	$^2\mathrm{P}^o_{1/2}$		[11]
1050	606.510	0.01	606.509	0.010	$2s2p^4$	$^2\mathrm{P}_{3/2}$–$2p^5$	$^2\mathrm{P}^o_{3/2}$		[11]
240	609.164	0.01	609.154	0.010	$2s2p^4$	$^2\mathrm{P}_{1/2}$–$2p^5$	$^2\mathrm{P}^o_{3/2}$		[11]
60	610.68	0.10	610.68	0.06	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$		[35]n
130	619.75	0.10	619.80	0.07	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}_{5/2}$		[35]n
80	629.74	0.15	629.77	0.07	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{1/2}$		[35]n
150bl	632.66	0.10	632.59	0.08	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{1/2}$		[35]n
120	633.04	0.10	633.13	0.06	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$		[35]n
100	634.37	0.10	634.33	0.06	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$		[35]n
80	677.47	0.15	677.39	0.11	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{3/2}$		[35]n
			677.5	0.2	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{P}_{3/2}$		[35]n
50	677.97	0.10	678.09	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{5/2}$		[35]n
80	679.24	0.10	679.24	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{7/2}$		[35]n
270	684.42	0.10	-	-	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}_{3/2}$	?	[35]n
			-	-	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}_{5/2}$	?	[35]n
820bl	684.76	0.10	-	-	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}_{9/2}$	?	[25]
			-	-	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}_{7/2}$	?	[25]
200	692.72	0.10	692.64	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{5/2}$		[25]
			692.79	0.11	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{3/2}$		[25]
230	693.23	0.10	693.20	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{7/2}$		[25]
50	693.63	0.15	693.60	0.11	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{3/2}$		[25]
70	694.44	0.15	694.31	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}_{5/2}$		[35]n

Table 1. *Continued.*

Observed			Calculated^b						
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å	Classification^c				Ref.^{d}
150bl	696.74	0.10	696.73	0.09	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{G}$		[25]
m	-	-	696.77	0.02	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{1/2}$		[35]n
210	697.41	0.10	697.41	0.09	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{G}$		[25]
m	-	-	698.13	0.02	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s2p^4$	$^4\mathrm{P}_{3/2}$		[35]n
m	-	-	698.35	0.02	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{3/2}$		[35]n
40	701.03	0.15	700.98	0.11	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^2\mathrm{F}_{7/2}$	?	[35]n
			701.10	0.09	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{F}_{7/2}$		[35]n
m	-	-	701.14	0.02	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s2p^4$	$^4\mathrm{P}_{5/2}$		[35]n
m	-	-	701.36	0.02	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{5/2}$		[30]
50	702.33	0.10	702.31	0.10	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o_{5/2}$		[35]n
170	712.89	0.15	712.83	0.13	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{F}_{5/2}$		[25]
260	713.10	0.10	713.13	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{F}_{7/2}$		[25]
170	720.75	0.10	720.73	0.09	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{D}_{5/2}$		[35]n
70	721.26	0.10	721.34	0.08	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{D}_{3/2}$		[35]n
100	728.53	0.15	728.47	0.11	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}_{5/2}$		[35]n
130	729.63	0.15	729.69	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{D}_{5/2}$		[35]n
270	730.44	0.10	730.29	0.10	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{F}_{7/2}$		[25]
			730.55	0.12	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{F}_{5/2}$		[25]
60w	758.317	0.02	758.32	0.02	$2p^5$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{S}_{1/2}$		[4]
m	-	-	763.89	0.03	$2p^5$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{S}_{1/2}$		[4]
60w	780.250	0.02	780.24	0.02	$2p^5$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
20	786.141	0.010	786.142	0.010	$2p^5$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}_{3/2}$		[4]
60	809.25	0.10	809.26	0.07	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$		[35]n
50	819.40	0.10	819.41	0.02	$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$–$2s2p^4$	$^4\mathrm{P}_{3/2}$		[35]n
			819.45	0.03	$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$–$2s2p^4$	$^4\mathrm{P}_{3/2}$		[35]n
80bl	821.06	0.10	821.01	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$		[25]
50	825.95	0.10	825.94	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{1/2}$		[25]
15	883.76	0.15	883.74	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$		[25]
90	886.52	0.10	886.49	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$		[25]
			886.58	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]
110	888.22	0.10	888.26	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]
110	889.52	0.10	889.43	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{1/2}$		[25]
430	890.25	0.10	890.28	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$		[25]
310*	891.05	0.10	891.04	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]
310*	891.05	0.10	891.12	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{1/2}$		[25]
m	-	-	906.49	0.10	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{3/2}$–$2s2p^3(^5\mathrm{S}^o)4s$	$^6\mathrm{S}^o_{5/2}$		[35]n
110	906.88	0.10	906.89	0.10	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{5/2}$–$2s2p^3(^5\mathrm{S}^o)4s$	$^6\mathrm{S}^o_{5/2}$		[35]n
140	907.54	0.10	907.54	0.10	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{7/2}$–$2s2p^3(^5\mathrm{S}^o)4s$	$^6\mathrm{S}^o_{5/2}$		[35]n
60	911.54	0.10	911.53	0.08	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$		[25]
170	914.39	0.10	914.41	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$		[25]
80	914.93	0.10	914.93	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]
50	916.35	0.10	916.34	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]
150	916.97	0.10	916.98	0.10	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}_{3/2}$		[35]n
180	918.14	0.10	918.13	0.10	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}_{5/2}$		[35]n
80	919.35	0.10	919.25	0.09	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$		[25]

Table 1. *Continued.*

Observed			Calculated^b					
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å	Classification^c			Ref.^{d}
			919.38	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{1/2}$	[25]
40	922.73	0.10	922.74	0.08	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3s$	$^4\mathrm{S}^o_{3/2}$	[35]n
50bl	938.03	0.10	938.03	0.13	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{D}_{5/2}$	[35]n
			938.08	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$	[25]
190	944.39	0.10	944.36	0.11	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$	[25]
			944.53	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{1/2}$	[25]
120	968.86	0.10	968.84	0.10	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}_{5/2}$	[35]n
80	969.83	0.10	969.79	0.10	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}_{3/2}$	[35]n
50	982.72	0.15	982.85	0.11	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[3]^o_{7/2}$	[35]n
50	985.91	0.10	985.93	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{9/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[4]^o_{9/2}$	[25]
120	986.39	0.10	986.34	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{5/2}$	[25]
60	987.58	0.10	987.63	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o_{9/2}$	[35]n
80	990.42	0.10	990.45	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{7/2}$	[25]
190	991.96	0.10	991.88	0.11	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{5/2}$	[25]n
			991.98	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{3/2}$	[25]
380	992.44	0.10	992.42	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{9/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o_{11/2}$	[25]
140	993.07	0.10	993.10	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{7/2}$	[35]n
310	993.81	0.10	993.83	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{9/2}$	[25]
60	994.23	0.15	994.15	0.15	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o_{5/2}$	[35]n
90	995.19	0.10	995.20	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o_{7/2}$	[35]n
50	995.52	0.15	995.54	0.12	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}_{1/2}$	[25]
80	995.95	0.10	995.89	0.11	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{7/2}$	[25]n
			996.01	0.12	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{3/2}$	[25]
440	998.28	0.10	998.18	0.13	$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{9/2}$–$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$	[25]
			998.22	0.14	$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{7/2}$–$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$	[25]
			998.28	0.14	$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{5/2}$–$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$	[25]
			998.35	0.14	$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{3/2}$–$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$	[25]
			998.39	0.13	$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{1/2}$–$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$	[25]
30	1002.15	0.10	1002.11	0.10	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}_{1/2}$	[25]
110	1021.98	0.10	1021.98	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[3]^o_{7/2}$	[25]
110	1022.89	0.10	1022.84	0.14	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o_{5/2}$	[25]
			1022.94	0.14	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o_{5/2}$	[25]
250	1023.48	0.10	1023.46	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[4]^o_{9/2}$	[25]
80	1024.10	0.10	1024.02	0.12	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[3]^o_{7/2}$	[25]
			1024.15	0.13	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o_{3/2}$	[25]n
170	1024.54	0.10	1024.53	0.10	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{7/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$	[35]n
70	1025.23	0.10	1025.21	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o_{3/2}$	[35]n
120	1026.03	0.10	1026.03	0.10	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$	[35]n
270	1026.77	0.10	1026.73	0.14	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{9/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[5]^o$	[35]n
			1026.82	0.14	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{7/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[5]^o$	[35]n
100bl	1027.23	0.10	1027.30	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{5/2}$	[35]n
90	1029.64	0.15	1029.73	0.18	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o_{5/2}$	[35]n
			1029.74	0.12	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}_{5/2}$	[35]n
40	1033.82	0.10	-	-	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[2]^o_{5/2}$	[35]n
40	1035.97	0.10	1035.94	0.13	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{9/2}$	[35]n

