Atomic Transitions for the Doubly Ionized Argon Spectrum, Ar III

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We present new experimental atomic transition values for the atomic emission spectrum of doubly ionized argon, Ar III. In this work we studied $3s^2 3p^4 - 3s^2 3p^3 3d$, $3s^2 3p^4 - 3s^2 3p^3 4s$, $3s^2 3p^4 - 3s^2 3p^3 4d$, $3s^2 3p^4 - 3s^2 3p^3 5s$, $3s^2 3p^3 3d - 3s^2 3p^3 4p$, and $3s^2 3p^3 4s - 3s^2 3p^3 4p$ transition arrays and 196 lines were identified as new atomic transitions between levels of these configurations. The experimental data were obtained from a capillary-discharge tube. The identifications are supported by multiconfiguration Hartree-Fock relativistic calculations.

I Introduction

The ground state configuration of doubly ionized argon, Ar III, is $3s^2 3p^4$ with the terms ^3P, ^1D, and ^1S. Ar III belongs to the S I isoelectronic sequence.

A complete tabulation of the Ar III energy levels was made by Moore [1]. Kelly [2] summarized all the wavelengths published in the vacuum ultra violet (VUV) region. Hansen and Persson [3] published a revised and extended analysis of the optical spectrum of Ar III. Lestven-Vaïsse et al. [4] studied the spectrum of Ar III using the technique of recoil ion spectroscopy and some lines of Ar III were published.

The spectra of argon ions have many applications in different fields of physics such as photo-electron spectroscopy, plasma physics, astrophysics, and collision experiments, for example, in connection with the study of charge exchange mechanisms.

The purpose of our work is to present a report of the analysis of the Ar III spectrum that includes 196 new classified lines.

II Experiments

The present work is based on photographic recordings of argon in the 280-5000 Å wavelength range. The spectra were obtained at Centro de Investigaciones Opticas, CIOp, using a capillary pulsed discharge. The light source is built with a Pyrex tube, 30 cm long, and with an inner diameter of 0.3 cm. The tube has inner electrodes and is viewed end on. The excitation of the gas is produced by discharging a bank of low-inductance capacitors varying between 2.5 and 100 nF and charged up to 19 kV through the tube.

In the VUV region the radiation was analyzed using a 3 m normal incidence spectrograph with a concave diffraction grating of 1200 l/mm blazed for 1200 Å. The plate factor in the first order is 2.77 Å/mm. Lines of C III and N II [5], O III [6], and lines of Ar III -Ar V [2], were used as internal wavelength standards.

In the visible region the radiation was detected with a 3.4 Ebert plane-grating spectrograph whose plate factor is 5 Å/mm in the first diffraction order. ^{232}Th lines [7] were used as wavelength standards.

In both experiments, a rotating prism photoelectric comparator, whose precision is 1 μm, was used to determine the positions of the spectral lines on the plates. The accuracy of the wavelength values is estimated to be $\pm$ 0.01 Å in the VUV region, whereas in the 2500-5000 Å region the uncertainty is estimated to be $\pm$ 0.01 Å and $\pm$0.008 Å in the first and second diffraction orders respectively.

The experiments are described in more detail elsewhere [8,9].

III Analysis and theoretical interpretation

Transition identifications were guided by theoretical predictions obtained from Cowan's computer code [10]. The theoretical predictions for the energy levels of the configurations were obtained by diagonalizing the energy matrices with appropriate Hartree-Fock relativistic (HFR) values for the energy parameters. The interpretation of configuration level structures was made by a least-squares fit of the parameters to the observed levels. In the calculations we have included the $3s^2 3p^4$ and $3s^2 3p^3 4p$ odd configurations and the $3s^2 3p^3 3d$, $3s^2 3p^3 4s$, $3s^2 3p^3 4d$, and $3s^2 3p^3 5s$ even configurations.

The energy level values were determined from the observed wavelengths using the program ELCALC [11], in which the individual wavelengths are weighted according to their uncertainties.

The adjusted experimental energy level values were used as input for the program STRANS. This program allows us to calculate the atomic transitions belonging to the Ar III spectrum.

Table 1 shows the 196 identified lines obtained from the combinations of the odd and even configurations cited above. In the first column of the table the intensities of the lines are shown. They are visual estimates of plate blackening. The second and third columns show the observed and calculated wavelength values.