Table 1. *Continued.*

Observed			Calculated[b]					
Intens.[a]	λ Å	unc. Å	λ Å	unc. Å	Classification[c]			Ref.[d]
			1036.09	0.12	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{7/2}$	[35]n
50	1038.37	0.10	1038.37	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o_{7/2}$	[35]n
50	1039.16	0.10	1039.10	0.11	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{9/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$	[35]n
			1039.20	0.11	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{7/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$	[35]n
50	1057.31	0.10	-	-	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[1]^o_{3/2}$	[35]n
40	1058.60	0.10	-	-	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[1]^o_{1/2}$	[35]n
40	1060.02	0.10	1059.95	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{7/2}$	[35]n
80	1060.90	0.10	1060.85	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{7/2}$	[25]
120	1062.44	0.10	1062.41	0.10	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o_{9/2}$	[25]
60	1063.88	0.10	1063.88	0.11	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[3]^o$	[25]c
			1063.89	0.14	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o_{7/2}$	[25]c
60	1064.52	0.10	1064.51	0.10	$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^1\mathrm{D})4f$	$2[3]^o$	[35]n
17	1066.29	0.15	1066.30	0.14	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o_{7/2}$	[35]n
10	1269.693	0.01	1269.680	0.007	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$	[10]
20	1274.522	0.01	1274.515	0.008	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{1/2}$	[10]
90	1281.176	0.01	1281.185	0.008	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$	[10]
10	1286.106	0.01	1286.109	0.007	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{1/2}$	[10]
500	1344.6	1.5	1343.5	0.5	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{3/2}$	[19]n
			1344.1	0.4	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{5/2}$	[19]n
			1344.3	0.6	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{9/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o_{7/2}$	[19]n
200	1356.6	1.5	1356.4	0.4	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{7/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o_{5/2}$	[19]n
			-	-	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o_{3/2}$	[19]n
100	1368.5	1.5	1368.5	0.5	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{5/2}$	[19]n
200	1374.484	0.01	1374.491	0.007	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$	[10]
20	1387.987	0.01	1387.985	0.007	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$	[10]
400	1389.896	0.01	1389.895	0.007	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$	[10]
50	1422.0	1.5	1421.9	0.9	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{1/2}$	[19]n
			1422.6	0.4	$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o_{3/2}$	[19]n
50	1493.4	1.5	1494.5	0.5	$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o_{5/2}$	[19]n
	1601.47	0.05	1601.45	0.03	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$	[15]
	1601.7	0.3	1601.61	0.03	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$	[13]
200	1617.9	1.7	1617.5	0.2	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$	[19]n
20	1633.608	0.01	1633.608	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{1/2}$	[10]
40	1643.853	0.01	1643.853	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}_{3/2}$	[10]
5	1774.344	0.01	1774.352	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$	[10]
20bl	1787.65	0.03	1787.642	0.012	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$	[10]
10bl	1787.93	0.03	1787.952	0.014	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$	[10]
10	1789.988	0.01	1789.989	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$	[10]
10	1792.651	0.01	1792.656	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$	[10]
40	1798.926	0.01	1798.932	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$	[10]
10	1799.23	0.03	1799.246	0.014	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$	[10]
200	1800.495	0.01	1800.494	0.010	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$	[10]
m	-	-	1800.72	0.02	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$	[10]
90	1808.210	0.01	1808.210	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$	[10]
90	1810.459	0.01	1810.459	0.010	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{1/2}$	[10]

Table 1. *Continued.*

Observed			Calculated^b					
Intens.^{a}	λ Å	unc. Å	λ Å	unc. Å	Classification^c			Ref.^{d}
20bl	1814.62	0.03	1814.595	0.013	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$	[10]
20bl	1814.69	0.03	1814.707	0.011	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$	[10]
20	1815.528	0.01	1815.526	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{1/2}$	[10]
2	1820.28	0.03	1820.271	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$	[10]
10	1829.387	0.01	1829.392	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{5/2}$	[10]
20	1831.810	0.01	1831.805	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$	[10]
40bl	1841.06	0.03	1841.042	0.011	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{5/2}$	[10]
90bl	1841.78	0.03	1841.767	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$	[10]
400	1854.804	0.01	1854.810	0.009	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$	[10]
900	1874.900	0.01	1874.894	0.009	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$	[10]
20	1895.775	0.01	1895.774	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{1/2}$	[10]
40	1899.395	0.01	1899.389	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$	[10]
200	1905.128	0.01	1905.133	0.008	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$	[10]
90	1905.481	0.01	1905.485	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{3/2}$	[10]
900	1910.647	0.01	1910.641	0.008	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{7/2}$	[10]
40	1917.774	0.01	1917.771	0.009	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}_{5/2}$	[10]
200	1931.36	0.03	1931.34	0.03	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{3/2}$	[10]
400	1931.930	0.01	1931.927	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$	[10]
200	1934.161	0.01	1934.161	0.010	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{7/2}$	[10]
900	1934.505	0.01	1934.511	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$	[10]
2000	1938.612	0.01	1938.612	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{9/2}$	[10]
40	1939.29	0.03	1939.31	0.03	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{3/2}$	[10]
400	1939.740	0.01	1939.740	0.010	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}_{9/2}$	[10]
40	1945.120	0.01	1945.119	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{5/2}$	[10]
40	1952.641	0.01	1952.636	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}_{7/2}$	[10]
10	1981.52	0.03	1981.51	0.02	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{5/2}$	[10]
90	1985.13	0.03	1985.108	0.014	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{5/2}$	[10]
20bl	1985.25	0.03	1985.25	0.03	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{3/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{1/2}$	[10]
40bl	1985.41	0.03	1985.42	0.03	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{3/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{3/2}$	[10]
20	1985.68	0.03	1985.68	0.02	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{3/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{5/2}$	[10]
10	1987.33	0.03	1987.32	0.03	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{3/2}$	[10]
40	1987.574	0.01	1987.574	0.010	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{5/2}$	[10]
90	1987.844	0.01	1987.846	0.010	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{7/2}$	[10]
40	1989.036	0.01	1989.029	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{1/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$	[10]
m	-	-	1990.99	0.03	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{7/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{7/2}$	[10]
400	1991.133	0.01	1991.135	0.010	$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{7/2}$–$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o_{9/2}$	[10]
20	1992.643	0.01	1992.640	0.010	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{7/2}$	[10]
2	1993.7	0.3	1993.696	0.015	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}_{3/2}$	[10]
400	2018.429	0.01	2018.425	0.009	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$	[12,10,7]
900	2022.186	0.005	2022.187	0.005	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$	[12]
900	2037.954	0.01	2037.952	0.018	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{5/2}$	[10]
			2037.954	0.013	$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}_{7/2}$	[10]
40	2068.763	0.01	2068.765	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$	[10]
10	2071.321	0.01	2071.323	0.010	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$	[10]
90	2073.814	0.01	2073.816	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{1/2}$	[10]

Table 1. *Continued.*

Observed			Calculated[b]		Classification[c]				Ref.[d]
Intens.[a]	λ Å	unc. Å	λ Å	unc. Å					
2	2077.99	0.03	2077.99	0.03	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{3/2}$	?	[10]
400	2099.503	0.01	2099.498	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{3/2}$		[10]
40	2104.707	0.01	2104.702	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{P}^o_{1/2}$		[10]
20	2137.938	0.01	2137.937	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{1/2}$		[10]
40	2144.524	0.01	2144.524	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{3/2}$		[10]
90	2157.206	0.01	2157.201	0.010	$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}_{5/2}$		[10]
90	2167.04	0.03	-	-	$2s^22p^2(^1\mathrm{S})3s$	$^2\mathrm{S}_{1/2}$–$2s^22p^2(^1\mathrm{S})3p$	$^2\mathrm{P}^o_{3/2}$		[10]
20	2167.22	0.03	-	-	$2s^22p^2(^1\mathrm{S})3s$	$^2\mathrm{S}_{1/2}$–$2s^22p^2(^1\mathrm{S})3p$	$^2\mathrm{P}^o_{1/2}$		[10]
90	2174.437	0.01	2174.436	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$		[10]
90	2176.142	0.01	2176.135	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$		[10]
m	-	-	2182.43	0.02	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$		[10]
40	2192.648	0.01	2192.647	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$		[10]
90	2200.780	0.01	2200.778	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{1/2}$		[10]
400	2203.850	0.01	2203.845	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{5/2}$		[10]
90	2220.772	0.01	2220.782	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{P}^o_{3/2}$		[10]
20	2245.10	0.03	2245.11	0.03	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{5/2}$		[10]
40	2247.28	0.03	2247.29	0.02	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}_{7/2}$		[10]
900	2258.02	0.02	2258.02	0.02	$2s2p^3(^5\mathrm{S}^o)3s$	$^6\mathrm{S}^o_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{7/2}$		[7]
400	2262.08	0.02	2262.08	0.02	$2s2p^3(^5\mathrm{S}^o)3s$	$^6\mathrm{S}^o_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{5/2}$		[7]
200	2264.54	0.02	2264.54	0.02	$2s2p^3(^5\mathrm{S}^o)3s$	$^6\mathrm{S}^o_{5/2}$–$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}_{3/2}$		[7]
900	2285.793	0.005	2285.792	0.005	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{7/2}$		[12]
150	2293.14	0.05	2293.12	0.03	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{5/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$		[8]
400	2293.48	0.02	2293.48	0.02	$2s^22p^2(^1\mathrm{D})3s$	$^2\mathrm{D}_{3/2}$–$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{F}^o_{5/2}$		[8,7,10]
90	2350.84	0.02	2350.855	0.014	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$		[8,10]
400	2352.554	0.005	2352.556	0.005	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$		[12]
2000	2357.980	0.005	2357.979	0.005	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{7/2}$		[12]
90	2362.68	0.01	2362.680	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$		[8,10]
5	2371.30	0.03	2371.30	0.02	$2s^22p^2(^1\mathrm{D})3p$	$^2\mathrm{P}^o_{3/2}$–$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}_{5/2}$	?	[10]
200	2372.16	0.02	2372.155	0.012	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$		[8,10]
400	2373.208	0.01	2373.210	0.010	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{5/2}$		[12,8,10]
90bl	2373.32	0.03	2373.33	0.02	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$		[10]
10	2384.20	0.05	2384.20	0.02	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{1/2}$		[8]
200	2384.96	0.02	2384.973	0.009	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{5/2}$		[8]
10	2405.11	0.03	2405.118	0.013	$2s^22p^2(^3\mathrm{P})3s$	$^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^4\mathrm{D}^o_{3/2}$		[10]
10	2413.83	0.03	2413.86	0.03	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{D}^o_{3/2}$		[10]
	2421.69	0.05	2421.66	0.05	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$		[15]
	2424.23	0.05	2424.28	0.05	$2s^22p^3$	$^4\mathrm{S}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$		[15]
84	2485.9	1.5	-	-	$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$–$2s^22p^2(^1\mathrm{D})5g$	2[5]	?	[18]n
90	2504.9	1.5	2503.8	1.5	$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o_{11/2}$–$2s^22p^2(^3\mathrm{P})5g$	2[6]	?	[18]n
			2506	2	$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{9/2}$–$2s^22p^2(^3\mathrm{P})5g$	1[5]	?	[18]n
64	2510.4	1.5	2509	2	$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o_{7/2}$–$2s^22p^2(^3\mathrm{P})5g$	1[5]	?	[18]n
			2511	2	$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o_{9/2}$–$2s^22p^2(^3\mathrm{P})5g$	2[6]	?	[18]n
64	2520.5	1.5	-	-	$2s^22p^2(^3\mathrm{P})4f$	$2[4]^o_{9/2}$–$2s^22p^2(^3\mathrm{P})5g$	2[5]	?	[18]n
			-	-	$2s^22p^2(^3\mathrm{P})4f$	$2[3]^o_{7/2}$–$2s^22p^2(^3\mathrm{P})5g$	2[4]	?	[18]n
m	-	-	3713.47	0.05	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{1/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$		[10]

Table 1. *Continued.*

Observed			Calculated[b]		Classification[c]				Ref.[d]
Intens.[a]	λ Å	unc. Å	λ Å	unc. Å					
40	3813.67	0.03	3813.67	0.03	$2s^22p^2(^3\mathrm{P})3s$	$^2\mathrm{P}_{3/2}$–$2s^22p^2(^3\mathrm{P})3p$	$^2\mathrm{S}^o_{1/2}$		[10]
121	4609.8	1.5	-	-	$2s^22p^2(^1\mathrm{D})5g$	2[5]–$2s^22p^2(^1\mathrm{D})6h$	$2[6]^o$	?	[18]n
			-	-	$2s^22p^2(^3\mathrm{P})5g$	2[6]–$2s^22p^2(^3\mathrm{P})6h$	$2[7]^o$	?	[18]n
46	4646.8	1.5	-	-	$2s^22p^2(^3\mathrm{P})5g$	1[5]–$2s^22p^2(^3\mathrm{P})6h$	$1[6]^o$	?	[18]n
45	4651.6	1.5	-	-	$2s^22p^2(^3\mathrm{P})5g$	2[4]–$2s^22p^2(^3\mathrm{P})6h$	$2[5]^o$	?	[18]n
	4714.25	0.04	4714.23	0.04	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$		[5]
	4715.61	0.04	4715.64	0.04	$2s^22p^3$	$^2\mathrm{D}^o_{5/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$		[5]
	4724.15	0.04	4724.17	0.04	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{3/2}$		[5]
	4725.62	0.04	4725.58	0.04	$2s^22p^3$	$^2\mathrm{D}^o_{3/2}$–$2s^22p^3$	$^2\mathrm{P}^o_{1/2}$		[5]

[a] Intensity legends: w – wide, diffuse, hazy; c – complex feature; bl – blended with another line that may affect the wavelength and/or intensity; (includes “shoulder”, “affected” etc.); m – masked (no wavelength measured); p – predicted (but not observed). Intensity values, converted to a uniform scale (see the text), are given in arbitrary units.

[b] If no calculated wavelength is given, this means that one of the levels involved in the transition is determined from this single line.

[c] The lines for which the classification is uncertain are marked with a question mark. Some of them are discussed in the text. In most of the other cases one of the levels involved is determined by this single line.

[d] References are given for the papers from which the wavelength was taken or derived. Symbol “n” after the reference indicates that a new identification is proposed here for this previously unclassified line; symbol “c” is to show that the identification is changed compared to the cited papers.

In the following section we discuss the lines for which some corrections have been made compared to the original literature.

Since the light source used by Paul and Polster [4] was contaminated by oxygen, the observed wavelength at 140.127 Å was probably affected by blending with the O V line at 140.115 Å [33], thus its assignment to the $2s^22p^3$ $^2\mathrm{D}^o$–$2s^22p^2(^1\mathrm{D})6s$ $^2\mathrm{D}$ transition [4] is questionable.

In Paul and Polster's Ne IV linelist [4], the wavelength 144.288 Å must read 144.278, as follows from the wavenumber 693 106 cm^{-1} given in the same table.

According to Bastin *et al.* [25], the $2s^22p^2(^1\mathrm{S})4d$ $^2\mathrm{D}$ term identification from [4] must be discarded, since both lines that were associated with this term (149.589 and 154.488 Å [4]) actually belong to Ne V, as found by Hermansdorfer [34]. The position of the $2s^22p^2(^1\mathrm{S})4d$ $^2\mathrm{D}$ term proposed in [4] (707 000 cm^{-1}) is too far from theoretical calculations (743 000 cm^{-1} [35], or 731 630 cm^{-1}, this work). Although the wavelength 154.488 Å is outside of the error bars of its predicted position in Ne V (154.520 ± 0.007 Å [31]), we could not find an unambiguous assignment for it among Ne IV transitions.

Paul and Polster's wavelength 151.817 Å must read 151.823 Å, since the given wavenumber 658 662 cm^{-1} exactly equals the difference of the $2s^22p^2(^1\mathrm{D})4d$ $^2\mathrm{D}$ energy and the centre of gravity of $2s^22p^3$ $^2\mathrm{D}$, as given by Paul and Polster [4]. The upper level was determined by this single line. There is also a misprint in the classification. The upper level must be $2s^22p^2(^1\mathrm{D})4d$ $^2\mathrm{D}$ instead of $2s^22p^2(^1\mathrm{S})4d$ $^2\mathrm{D}$, as follows from the table of energy levels in [4]. The neighboring line, listed as 151.456 Å [4], has the same misprint in the parent term. Its upper level should read $2s^22p^2(^1\mathrm{D})4d$ $^2\mathrm{P}$. We do not give an observed wavelength for this line since it was masked by O V, and the wavelength given by Paul and Polster [4] is the calculated one.

The wavelength 158.646 Å does not agree with the wavenumber 630 302 cm^{-1} [4]. We think the wavelength must read 158.654 Å, since the given wavenumber 630 302 cm^{-1} exactly corresponds to the difference of energies in the level list of [4], and the upper level was determined from this single line.

The line at 158.063 Å had been assigned to the $2s^22p^3$ $^2\mathrm{D}^o$–$2s^22p^2(^3\mathrm{P})4d$ $^2\mathrm{D}_{5/2}$ by Paul and Polster [4]. Based on our parametric calculations, we have restricted this assignment to the $J = 5/2 - 5/2$ component since the $J = 3/2 - 5/2$ component has a negligible intensity.

In the same way, the 158.822 Å line is associated with the $[2s^2]2p^3$ $^2\mathrm{D}^o_{3/2}$–$2p^2(^3\mathrm{P})4d$ $^2\mathrm{F}_{5/2}$ transition, as the $J = 5/2 - 5/2$ transition gives only a 5% contribution to the line intensity. It should be noted that this assignment is consistent with our parametric calculations and supported by the observation of the $[2s^2]2p^2(^3\mathrm{P})3p$ $^2\mathrm{D}^o_{3/2}$–$2p^2(^3\mathrm{P})4d$ $^2\mathrm{F}_{5/2}$ combination at 712.89 Å [25], as well as the $[2s^2]2p^3$ $^2\mathrm{D}^o_{5/2}$–$2p^2(^3\mathrm{P})4d$ $^2\mathrm{F}_{7/2}$ and $[2s^2]2p^2(^3\mathrm{P})3p$ $^2\mathrm{D}^o_{5/2}$–$2p^2(^3\mathrm{P})4d$ $^2\mathrm{F}_{7/2}$ transitions at 158.654 and 713.10 Å [4,25]. Thus blending of the 158.822 Å line by Ne V and O V [31,33,34] does not cause any questions with the Ne IV assignment.

The wavelength at 181.691 Å [4] must read 181.651, as follows from its wavenumber 550 506 cm^{-1}.

New identifications of the $2s^22p^2(^3\mathrm{P})4s\ ^2\mathrm{P}_{3/2}$ level [25] are incompatible with Paul and Polster's assignments of the lines, listed by them at 174.303, 174.120 and 167.921 Å, to this term. As pointed out by Bastin *et al.* [25], the line at 174.120 Å was marked as "blended with O V" in [4], and the line at 167.921 Å was also assigned to a Ne V transition in [4]. Thus Paul and Polster's assignment of the $2s^22p^2(^3\mathrm{P})4s\ ^2\mathrm{P}_{3/2}$ level is based on one weak line at 174.303 Å, and rejection of this assignment in [25] seems reasonable. The assignment of the 168.101 Å line (which appears to be blended with the O V 168.132 Å line [33]) to the $[2s^2]2p^3\ ^2\mathrm{D}^o_{3/2}$–$2p^2(^3\mathrm{P})4s\ ^2\mathrm{P}_{1/2}$ transition has also to be discarded, as the predicted position of this line (based on Bastin's identification of the $4s\ ^2\mathrm{P}_{1/2}$ level) is 168.006 ± 0.004 Å. It was probably masked by the O V line at 168.007 Å [33].