Acknowledgements

References

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Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J - J$
3	368.300	368.314	271507.56	$3s^2 3p^3(^2D)4d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	2-2
3	371.750	371.747	269000.19	$3s^2 3p^3(^2D)4d - 3s^2 3p^4$	$^3D^0\text{-}^3P$	3-2
1	400.630	400.639	249601.47	$3s^2 3p^3(^4S)5s - 3s^2 3p^4$	$^5S^0\text{-}^3P$	2-1
1	409.080	409.071	244456.45	$3s^2 3p^3(^4S)4d - 3s^2 3p^4$	$^5D^0\text{-}^3P$	1-0
1	422.490	422.471	236702.90	$3s^2 3p^3(^4S)5s - 3s^2 3p^4$	$^5S^0\text{-}^1D$	2-2
5	472.660	472.674	211562.38	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3D^0\text{-}^3P$	1-2
3	475.160	475.168	210451.89	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3D^0\text{-}^3P$	1-1
6	475.460	475.457	210324.11	$3s^2 3p^3(^2D)3d - 3s^2 3p^4$	$^1F^0\text{-}^1D$	3-2
3	476.200	476.208	209992.37	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3D^0\text{-}^3P$	1-0
3	477.340	477.343	209493.01	$3s^2 3p^3(^2P)4s - 3s^2 3p^4$	$^1P^0\text{-}^3P$	1-0
6	485.680	485.676	205898.69	$3s^2 3p^3(^2D)3d - 3s^2 3p^4$	$^1P^0\text{-}^1D$	1-2
3	490.230	490.230	203985.89	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^1P^0\text{-}^1S$	1-0
3	503.390	503.392	198652.16	$3s^2 3p^3(^2D)4s - 3s^2 3p^4$	$^1D^0\text{-}^3P$	2-1
3	506.200	506.192	197553.32	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3D^0\text{-}^1D$	1-2
6	507.480	507.475	197053.96	$3s^2 3p^3(^2P)4s - 3s^2 3p^4$	$^1P^0\text{-}^1D$	1-2
6	517.560	517.538	193222.38	$3s^2 3p^3(^2P)4s - 3s^2 3p^4$	$^3P^0\text{-}^1D$	2-2
6	528.040	528.040	189379.50	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	2-2
6	530.460	530.458	188516.28	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	1-2
6	531.160	531.155	188269.02	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	2-1
3	533.630	533.601	187405.80	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	1-1
3	534.920	534.913	186946.27	$3s^2 3p^3(^2P)3d - 3s^2 3p^4$	$^3P^0\text{-}^3P$	1-0
6	535.790	535.787	186641.46	$3s^2 3p^3(^2D)3d - 3s^2 3p^4$	$^1P^0\text{-}^1S$	1-0
6	538.350	538.348	185753.58	$3s^2 3p^3(^2D)4s - 3s^2 3p^4$	$^1D^0\text{-}^1D$	2-2
6	547.450	547.434	182670.29	$3s^2 3p^3(^2D)4s - 3s^2 3p^4$	$^3D^0\text{-}^1D$	3-2
1	552.240	552.243	181079.78	$3s^2 3p^3(^2D)3d - 3s^2 3p^4$	$^3P^0\text{-}^1S$	1-0

Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J - J$
6	562.440	562.440	177796.73	$3s^2 3p^3(^2P)4s - 3s^2 3p^4$	$^1P^0\text{-}^1S$	1-2
3	573.840	573.840	174264.54	$3s^2 3p^3(^2P)4s - 3s^2 3p^4$	$^3P^0\text{-}^1S$	1-0
9	1005.270	1005.291	99473.70	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^1D\text{-}^5D^0$	2-2
9	1014.780	1014.779	98543.66	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^3P\text{-}^5D^0$	2-1
12	1017.660	1017.657	98264.97	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^3P\text{-}^5D^0$	1-1
12	1048.200	1048.213	95400.48	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^3D\text{-}^5D^0$	3-3
15	1048.380	1048.362	95386.92	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^3D\text{-}^5D^0$	3-4
6	1049.690	1049.681	95267.00	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	$^3D\text{-}^5D^0$	1-2
1	1157.470	1157.459	86396.17	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3P\text{-}^3D^0$	2-1
6	1159.770	1159.756	86225.06	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3P\text{-}^3D^0$	1-2
12	1199.370	1199.376	83376.72	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3D^0$	3-3
12	1199.950	1199.958	83336.27	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3D^0$	2-2
6	1201.490	1201.491	83229.91	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3D^0$	2-1
9	1203.030	1203.046	83122.33	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3D^0$	1-1
9	1245.760	1245.773	80271.44	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^4S)3d$	$^3D\text{-}^5D^0$	1-1
15	1250.630	1250.656	79958.03	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^1P\text{-}^1S^0$	1-0
3	1265.250	1265.251	79035.67	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	$^1D\text{-}^3D^0$	2-1
3	1290.310	1290.293	77501.75	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3F^0$	2-2
9	1292.070	1292.067	77395.39	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3F^0$	1-2
3	1295.060	1295.064	77216.28	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3F^0$	3-3
12	1295.630	1295.632	77182.42	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3F^0$	2-3
15	1301.820	1301.824	76815.28	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2D)3d$	$^3D\text{-}^3F^0$	3-4
6	1333.860	1333.860	74970.39	$3s^2 3p^3(^2P)4d - 3s^2 3p^3(^4S)4p$	$^3D^0\text{-}^3P$	2-1
6	1337.420	1337.428	74770.36	$3s^2 3p^3(^2P)4d - 3s^2 3p^3(^4S)4p$	$^3D^0\text{-}^3P$	3-2
9	1338.240	1338.237	74725.16	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	$^3P\text{-}^3D^0$	0-1

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Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J-J$
12	1338.620	1338.595	74705.22	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}P-^{3}D^0	1-2
9	1340.520	1340.525	74597.64	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}P-^{3}D^0	1-1
12	1343.710	1343.725	74419.97	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}P-^{3}D^0	2-2
3	1345.680	1345.671	74312.39	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}P-^{3}D^0	2-1
9	1422.000	1422.013	70322.86	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{1}F-^{3}D^0	3-2
12	1434.070	1434.077	69731.25	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	4-3
15	1437.020	1437.019	69588.50	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	3-3
12	1437.170	1437.155	69581.91	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	3-2
3	1440.070	1440.065	69441.33	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	2-3
12	1440.210	1440.201	69434.73	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	2-2
9	1442.440	1442.436	69327.16	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}D^0	2-1
9	1500.740	1500.731	66634.17	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{1}P-^{3}D^0	1-1
9	1542.540	1542.536	64828.31	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{1}D-^{1}D^0	2-2
1	1556.220	1556.203	64258.95	$3s^2 3p^3(^4S)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{5}D^0	2-3
1	1556.630	1556.647	64240.66	$3s^2 3p^3(^4S)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{5}D^0	1-2
9	1568.690	1568.692	63747.39	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	3-2
3	1571.920	1571.913	63616.76	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}P-^{1}D^0	1-2
12	1572.320	1572.322	63600.22	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	2-2
1	1573.050	1573.049	63570.81	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	4-3
12	1576.590	1576.589	63428.06	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	3-3
9	1580.260	1580.256	63280.89	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	2-3
15	1583.040	1583.035	63169.81	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	4-4
1	1586.330	1586.340	63038.17	$3s^2 3p^3(^2D)5s - 3s^2 3p^3(^4S)4p$	^{3}D^0-^{3}P	2-2
1	1586.620	1586.620	63027.06	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}F^0	3-4
1	1588.740	1588.713	62944.05	$3s^2 3p^3(^2D)4d - 3s^2 3p^3(^4S)4p$	^{3}S^0-^{3}P	1-1