The wavelength 185.370 Å [4] is a misprint: 185.730 should stay instead, as follows from the wavenumber presented in the same table. Also, the line is marked as blended by O V [4]. There exists an intense O V line at 185.745 Å [33], but there is none around 185.37 Å.

The lines at 186.575 and 194.276 Å [4] cannot be the $[2s^2]2p^3\ ^2\mathrm{D}^o$–$2p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ and $[2s^2]2p^3\ ^2\mathrm{P}^o$–$2p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ transitions since, as pointed out by Bastin *et al.* [25], these assignments place the $2s^22p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ term substantially lower than its predicted position. The 186.575 Å line is located very close to the predicted position of the $[2s^2]2p^3\ ^2\mathrm{D}^o_{3/2}$–$2p^2(^3\mathrm{P})3d\ ^4\mathrm{D}_{1/2}$ transition which is determined by Lindeberg's assignment of the 1895.775 Å line to the $[2s^2]2p^2(^3\mathrm{P})3p\ ^4\mathrm{P}^o$–$2p^2(^3\mathrm{P})3d\ ^4\mathrm{D}_{1/2}$ transition. Yet the observed intensity of the 186.575 Å line is much larger than it should be according to our parametric calculations. Some unknown blending can be responsible for this anomalous intensity. The 194.276 Å line is close to the predicted position of the $[2s^2]2p^3\ ^2\mathrm{P}^o_{3/2}$–$2p^2(^3\mathrm{P})3d\ ^4\mathrm{D}_{3/2}$ transition but it is much stronger than that transition could be. In addition, the twice more intense $[2s^2]2p^3\ ^2\mathrm{P}^o_{1/2}$–$2p^2(^3\mathrm{P})3d\ ^4\mathrm{D}_{1/2}$ transition was not observed at its predicted position 194.247 Å, so the 194.276 Å line is questionable.

Regarding the $2s^22p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ term, in order to predict its position, we have made an isoelectronic interpolation (the details are presented in column A of Tab. 2). The result is $640\,020 \pm 100$ cm^{-1} (Bastin *et al.* [25] have obtained 639 600 cm^{-1}, but their *HF* calculations were less accurate since they did not include the $2p^4nl$ configurations – see the following sections). This term energy implies that the intense $[2s^2]2p^3\ ^2\mathrm{P}^o$–$2p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ transition should occur in the close vicinity of the very intense O VI line at 173.082 Å and was probably masked by this line in [4].

In an analogous way, the $2s2p^3(^5\mathrm{S}^o)3p\ ^4\mathrm{P}$ term can be predicted from an isoelectronic interpolation of the difference between the experimental and *HF* energies. The related data are presented in column B of Table 2.

It should be noted that the experimental energy for Si VIII fits well to the smooth curve, confirming the identification for this ion, but the last point (sulfur) deviates too much which indicates a probable error in the identification.

The predicted position $625\,518 \pm 20$ cm^{-1} of the $2s2p^3(^5\mathrm{S}^o)3p\ ^4\mathrm{P}$ implies that the $2s^22p^3\ ^4\mathrm{S}^o$–$2s2p^3(^5\mathrm{S}^o)3p\ ^4\mathrm{P}$ transition is masked by (or blended with) the Ne VI line at 159.82 Å [34].

The unclassified Ne IV line observed at 197.6 Å [23] may be the $2s2p^4\ ^4\mathrm{P}_{5/2}$–$2s2p^3(^3\mathrm{P}^o)3s\ ^4\mathrm{P}_{5/2}$ transition. It combines with another unassigned Ne IV line at 475.30 Å [35] which we associate with the $2s^22p^2(^3\mathrm{P})3s\ ^4\mathrm{P}_{5/2}$–$2s2p^3(^3\mathrm{P}^o)3s\ ^4\mathrm{P}^o_{5/2}$ transition. The isoelectronic comparison cannot provide a decisive conclusion in this case because of the lack of data, so both assignments are questionable.

Paul and Polster's assignment of the 204.270 Å line to the $[2s^2]2p^3\ ^2\mathrm{P}^o$–$2p^2(^1\mathrm{S})3s\ ^2\mathrm{S}_{1/2}$ transition is discarded by Lindeberg [10] and Bastin [35] since it disagrees with isoelectronic interpolation. The value of $2s^22p^2(^1\mathrm{S})3s\ ^2\mathrm{S}_{1/2}$ from [4] based on the 204.270 Å line deviates by 5577 cm^{-1} from the parametric calculation (using Cowan's code [28]) with the parameters interpolated along the isoelectronic sequence [25]. The $[2s^2]2p^3\ ^2\mathrm{P}^o_{1/2,3/2}$–$2p^2(^1\mathrm{S})3s\ ^2\mathrm{S}_{1/2}$ transition can be definitely associated with the previously unclassified line at 206.7 ± 0.2 Å observed in [23] and determined to belong to Ne IV. This assignment places the $2s^22p^2(^1\mathrm{S})3s\ ^2\mathrm{S}_{1/2}$ level at $546\,200 \pm 500$ cm^{-1}, in good agreement with Lindeberg's estimate $546\,500 \pm 300$ cm^{-1} [10]. Our isoelectronic interpolation, contrary to the results of Bastin *et al.* [25], confirms this level position (see column C of Tab. 2).

The 204.270 Å line is now identified with the $2s2p^4\ ^4\mathrm{P}_{5/2}$–$2s^22p^2(^3\mathrm{P})4f\ 0[3]^o_{7/2,5/2}$ two-electron transition which gains its intensity because of the mixing of the upper states with $2s2p^3(^5\mathrm{S}^o)3d\ ^4\mathrm{D}^o$.

The lines at 215.396, 215.711, and 215.843 Å previously associated with the $2s2p^4\ ^4\mathrm{P}$–$2s^22p^2(^3\mathrm{P})4p\ ^4\mathrm{S}^o$ multiplet [4] have been omitted since, as already noted by Bastin *et al.* [25], these assignments place the $^4\mathrm{S}^o$ level too far from its predicted position at 655 300 cm^{-1} resulting from the parametric calculations. The predicted transition rates are so small that this multiplet could hardly be observed. It has not been observed in N I, O II and F III (where the $^4\mathrm{S}^o$ level has been found from some other combinations). A search for possible assignment of these lines among the other ionisation stages of neon gave no reasonable candidates in the Ne IV, V and VI spectra, but there are suitable ones in the Ne III spectrum: $2p^4\ ^1\mathrm{D}_2$–$2p^3(^2\mathrm{D})4d\ ^1\mathrm{F}^o_3$, $^1\mathrm{D}^o_2$, and $^1\mathrm{P}^o_1$ (all of the upper terms are not identified yet). The parametric calculations yield wavelengths 215.482, 215.677 and 215.825 Å and relative rates 12 : 7 : 2 for these transitions in Ne III [38].

Bastin *et al.* [25] have found that Paul and Polster's identification of the $2s^22p^2(^3\mathrm{P})4p\ ^4\mathrm{P}$ and $^4\mathrm{D}$ terms places these terms about 7000 cm^{-1} above the predicted energies resulting from an isoelectronic interpolation, while their own new identifications in the VUV range agree well

Table 2. Experimental energy E and $E\text{-}HF$ difference for excited term energies along the Ne I sequence: A – $2s^22p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$; B – $2s2p^3(^5\mathrm{S}^o)3p\ ^4\mathrm{P}$; C – $2s^22p^2(^1\mathrm{S})3s\ ^2\mathrm{S}$. Energy values are in cm^{-1}.

	A		B		C	
	E^a	$E\text{-}HF^b$	E^a	$E\text{-}HF^b$	E^a	$E\text{-}HF^b$
N I	–	–	144360	5986	116278.558	5946
O II	276038	7620	–	–	230609.45	8325
F III	442727	7333	434562	3533	372678.47	8955
Ne IV^c	640020*	6904*	625518*	2304*	546200	10214
Na V	867530	6512	847539	1057	749402	10544
Mg VI	1124890	5628	1100150	−166	983420	11211
Al VII	1411930	3887	1383560	−1431	1248430	12331
Si VIII	–	–	1698230	−2558	–	–
P IX	–	–	2044000	−3619	–	–
S X^d	–	–	2417970	−7776	–	–

[a] Experimental energies were taken from AEL database [36] for Na V through S X, from Palénius [37] for F III, and from Kelly [33] for N I.

[b] The calculation is designated as HF for brevity, but actually the *ab initio* values of the Coulomb, exchange and CI parameters have been scaled down by a factor of 0.9. The configurations included in the calculations are described in the following sections.

[c] The starred values for Ne IV result from the fits of $E\text{-}HF$ *vs.* Z_c: A – linear fit between O II and Na V (rms 66 cm^{-1}); B – linear fit in the interval N I through Al VII (rms 14 cm^{-1}).

[d] The energies presented in column B for S X refer to the $J = 5/2$ level.

with the interpolation. The ^{4}P term was based on lines at 217.337, 217.640, 217.777 and 218.131 Å that actually belong to Ne III [25,38,39]. The ^{4}D term was based partially on the 218.184, 218.343, 218.483, 218.643 and 218.766 Å lines, all belonging to Ne III. Apart of these there is only one line at 217.830 Å (blended) which is unclassified now. This line is probably the 217.836 Å line of N IV [33] as Paul and Polster's spectrum was strongly contaminated by nitrogen, carbon and oxygen lines.

The unclassified line at 241.9 ± 0.2 Å, determined to belong to Ne IV (blended with second order of a Ne VI line) [23], is associated with the $2s2p^4\ ^2\mathrm{D}_{5/2}-2s2p^3(^3\mathrm{D}^o)3s\ ^2\mathrm{D}^o_{5/2} + 2s2p^4\ ^2\mathrm{D}_{3/2}-2s2p^3(^3\mathrm{D}^o)3s\ ^2\mathrm{D}^o_{3/2}$ unresolved transitions. This assignment is confirmed by observation of two other combinations at 558.07 and 560.48 Å in the beam-foil spectrum [35], and by extrapolation of the differences of the experimental energies of $2s2p^3(^3\mathrm{D}^o)3s\ ^2\mathrm{D}^o$ from the calculated HF energies for Mg VI and Na V (−2185 and −1477 cm^{-1}, respectively). Our identifications yield −919 cm^{-1} for this difference in Ne IV. The irregular change of this quantity for F III (−2782 cm^{-1}) is not surprising because the strongly interacting $2s2p^3(^3\mathrm{D}^o)3s\ ^2\mathrm{D}^o$ and $2s^22p^2(^1\mathrm{D})4p\ ^2\mathrm{D}^o$ interchange their positions between F III and Ne IV. Experimental data from the AEL database [36] for Mg VI and Na V and from Palénius [37] for F III have been used for the isoelectronic comparison.

The wavelength 286.688 Å does not agree with the wavenumber 349 104 cm^{-1} [4]. We think the wavenumber is correct, since the wavenumber calculated from Paul and Polster's levels list [4] is 349 118 cm^{-1} (the upper level is determined from three lines). Thus we have changed the wavelength to 286.448 Å, as follows from the wavenumber.

We have made a large number of new line identifications on the basis of the beam-foil spectra obtained in the work of Bastin *et al.* [25] and presented in Bastin's thesis [35]. The complete data set included line wavelength and intensity measurements with low ion-beam energy 0.8 MeV made by Krenzer [27], and with higher ion-beam energies 1.2 and 2.5 MeV [25]. This allowed an almost certain charge-state assignment of the lines. Most of the total of about 70 new lines have been observed with at least two ion-beam energies, usually 0.8 and 1.2 MeV [35]. However, 16 of these new lines have been observed with the single beam energy 0.8 MeV. The lines measured at two or three beam energies are considered as accurate to ± 0.1 Å [25], while the wavelengths measured at a single beam energy are certain only to ± 0.15 Å. The new identifications, with very few exceptions discussed hereafter support assignments made by Bastin *et al.* [25].

We have omitted the $2s^22p^2(^3\mathrm{P})4d\ ^4\mathrm{D}_{1/2}$ level from the list of Bastin *et al.* [25] which was derived from just one blended line at 692.72 Å, because the $[2s^2]2p^2(^3\mathrm{P})3p\ ^4\mathrm{P}^o_{1/2}-2p^2(^3\mathrm{P})4d\ ^4\mathrm{D}_{1/2}$ transition should contribute not more than 20% of the total intensity of this blend (according to our parametric calculations), and the theoretical $^4\mathrm{D}_{3/2}-^4\mathrm{D}_{1/2}$ separation is not certain. Previous calculations had yielded 13 cm^{-1} for this separation [25], while our present extended calculations have resulted in 63 cm^{-1}.

The assignment of the $[2s^2]2p^2(^3\mathrm{P})3d\ ^4\mathrm{F}_{3/2}-2p^24f\ 1[3]^o_{5/2}$ transition to the 992.44 Å (blended) line [25] is changed to 991.96 Å line, as it better agrees with the relative intensities, and brings the level separations into better agreement with HF calculations. Then the $[2s^22p^2(^3\mathrm{P})]3d\ ^2\mathrm{P}_{3/2}-4f\ 1[3]^o_{5/2}$ combination is identified with the 1027.23 Å line (blended by Ne III). There's no line around 1027.9 Å (position predicted from identification of Bastin *et al.*) that could be this transition.

The identification of the $2s^2 2p^2 4f\ 1[3]^o_{7/2}$ level [25] has been changed. Its energy has been changed by $+130$ cm^{-1} due to the new identifications. The old identification was based on one doubly classified line at 993.81 Å which is mainly due to the $[2s^2 2p^2(^3\mathrm{P})]3d\ ^4\mathrm{F}_{7/2}$–$4f\ 1[4]^o_{9/2}$ transition. The new level position is based on the three previously unassigned lines at 993.07, 1060.02, 1063.88 Å identified with transitions down to the $2s^2 2p^2(^3\mathrm{P})3d\ ^4\mathrm{F}_{5/2}$, $^4\mathrm{P}_{5/2}$ and $^2\mathrm{F}_{5/2}$ levels, and two blends at 995.95 Å and 1035.97 Å where the transitions down to the $^4\mathrm{F}_{7/2}$ and $^4\mathrm{D}_{5/2}$ levels of the same $2s^2 2p^2(^3\mathrm{P})3d$ configuration occur. The line observed at 993.07 Å [35] coincides with the predicted position of the weak intercombination line $2s^2 2p\ ^2\mathrm{P}^o_{1/2}$–$2s2p^2\ ^4\mathrm{P}_{3/2}$ in Ne VI [40]. Nonetheless, we have assigned it to Ne IV since this line has been observed only at the ion-beam energies 0.8 and 1.2 MeV and disappeared at 2.5 MeV where the Ne VI lines must be more intense. Neither of the other four lines of the same Ne VI multiplet observed in solar spectra [13] at 997.1, 999.2, 1005.7 and 1010.2 Å [13] have been found in the beam-foil spectra [35] at beam energies 1.2 and 2.5 MeV.

The identification of the $2s^2 2p^2(^3\mathrm{P})4f\ 0[3]^o_{7/2}$ level [25] has been changed. The old level position was based on one line at 1063.88 Å assigned to the $3d\ ^4\mathrm{P}_{5/2}$–$4f\ 0[3]^o_{7/2}$ transition. The new level position relies on the four new line assignments of the transitions down to the $3d\ ^4\mathrm{P}_{5/2}$, $^4\mathrm{F}_{5/2}$, $^4\mathrm{D}_{5/2}$, and $^2\mathrm{F}_{5/2}$ levels. These transitions have been associated with the lines at 1062.44, 995.19, 1038.37, and 1066.29 Å, respectively.

The lines at 2077.99 and 2371.30 Å are marked as questionable as they were in [10].

The weak 2365.49 and 2404.28 Å lines, observed by Goldsmith and Kaufman [8], were discarded by Lindeberg [10] and remain unidentified since then.

We have identified two groups of Ne IV lines observed by Denis *et al.* [18] in the UV and visible regions with the (theoretically) most intense of the $4f$–$5g$ and $5g$–$6h$ transitions. The lifetimes 1.1 ± 0.1 ns and 4.2 ± 0.4 ns measured for two of these lines (at 2485.9 and 4646.8 Å) by Denis *et al.* [19] are in satisfactory agreement with the lifetimes of the $5g$ and $6h$ terms resulting from our parametric calculations (0.95 and 2.4 ns, respectively).

Two lines, observed at 7719.5 and 7746.5 Å by Baluteau *et al.* [41] in the highly-excited emission spectrum of the planetary nebula NGC 7027, were tentatively assigned to the $6g$–$7h$ and $6h$–$7i$ transitions in Ne IV. We could neither confirm nor reject these assignments since, under assumption of statistical populations, theoretical (HF) spectra of each of these transition arrays consist of 5 to 10 lines (depending on spectral resolution) of almost equal intensity, the range of wavelengths being 7650–7710 and 7705–7740 Å for the $[2s^2 2p^2]6g$–$7h$ and $[2s^2 2p^2]6h$–$7i$ transitions, respectively. In principle, the excitation conditions in this very peculiar nebula can be far from statistical, so it is feasible that only some particular components of these transition arrays are observed, but it is not possible to identify them now.

3 Energy levels

The list of energy levels derived from the observed lines is presented in Table 3. The energies have been obtained by means of the least-squares optimisation code LOPT described elsewhere [31,38].

In the level-optimisation procedure, the intervals $2s2p^3(^3\mathrm{D}^o)3p\ ^2\mathrm{F}\ (5/2{-}7/2)$, $2s^2 2p^2(^1\mathrm{D})4d\ ^2\mathrm{D}\ (3/2{-}5/2)$, and $2s^2 2p^2(^1\mathrm{D})4d\ ^2\mathrm{F}\ (7/2-5/2)$ have been fixed at their theoretical values 13, 20, and 50 cm^{-1}, respectively.

In Table 3, the estimated uncertainty D of energies relative to the ground state (or to the lowest state in the isolated level sub-system) includes two components: (1) standard dispersion defined by the declared wavenumber-measurement uncertainties of the lines involved in all (direct and multi-stage) connections of the level with the ground state, as explained in [38], and (2) an estimate of possible effects of systematic errors in measured wavenumbers, as described in [31]. For the sextet levels, D is the estimated uncertainty relative to the lowest sextet, $2s2p^3(^5\mathrm{S}^o)3s\ ^6\mathrm{S}^o$. In an analogous way, for the $2s^2 2p^2(^1\mathrm{S})3p$ levels D is the uncertainty relative to the $2s^2 2p^2(^1\mathrm{S})3s\ ^2\mathrm{S}$ level. The number of digits given for the energy is determined by the minimal uncertainty of the level relative to other levels, so that all transition wavelengths can be reproduced with the needed accuracy.