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Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J-J$
6	1596.210	1596.234	62647.45	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	3-2
9	1602.570	1602.568	62399.83	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	1-2
9	1602.790	1602.758	62392.45	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	2-2
9	1604.410	1604.412	62328.12	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	3-3
12	1605.710	1605.715	62277.55	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{1}P-^{1}D^0	1-2
15	1611.000	1610.978	62074.08	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	2-3
15	1614.790	1614.801	61927.12	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}D-^{3}F^0	3-4
9	1617.760	1617.758	61813.94	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{1}P-^{1}S^0	1-0
1	1649.570	1649.561	60622.20	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}D-^{1}D^0	1-2
0	1650.020	1649.994	60606.27	$3s^2 3p^3(^2P)5s - 3s^2 3p^3(^2D)4p$	^{3}P^0-^{3}D	2-3
3	1675.540	1675.550	59681.91	$3s^2 3p^3(^4S)4p - 3s^2 3p^3(^4S)3d$	^{5}P-^{5}D^0	1-1
6	1768.830	1768.817	56534.95	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2P)3d$	^{1}D-^{1}D^0	2-2
1	1786.520	1786.504	55975.25	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{3}D^0	1-1
3	1793.640	1793.631	55752.81	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{3}D^0	0-1
6	1798.500	1798.499	55601.92	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{3}D^0	2-2
1	1814.630	1814.615	55108.09	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{1}F-^{3}G^0	3-4
6	1827.800	1827.788	54710.95	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^4S)3d$	^{3}P-^{3}D^0	2-3
3	1834.530	1834.529	54509.89	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}G^0	4-4
12	1836.370	1836.370	54455.25	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}G^0	4-5
3	1838.090	1838.092	54404.23	$3s^2 3p^3(^2D)4p - 3s^2 3p^3(^2D)3d$	^{3}F-^{3}G^0	3-3
6	1850.320	1850.317	54044.80	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}P-^{3}P^0	2-2
9	1855.660	1855.655	53889.33	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}D-^{3}F^0	3-4
3	1859.890	1859.908	53766.11	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}P-^{3}P^0	1-2
1	1864.500	1864.496	53633.80	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}D-^{3}F^0	3-3
6	1865.670	1865.674	53599.94	$3s^2 3p^3(^2P)4p - 3s^2 3p^3(^2P)3d$	^{3}D-^{3}F^0	2-3

Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J-J$
1	1874.270	1874.259	53354.41	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}F^0	2-2
6	1878.000	1878.003	53248.05	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}F^0	1-2
0	1907.140	1907.144	52434.44	$3s^23p^3(^2P)4p$ - $3s^23p^3(^4S)3d$	^{3}D-^{3}D^0	2-2
9	1938.790	1938.791	51578.55	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2D)3d$	^{1}F-^{1}G^0	3-4
5	1958.890	1958.902	51049.02	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}S-^{3}P^0	1-0
6	1965.490	1965.513	50877.31	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}P^0	2-2
3	1973.300	1973.315	50676.14	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}S-^{3}P^0	1-1
6	2007.540	2007.511	49812.92	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}S-^{3}P^0	1-2
1	2064.810	2064.810	48430.61	$3s^23p^3(^2D)4d$ - $3s^23p^3(^2D)4p$	^{1}D^0-^{1}P	2-1
4	2082.810	2082.800	48012.30	$3s^23p^3(^4S)5s$ - $3s^23p^3(^4S)4p$	^{3}S^0-^{5}P	1-1
1	2107.180	2107.171	47456.98	$3s^23p^3(^4S)4d$ - $3s^23p^3(^4S)4p$	^{3}D^0-^{5}P	2-3
5	2136.000	2136.005	46816.36	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	2-1
4	2141.800	2141.791	46689.89	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	1-1
1	2144.130	2144.129	46638.98	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	0-1
1	2187.300	2187.317	45718.11	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}D	2-3
1	2191.740	2191.757	45625.50	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}D	1-2
2	2242.460	2242.428	44594.51	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2D)4s$	^{1}D-^{1}D^0	2-2
1	2270.450	2270.469	44043.76	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)4s$	^{1}S-^{1}P^0	0-1
1	2299.770	2299.783	43482.36	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}P-^{3}P^0	1-0
1	2312.830	2312.834	43237.00	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}P-^{3}P^0	0-1
4	2330.620	2330.628	42906.89	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	2-1
3	2336.010	2336.011	42808.02	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	1-1
2	2338.880	2338.878	42755.55	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}S	0-1
3	2348.280	2348.273	42584.48	$3s^23p^3(^2P)5s$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	2-2
1	2356.840	2356.846	42429.58	$3s^23p^3(^2D)4d$ - $3s^23p^3(^2D)4p$	^{3}G^0-^{3}D	4-3

Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Configurations	Terms	$J-J$
1	2367.040	2367.073	42246.27	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}P-^{3}P^0	1-2
5	2378.480	2378.475	42043.75	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2D)4s$	^{1}P-^{1}D^0	1-2
4	2383.130	2383.164	41961.02	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}P-^{3}P^0	2-2
2	2420.150	2420.144	41319.86	$3s^23p^3(^2D)4d$ - $3s^23p^3(^2D)4p$	^{3}F^0-^{3}D	2-3
8	2420.650	2420.664	41310.99	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}F^0-^{3}D	2-1
8	2426.220	2426.220	41216.38	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}F^0-^{3}D	3-2
4	2426.910	2426.912	41204.63	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}F^0-^{3}D	2-2
3	2427.480	2427.480	41194.98	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}D^0-^{3}P	1-0
1	2466.830	2466.827	40537.91	$3s^23p^3(^2D)4d$ - $3s^23p^3(^2D)4p$	^{3}G^0-^{1}F	3-3
8	2469.420	2469.428	40495.20	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}D^0-^{3}P	3-2
2	2475.960	2475.994	40387.81	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2D)4s$	^{3}D-^{1}D^0	1-2
1	2503.770	2503.782	39939.58	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{1}F^0	2-3
1	2510.860	2510.855	39827.06	$3s^23p^3(^2D)4d$ - $3s^23p^3(^2D)4p$	^{3}F^0-^{1}F	4-3
2	2527.680	2527.656	39562.34	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}D^0-^{1}D	3-2
1	2539.060	2539.073	39384.45	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2D)4s$	^{1}D^0-^{3}D	2-3
8	2567.160	2567.150	38953.70	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	2-1
5	2577.160	2577.163	38802.36	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	0-1
8	2585.650	2585.649	38675.01	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	2-2
7	2592.280	2592.276	38576.14	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	1-2
1	2597.410	2597.395	38500.11	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}F^0	3-2
4	2693.550	2693.551	37125.72	$3s^23p^3(^2P)4p$ - $3s^23p^3(^2P)4s$	^{1}D-^{3}P^0	2-2
1	2695.120	2695.107	37104.28	$3s^23p^3(^2P)4d$ - $3s^23p^3(^2P)4p$	^{3}F^0-^{1}D	2-2
5	2701.880	2701.864	37011.49	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}P^0	1-0
5	2729.370	2729.361	36638.61	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2P)3d$	^{3}D-^{3}P^0	1-1
10	2754.750	2754.733	36301.16	$3s^23p^3(^2D)4p$ - $3s^23p^3(^2D)4s$	^{1}D-^{1}D^0	2-2

Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Transition	Terms	$J-J$
8	2795.800	2795.794	35768.02	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{3}D-^{3}P^0	2-2
10	2797.500	2797.472	35746.56	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{1}D-^{1}F^0	2-3
7	2808.440	2808.401	35607.45	$3s^23p^3(^2D)4d - 3s^23p^3(^2D)4p$	^{3}P^0-^{1}D	1-2
6	2840.990	2840.987	35199.03	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}S-^{1}P^0	0-1
3	2882.450	2882.451	34692.70	$3s^23p^3(^2D)4d - 3s^23p^3(^2D)4p$	^{1}P^0-^{1}D	1-2
2	2928.610	2928.595	34146.06	$3s^23p^3(^2P)4p - 3s^23p^3(^2P)3d$	^{1}D-^{3}D^0	2-3
8	2929.680	2929.661	34133.64	$3s^23p^3(^2P)4p - 3s^23p^3(^2P)4s$	^{1}P-^{3}P^0	1-0
12	3003.550	3003.532	33294.14	$3s^23p^3(^2P)4p - 3s^23p^3(^2P)4s$	^{1}D-^{1}P^0	2-1
1	3224.320	3224.321	31014.28	$3s^23p^3(^2D)4d - 3s^23p^3(^2P)4p$	^{1}F^0-^{1}D	3-2
9	3252.730	3252.733	30743.38	$3s^23p^3(^2P)4p - 3s^23p^3(^2P)4s$	^{1}P-^{1}P^0	1-1
9	3264.820	3264.805	30629.70	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{1}F-^{3}D^0	3-2
5	3291.570	3291.539	30380.92	$3s^23p^3(^2D)5s - 3s^23p^3(^2P)4p$	^{3}D^0-^{1}P	2-1
2	3332.100	3332.101	30011.09	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}D-^{3}P^0	2-1
6	3437.910	3437.910	29087.44	$3s^23p^3(^2P)4p - 3s^23p^3(^2P)4s$	^{3}D-^{1}P^0	1-1
2	3495.270	3495.268	28610.11	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{1}P	1-1
3	3540.230	3540.205	28246.95	$3s^23p^3(^2D)4d - 3s^23p^3(^2P)4p$	^{3}P^0-^{3}P	1-2
12	3638.920	3638.909	27480.76	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{1}F-^{1}D^0	3-2
7	3671.320	3671.310	27238.24	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}P-^{3}P^0	1-0
6	3684.480	3684.478	27140.89	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	3-2
5	3686.650	3686.651	27124.89	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	1-2
6	3687.650	3687.654	27117.51	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	1-1
7	3689.280	3689.280	27105.56	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	2-2
4	3690.300	3690.284	27098.19	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	2-1
9	3697.040	3697.050	27048.59	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{1}P-^{3}D^0	1-2
10	3713.820	3713.859	26926.17	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{1}F-^{1}F^0	3-3