While the doublet levels are connected with the quartet system by a number of observed intercombination lines, the sextet system is isolated. The absolute position of the sextets has been estimated on the basis of extrapolation of the difference of experimental and theoretical (Hartree-Fock) sextet-quartet separations for the $2s2p^3(^5\mathrm{S}^o)3s\ ^{6,4}\mathrm{S}^o$, $3p\ ^{6,4}\mathrm{P}$ and $3d\ ^{6,4}\mathrm{D}^o$ terms from F III where several intersystem lines have been found by Palénius [37]. The mean of the three resulting values of the $2s2p^3(^5\mathrm{S}^o)3s\ ^4\mathrm{S}^o$–$^6\mathrm{S}^o$ separation has been subtracted from the experimental $2s2p^3(^5\mathrm{S}^o)3s\ ^4\mathrm{S}^o$ energy to obtain the adopted energy of $2s2p^3(^5\mathrm{S}^o)3s\ ^6\mathrm{S}^o$ at 568 350 cm^{-1}. We estimate the uncertainty x of this value as ± 500 cm^{-1}. It should be noted that this energy is 30 000 cm^{-1} higher than the previous estimate of Bockasten *et al.* [7].

The quantity y defines the unknown shift of the $2s^2 2p^2(^1\mathrm{S})nl$ terms relative to the $2s^2 2p^2(^1\mathrm{S})3s\ ^2\mathrm{S}$ level position derived from the 206.7 ± 0.2 Å line observed by Buchet *et al.* [23]. Although its bounds (± 500 cm^{-1}) are not improved compared to Lindeberg's estimate [10], we prefer to use the value determined directly from experiment to the one obtained from an isoelectronic interpolation.

The relative uncertainties of the doublet levels of the ground configuration are less than 0.2 cm^{-1} due to Bowen's observation of transitions between them [5], while their absolute position with respect to the ground level $^4\mathrm{S}^o_{3/2}$ is certain to less than 1 cm^{-1} due to the observation of the parity-forbidden intercombinations by Penston

Table 3. The optimised energy levels of Ne IV.

Designation^a		J	Energy, cm^{-1}		Unc. D^b cm^{-1}	Num. lines^c	Leading percentages	
$2s^22p^3$	^{4}S^o	3/2	0.0		-	19, 2Q	100%	
$2s^22p^3$	^{2}D^o	5/2	41236.9		1.0	26, 2B, 3Q, 1L, 14D	99%	
$2s^22p^3$	^{2}D^o	3/2	41281.5		1.0	27, 3B, 4Q, 2L, 13D	100%	
$2s^22p^3$	^{2}P^o	1/2	62437.0		1.0	23, 1B, 2Q, 1L, 20D	97%	
$2s^22p^3$	^{2}P^o	3/2	62443.34		1.0	27, 1B, 2Q, 1L, 21D	97%	
$2s2p^4$	^{4}P	5/2	183862		3	10, 1Q, 1L, 3D	99%	
$2s2p^4$	^{4}P	3/2	184476		3	13, 6D	99%	
$2s2p^4$	^{4}P	1/2	184800		3	7, 1D	99%	
$2s2p^4$	^{2}D	5/2	254082		2	5, 1D	99%	
$2s2p^4$	^{2}D	3/2	254104		2	6, 3D	99%	
$2s2p^4$	^{2}S	1/2	299630		3	5, 3D	99%	
$2s2p^4$	^{2}P	3/2	320026		3	6, 2D	98%	
$2s2p^4$	^{2}P	1/2	320742		3	6, 2D	98%	
$2s^22p^2(^3\mathrm{P})3s$	^{4}P	1/2	478690.71		9	8, 2D	97%	
$2s^22p^2(^3\mathrm{P})3s$	^{4}P	3/2	479072.51		9	14, 2D	97%	
$2s^22p^2(^3\mathrm{P})3s$	^{4}P	5/2	479650.05		9	12, 1B	97%	
$2p^5$	^{2}P^o	3/2	484904		3	6	95%	
$2p^5$	^{2}P^o	1/2	485866.5		3	5	95%	
$2s^22p^2(^3\mathrm{P})3s$	^{2}P	1/2	488502.2		8	11, 1L, 2D	98%	
$2s^22p^2(^3\mathrm{P})3s$	^{2}P	3/2	489209.49		8	14, 2D	98%	
$2s^22p^2(^1\mathrm{D})3s$	^{2}D	5/2	511721.90		8	7, 1L, 2D	98%	
$2s^22p^2(^1\mathrm{D})3s$	^{2}D	3/2	511728.8		8	6, 2L, 3D	98%	
$2s^22p^2(^3\mathrm{P})3p$	^{2}S^o	1/2	515423.5		8	6	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}D^o	1/2	521002.6		9	7, 1L, 1D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}D^o	3/2	521215.4		9	14, 5D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}D^o	5/2	521566.46		9	14, 4D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}D^o	7/2	522046.29		9	9	98%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}P^o	1/2	524496.8		9	11, 1L, 4D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}P^o	3/2	524665.23		9	18, 4D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{4}P^o	5/2	525011.14		9	14, 1D	97%	
$2s^22p^2(^3\mathrm{P})3p$	^{2}D^o	3/2	530624.3		8	8, 1Q, 3D	82%	+ 16% $2s^22p^2(^1\mathrm{D})3p$ ^{2}D^o
$2s^22p^2(^3\mathrm{P})3p$	^{2}D^o	5/2	531333.65		8	6, 1Q, 3D	82%	+ 16% $2s^22p^2(^1\mathrm{D})3p$ ^{2}D^o
$2s^22p^2(^3\mathrm{P})3p$	^{4}S^o	3/2	532986.39		9	13, 1L, 1D	90%	+ 8% $2s2p^3(^5\mathrm{S}^o)3s$ ^{4}S^o
$2s^22p^2(^3\mathrm{P})3p$	^{2}P^o	1/2	536707.1		8	5	82%	+ 13% $2s^22p^2(^1\mathrm{D})3p$ ^{2}P^o
$2s^22p^2(^3\mathrm{P})3p$	^{2}P^o	3/2	536824.8		8	8, 2D	82%	+ 14% $2s^22p^2(^1\mathrm{D})3p$ ^{2}P^o
$2s^22p^2(^1\mathrm{S})3s$	^{2}S	1/2	546200	$+y$	500	1	93%	+ 5% $2p^4(^1\mathrm{S})3s$ ^{2}S
$2s^22p^2(^1\mathrm{D})3p$	^{2}F^o	5/2	555317.2		8	7, 1B, 1L, 1D	98%	
$2s^22p^2(^1\mathrm{D})3p$	^{2}F^o	7/2	555456.91		8	7, 1L, 1D	98%	
$2s^22p^2(^1\mathrm{D})3p$	^{2}D^o	5/2	561157.38		8	9, 1Q, 2D	80%	+ 16% $2s^22p^2(^3\mathrm{P})3p$ ^{2}D^o
$2s^22p^2(^1\mathrm{D})3p$	^{2}D^o	3/2	561256.4		8	9, 1Q, 1D	80%	+ 16% $2s^22p^2(^3\mathrm{P})3p$ ^{2}D^o
$2s^22p^2(^1\mathrm{D})3p$	^{2}P^o	1/2	566963.4		8	4	83%	+ 13% $2s^22p^2(^3\mathrm{P})3p$ ^{2}P^o
$2s^22p^2(^1\mathrm{D})3p$	^{2}P^o	3/2	567262.2		8	7, 1Q, 1L, 2D	82%	+ 14% $2s^22p^2(^3\mathrm{P})3p$ ^{2}P^o
$2s2p^3(^5\mathrm{S}^o)3s$	^{6}S^o	5/2	568350.0	$+x$	500	-	100%	
$2s^22p^2(^3\mathrm{P})3d$	^{4}F	3/2	572780.2		9	4, 1D	98%	

Table 3. *Continued.*

Designation[a]		J	Energy, cm^{-1}		Unc. D[b] cm^{-1}	Num. lines[c]	Leading percentages	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}$	5/2	572977.2		9	6, 1D	97%	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}$	7/2	573259.1		9	7, 2D	97%	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{F}$	9/2	573629.6		9	3, 1D	98%	
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}$	3/2	576256.2		8	7, 5D	86%	+ 10% $^4\mathrm{D}$
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{P}$	1/2	576637.7		8	4, 2D	50%	+ 47% $^4\mathrm{D}$
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}$	3/2	577145.3		9	8, 2Q, 4D	86%	+ 10% $^2\mathrm{P}$
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}$	5/2	577155.0		9	9, 2D	93%	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}$	1/2	577245.7		9	6, 3Q, 2D	50%	+ 47% $^2\mathrm{P}$
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{D}$	7/2	577349.6		9	7, 2D	97%	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}$	5/2	579328.2		9	5	93%	
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}$	3/2	579602.1		9	6, 1D	95%	
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}$	5/2	579677.4		8	6, 1B, 2D	92%	+ 6% $2s^22p^2(^1\mathrm{D})3d\ ^2\mathrm{F}$
$2s^22p^2(^3\mathrm{P})3d$	$^4\mathrm{P}$	1/2	579745.7		9	4, 1D	97%	
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{F}$	7/2	580386.7		8	4, 2D	92%	+ 6% $2s^22p^2(^1\mathrm{D})3d\ ^2\mathrm{F}$
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}$	3/2	586982.9		8	6, 2D	97%	
$2s^22p^2(^3\mathrm{P})3d$	$^2\mathrm{D}$	5/2	587199.9		8	5	97%	
$2s2p^3(^5\mathrm{S}^o)3s$	$^4\mathrm{S}^o$	3/2	588023		13	4	89%	+ 7% $2s^22p^2(^3\mathrm{P})3p\ ^4\mathrm{S}^o$
$2s^22p^2(^1\mathrm{S})3p$	$^2\mathrm{P}^o$	1/2	592327.5	$+y$	0.6	1	92%	+ 5% $2p^4(^1\mathrm{S})3p\ ^2\mathrm{P}^o$
$2s^22p^2(^1\mathrm{S})3p$	$^2\mathrm{P}^o$	3/2	592331.4	$+y$	0.6	1	92%	+ 5% $2p^4(^1\mathrm{S})3p\ ^2\mathrm{P}^o$
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}$	7/2	605641.6		8	4, 1L, 1D	91%	+ 5% $2s^22p^2(^3\mathrm{P})3d\ ^2\mathrm{F}$
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{F}$	5/2	605783.8		8	4, 1D	92%	+ 6% $2s^22p^2(^3\mathrm{P})3d\ ^2\mathrm{F}$
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}$	9/2	607010.2		8	3, 2D	98%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{G}$	7/2	607019.2		8	3, 2D	99%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}$	3/2	609364.5		8	3, 1Q, 1L, 2D	96%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{D}$	5/2	609420.3		8	4, 1Q, 1D	96%	
$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}$	3/2	612495.4	$+x$	0.3	5	100%	
$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}$	5/2	612543.5	$+x$	0.3	5	100%	
$2s2p^3(^5\mathrm{S}^o)3p$	$^6\mathrm{P}$	7/2	612622.9	$+x$	0.4	3	100%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}$	1/2	612960		30	3, 2D	97%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{P}$	3/2	613070		4	5, 2D	97%	
$2s^22p^2(^1\mathrm{D})3d$	$^2\mathrm{S}$	1/2	616775		5	3, 2D	96%	
$2s2p^3(^5\mathrm{S}^o)3p$	$^4\mathrm{P}$		[625520]		20	1, 1B	94%	
$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}$	1/2	633434		14	5, 2D	94%	
$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}$	3/2	633795		13	8, 4D	94%	
$2s^22p^2(^3\mathrm{P})4s$	$^4\mathrm{P}$	5/2	634371		13	7, 1D	95%	
$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}$	1/2	636497		14	3, 1D	98%	
$2s^22p^2(^3\mathrm{P})4s$	$^2\mathrm{P}$	3/2	637225		13	4, 3D	97%	
$2s^22p^2(^1\mathrm{S})3d$	$^2\mathrm{D}$		[640020]		100	-	93%	+ 5% $2p^4(^1\mathrm{S})3d\ ^2\mathrm{D}$
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o$	1/2	647290		20	4, 1D	67%	+ 19% $2s^22p^2(^3\mathrm{P})4p\ ^2\mathrm{S}^o$ + 11% $2s2p^3(^3\mathrm{D}^o)3s\ ^4\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o$	3/2	647410		30	3, 1D	83%	+ 14% $2s2p^3(^3\mathrm{D}^o)3s\ ^4\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o$	5/2	647660		20	3, 2D	82%	+ 15% $2s2p^3(^3\mathrm{D}^o)3s\ ^4\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{D}^o$	7/2	648020		30	2, 1D	82%	+ 16% $2s2p^3(^3\mathrm{D}^o)3s\ ^4\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o$	1/2	649930		40	3, 2D	95%	
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o$	3/2	650040		20	6, 1B, 4D	95%	

Table 3. *Continued.*

Designation[a]		J	Energy, cm^{-1}		Unc. D[b] cm^{-1}	Num. lines[c]	Leading percentages	
$2s^22p^2(^3\mathrm{P})4p$	$^4\mathrm{P}^o$	5/2	650420		30	4, 2D	95%	
$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o$	3/2	653390		120	1, 1D	94%	
$2s^22p^2(^3\mathrm{P})4p$	$^2\mathrm{D}^o$	5/2	654110		20	3, 1D	94%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o$	9/2	662845.5	$+x$	0.5	2, 1D	100%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o$	7/2	662849.2	$+x$	0.4	2, 1D	100%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o$	5/2	662856.1	$+x$	0.4	3, 1D	100%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o$	3/2	662862.5	$+x$	0.6	3, 1D	100%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^6\mathrm{D}^o$	1/2	662866.8	$+x$	0.8	2, 1D	100%	
$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}$	3/2	664371		14	3, 1Q, 1D	97%	
$2s^22p^2(^1\mathrm{D})4s$	$^2\mathrm{D}$	5/2	664374		14	4, 1Q, 2D	97%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}$	3/2	667110	?	30	1, 1Q, 1D	95%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}$	5/2	667320	?	30	1, 1Q, 1D	91%	+ 6% $^4\mathrm{D}$
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}$	7/2	667600	?	30	1, 1Q, 1D	90%	+ 8% $^4\mathrm{D}$
$2s2p^3(^3\mathrm{D}^o)3s$	$^2\mathrm{D}^o$	5/2	667630		30	2, 1D	75%	+ 22% $2s^22p^2(^1\mathrm{D})4p$ $^2\mathrm{D}^o$
$2s2p^3(^3\mathrm{D}^o)3s$	$^2\mathrm{D}^o$	3/2	667690		30	2, 1D	75%	+ 22% $2s^22p^2(^1\mathrm{D})4p$ $^2\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{F}$	9/2	668080	?	30	1, 1Q, 1D	98%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}$	3/2	668840		20	3, 2D	86%	+ 6% $^2\mathrm{P}$
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}$	5/2	669040		20	3, 1D	87%	+ 6% $^4\mathrm{F}$ + 5% $^4\mathrm{P}$
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{D}$	7/2	669270		20	2	90%	+ 8% $^4\mathrm{F}$
$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{F}$	5/2	670910		30	2	95%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{P}$	5/2	671400		50	1	93%	+ 5% $^4\mathrm{D}$
$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{F}$	7/2	671560		20	2	96%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{P}$	3/2	672100		40	2, 1D	95%	
$2s^22p^2(^3\mathrm{P})4d$	$^4\mathrm{P}$	1/2	672670		50	1	97%	
$2s2p^3(^5\mathrm{S}^o)3d$	$^4\mathrm{D}^o$		672800		30	3	75-94%	+ 22-5% $2s^22p^2(^3\mathrm{P})4f$ $^4\mathrm{D}^o$
$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o$	5/2	673369		20	3, 2D	81%	+ 9% $2[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$0[3]^o$	7/2	673460		13	4, 1D	75%	+ 14% $2s2p^3(^5\mathrm{S}^o)3d$ $2[4]^o$ + 5% $2[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o$	5/2	673599		13	2, 1D	89%	+ 7% $0[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$1[3]^o$	7/2	673672		13	5, 3D	80%	+ 7% $2s2p^3(^5\mathrm{S}^o)3d$ $2[4]^o$ + 6% $1[4]^o$
$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{D}$	3/2	673700		60	4, 4B, 4D	95%	
$2s^22p^2(^3\mathrm{P})4d$	$^2\mathrm{D}$	5/2	673869		20	4, 1D	95%	
$2s^22p^2(^3\mathrm{P})4f$	$1[2]^o$	5/2	673874		10	1	62%	+ 28% $2[2]^o$ + 7% $2s2p^3(^5\mathrm{S}^o)3d$ $2[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o$	9/2	673880		14	2, 1D	88%	+ 9% $2[4]^o$
$2s^22p^2(^3\mathrm{P})4f$	$1[4]^o$	7/2	673941		13	2	80%	+ 10% $2[4]^o$ + 5% $1[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$2[1]^o$	3/2	674182		10	1	94%	
$2s^22p^2(^3\mathrm{P})4f$	$2[1]^o$	1/2	674210		10	1	93%	
$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o$	11/2	674393		20	1	98%	
$2s^22p^2(^3\mathrm{P})4f$	$2[5]^o$	9/2	674512		13	2	97%	
$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o$	3/2	674787		14	2, 1D	69%	+ 29% $1[2]^o$
$2s^22p^2(^3\mathrm{P})4f$	$2[2]^o$	5/2	674912		20	2, 2D	53%	+ 24% $1[2]^o$ + 20% $2[3]^o$
$2s^22p^2(^3\mathrm{P})4f$	$2[3]^o$	7/2	675004		14	3, 1D	73%	+ 16% $2[4]^o$
$2s^22p^2(^3\mathrm{P})4f$	$2[4]^o$	9/2	675057		14	2	89%	+ 9% $1[4]^o$