Table 1. New Observed lines in Ar III

Intensity[a]	$\lambda_{Obs.}$ (Å)	$\lambda_{Calc.}$ (Å)	Wavenumber (cm^{-1})	Transition	Terms	$J-J$
8	3717.610	3717.615	26898.97	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)3d$	^{3}P-^{3}S^0	1-1
5	3724.310	3724.317	26850.56	$3s^23p^3(^4S)4d - 3s^23p^3(^2D)4p$	^{3}D^0-^{3}D	2-3
8	3739.730	3739.742	26739.81	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{3}F-^{1}D^0	3-2
9	3757.450	3757.461	26613.72	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)3d$	^{3}P-^{3}S^0	2-1
4	3868.060	3868.067	25852.70	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{1}D-^{3}D^0	2-3
8	3938.200	3938.209	25392.25	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{3}D-^{1}D^0	1-2
8	3996.720	3996.730	25020.45	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}D-^{1}D^0	2-2
9	4184.160	4184.161	23899.66	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)4s$	^{1}P-^{1}D^0	1-2
7	4450.450	4450.440	22469.69	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}P-^{1}D^0	1-2
2	4549.840	4549.843	21978.78	$3s^23p^3(^4S)4p - 3s^23p^3(^4S)3d$	^{3}P-^{3}D^0	2-1
8	4566.490	4566.493	21898.64	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}P-^{1}P^0	1-1
5	4688.930	4688.943	21326.77	$3s^23p^3(^4S)4p - 3s^23p^3(^4S)3d$	^{3}P-^{3}D^0	2-2
7	4732.710	4732.737	21129.42	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{3}P-^{3}D^0	2-3
4	4773.500	4773.480	20949.08	$3s^23p^3(^4S)5s - 3s^23p^3(^2D)4p$	^{3}S^0-^{3}P	1-1
2	4802.710	4802.713	20821.56	$3s^23p^3(^4S)5s - 3s^23p^3(^2D)4p$	^{3}S^0-^{3}P	1-0
11	4849.200	4849.220	20621.88	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{3}P-^{3}D^0	1-2
6	4893.350	4893.374	20435.80	$3s^23p^3(^4S)4p - 3s^23p^3(^4S)3d$	^{3}P$_2$-^{3}D^0	2-3
2	4940.050	4940.052	20242.70	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{3}D-^{1}P^0	1-1
10	4952.720	4952.725	20190.91	$3s^23p^3(^2D)4p - 3s^23p^3(^2P)3d$	^{3}P-^{3}D^0	0-1
10	4994.010	4994.011	20023.98	$3s^23p^3(^2P)4p - 3s^23p^3(^2D)3d$	^{1}D-^{1}F^0	2-3
1	5744.740	5744.743	17407.22	$3s^23p^3(^2D)4p - 3s^23p^3(^2D)3d$	^{3}P-^{3}P^0	0-1

[a] The intensities of the lines are visual estimates of plate blackening. They vary from 1 to 12.