Table 3. *Continued.*

Designation[a]			J	Energy, cm^{-1}		Unc. D[b] cm^{-1}	Num. lines[c]	Leading percentages	
$2s2p^3(^3\mathrm{P}^o)3s$	$^4\mathrm{P}^o$		5/2	690040	?	50	2, 2Q	91%	+ 5% $2s^22p^2(^3\mathrm{P})5p\ ^4\mathrm{P}^o$
$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}$		1/2	693100		50	1	94%	
$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}$		3/2	693720		20	4, 1Q, 1D	94%	
$2s^22p^2(^3\mathrm{P})5s$	$^4\mathrm{P}$		5/2	694330		20	5, 1Q, 1D	95%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{F}$		7/2	698090		20	3, 3D	92%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{F}$		5/2	698140		20	3, 3D	94%	
$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}$		3/2	698510		20	4, 1L, 2D	97%	
$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}$		5/2	698530		20	4, 3D	98%	
$2s2p^3(^3\mathrm{D}^o)3p$	$^4\mathrm{D}$		7/2	698570		20	3, 1D	98%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{G}$			698844		20	2, 1B	96-99%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{D}$		3/2	699887		20	4, 2D	96%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{D}$		5/2	699905		20	3, 2D	96%	
$2s^22p^2(^1\mathrm{D})4d$	$^2\mathrm{P}$			701500		90	2, 2D	78-93%	+ 18-4% $2s2p^3(^3\mathrm{D}^o)3p\ ^2\mathrm{P}$
$2s^22p^2(^1\mathrm{D})4f$	$2[4]^o$			703247		12	4	98%	
$2s^22p^2(^1\mathrm{D})4f$	$2[3]^o$			703360		13	2, 1D	98%	
$2s2p^3(^3\mathrm{D}^o)3p$	$^2\mathrm{F}$		5/2	703802	?	20	2, 2Q, 1D	91%	+ 6% $2s^22p^2(^3\mathrm{P})5d\ ^2\mathrm{F}$
$2s2p^3(^3\mathrm{D}^o)3p$	$^2\mathrm{F}$		7/2	703815	?	20	3, 3Q, 3D	92%	+ 5% $2s^22p^2(^3\mathrm{P})5d\ ^2\mathrm{F}$
$2s^22p^2(^1\mathrm{D})4f$	$2[5]^o$			704407		15	1	99%	
$2s^22p^2(^3\mathrm{P})5g$	$1[5]$	?		713780		30	2, 2Q, 2D	97%	
$2s^22p^2(^3\mathrm{P})5g$	$2[6]$	?		714320		30	2, 2Q, 2D	99%	
$2s^22p^2(^3\mathrm{P})5g$	$2[4]$	?		714670		40	1, 1Q, 1D	97%	
$2s^22p^2(^3\mathrm{P})5g$	$2[5]$	?		714720		30	1, 1Q, 1D	97%	
$2s2p^3(^5\mathrm{S}^o)4s$	$^6\mathrm{S}^o$		5/2	722811	$+x$	8	3	100%	
$2s^22p^2(^1\mathrm{D})5s$	$^2\mathrm{D}$			724910		20	6, 1B, 1L, 1D	93%	
$2s^22p^2(^3\mathrm{P})6h$	$1[6]^o$	?		735291		30	1, 1Q	99%	
$2s^22p^2(^3\mathrm{P})6h$	$2[7]^o$	?		736006		30	1, 1Q, 1D	99%	
$2s^22p^2(^3\mathrm{P})6h$	$2[5]^o$	?		736159		40	1, 1Q	98%	
$2s^22p^2(^1\mathrm{D})5d$	$^2\mathrm{F}$			740900		50	2, 2D	95%	
$2s^22p^2(^1\mathrm{D})5g$	$2[5]$			743460	?	30	1, 1Q	99%	
$2s^22p^2(^1\mathrm{D})6s$	$^2\mathrm{D}$			754900	?	100	1, 1Q	98%	
$2s2p^3(^3\mathrm{D}^o)3d$	$^4\mathrm{P}^o$		5/2	757580	?	30	1, 1Q	96%	
$2s2p^3(^5\mathrm{S}^o)4f$	$^6\mathrm{F}$			763028	$+x$	10	5, 5D	100%	
$2s^22p^2(^1\mathrm{D})6h$	$2[6]^o$			765148	?	30	1, 1Q, 1D	99%	

[a] The level designations are based on the leading percentage in the appropriate coupling scheme (see text). Uncertain levels are quoted with a question mark.

[b] The meaning of the uncertainties is explained in the text.

[c] "Num. lines" is the number of observed combinations determining the level. The details of the records are best explained by an example: "6, 1B, 1Q, 1L, 1D" would mean: total 6 combinations, including 1 blended line, 1 questionable line, 1 line with large deviation of the observed wavelength from the calculated one (greater than 1.2 times uncertainty), and 1 doubly (or multiply) classified line.

et al. [15]. The levels of the $2s2p^4$ and $2p^5$ configurations are accurate to $\pm\,(2–3)$ cm^{-1}. The new level values of the $n = 2$ complex are in good agreement with Edlén's interpolated data [30].

Most of the excitation energies of the $n = 3$ configurations are determined to $\pm\,10$ cm^{-1}, excluding the highly lying levels of the $2s2p^33l$ configurations having uncertainties of $\pm\,(20–50)$ cm^{-1}, and the sextet levels which may all be shifted by as much as $\pm\,500$ cm^{-1}. The adopted interpolated values of the $2s2p^3(^5\mathrm{S}^o)3p\ ^4\mathrm{P}$ and $2s^22p^2(^1\mathrm{S})3d\ ^2\mathrm{D}$ levels are expected to be accurate to $\pm\,20$ and $\pm\,100$ cm^{-1}, respectively.

For the $4l$ ($l = s$, p, d, f) and $5s$ configurations, the uncertainties are generally in the range 15–20 cm^{-1}, while for the $5d$, $5g$ and $6h$ configurations they increase to 30–50 cm^{-1}.

The levels, for which the identifications are uncertain, are marked with a question mark in Table 3. The configuration assignments of the $[2s^22p^2(^3\mathrm{P})]5g$ and $6h$ levels are certain, thus only the term assignments are questionable for them.

In order to find the percentage composition of the levels, and to facilitate the new identifications, a set of Hartree-Fock and parametric calculations have been performed using Cowan's codes [28]. The following configurations have been included in the computational procedure: $2s2p^3nl$ ($nl = 2s$, $3s$, $4s$, $5s$, $3d$, $4d$, $5d$, $5g$) and $(2s^22p^2 + 2p^4)nl$ ($nl = 2p$, $3p$, $4p$, $5p$, $6p$, $4f$, $5f$, $6f$, $6h$) of odd parity; $2s2p^3nl$ ($nl = 2p$, $3p$, $4p$, $5p$, $4f$, $5f$) and $(2s^22p^2 + 2p^4)nl$ ($nl = 3s$, $4s$, $5s$, $6s$, $3d$, $4d$, $5d$, $6d$, $5g$, $6g$) of even parity. Inclusion of the $2p^4nl$ configurations is necessary for a correct representation of the levels based on $^1\mathrm{S}$ parents. In the Hartree-Fock calculations, the Coulomb, exchange and CI parameters have been scaled down by a factor of 0.9. The same kind of HF calculations have been performed for all isoelectronic ions in the interval N I through S X, in order to facilitate isoelectronic interpolations (see previous section). The parametric fitting has been performed for F III and Ne IV, and the ratios of parameters to their Hartree-Fock values have been verified to behave smoothly.

The levels of the $[2s^22p^2]nf$, ng and nh configurations are found to be best represented in terms of the $LSJK$ coupling scheme, where the total angular momentum J of the LS parent term is coupled with the orbital quantum number L of the outer electron, and the resulting intermediate momentum K is coupled with spin of the outer electron [28]. The other configurations are better described in the frame of the LS coupling scheme.

The fitted Slater parameters have been used to calculate improved transition rates which in turn have been used in Azarov's line-identification code IDEN [29] to find new assignments for unclassified lines of Ne IV. These transition rates have also been used in the level-optimisation procedure to weight the components of unresolved blends, so as to make the centre of gravity of such a blend coincide with the observed wavelength.

4 Ionisation potential

The identification of the $2s^22p^24f$, $5g$ and $6h$ configurations provides a possibility to determine the ionisation potential (IP) by means of the polarisation formula [42]. In this procedure, centres of gravity of the level groups having the $^3\mathrm{P}_0$, $^3\mathrm{P}_1$, $^3\mathrm{P}_2$ and $^1\mathrm{D}_2$ parent terms can be used. To find these centres of gravity, the unobserved energies have been replaced by the values obtained in the parametric fitting. Since the rms deviations of the observed levels of the $(2s^22p^2)4f$, $5g$ and $6h$ configurations are about 40 cm^{-1} in the fitting, the obtained centre-of-gravity energies are expected to be accurate to 50–80 cm^{-1} (including the measurement uncertainties). Using the known separations within the ground configuration of Ne V [31], we have obtained a set of fitted values of the ionisation potential. The mean of these values is $783\,700 \pm 80$ cm^{-1}, the scatter being consistent with the uncertainties of the energy levels. This agreement supports the suggested term assignments of the $5g$ and $6h$ configurations, but still there are some doubts because the observed lines were rather weak, and the spectral resolution was rather poor [18].

Another way of determining the ionisation potential is proposed in Edlén's classic review [42]. Using the semiempirical Z-expansion formulas suggested by Edlén, the IP can be extrapolated from the first three members of the isoelectronic sequence. Since the currently available values of IP for O II [43] and F III [37] are much more accurate than those used by Edlén [42], the extrapolation to Ne IV needs to be revised. Using Edlén's procedure, we have obtained as the new extrapolated IP of Ne IV $783\,890 \pm 20$ cm^{-1}, the uncertainty being determined mainly by the uncertainty of Palénius's result for F III ($505\,777 \pm 5$ cm^{-1} [37]).

The new extrapolated IP of Ne IV is substantially higher than the previous Edlén's value ($783\,300$ cm^{-1}) and also somewhat higher than the value obtained by means of the core-polarisation theory. We consider the extrapolated IP as more accurate because of the assignment uncertainties of the levels used in the fitting of the polarisation formula. In a recent work of Biémont *et al.* [44], the ionisation potentials of the ions in several isoelectronic sequences have been determined using interpolation/extrapolation of differences between experimental data and results of relativistic MCDF calculations. Their IP value for Ne IV ($784\,030 \pm 370$ cm^{-1}) agrees with our result.

5 Summary

As a result of the present analysis, a consistent linelist with energy-level classifications of Ne IV has been built, and a complete set of optimised energy levels has been derived. The previous knowledge of the Ne IV spectrum has been substantially extended. In total, 35 new energy levels have been found and about 90 new spectral lines classified. An improved value of the ionisation potential has been obtained.

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