Atomic data for varying many-multiplet and alkali-doublet analyses of varying- $\!\alpha\!$

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ABSTRACT

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Key words: atomic data – line: profiles – methods: laboratory – techniques: spectroscopic – quasars: absorption lines – ultraviolet: general

1 INTRODUCTION

This paper has been typeset from a TEX/LATEX file prepared by the author.

2 INPUT DATA

2.1 Atomic data

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Table 1. Atomic data for transitions usable in many-multiplet or alkali-doublet analyses, i.e. transitions with precise laboratory wavelengths. Information for isotopic and hyperfine components is given in italics. Columns 1 and 2 show the common names used for the transitions. Column 3 shows the mass number for each ionic species. The derivation of the laboratory wavenumbers, $ω_0$, is summarized by the value of X as follows: 0 – Measured wavenumber; 1 – Inferred from measured component wavenumbers; 2 – Inferred from measured composite wavenumber and measured component splitting; 3 – Inferred from measured composite wavenumber and calculated component splitting. Column 6 gives the reference(s) for the wavenumber measurement and/or calculations (specified below the table). Vacuum laboratory wavelengths, $λ_0$, are derived from the wavenumbers. Columns 8 and 9 show the lower and upper/excited state electronic configurations. The ID letters in column 10 offer a simple shorthand for labelling transitions used to fit absorption systems. Column 11 shows the ionization potential for the relevant ion, IP⁺, and for the ion with a unit lower charge, IP⁻. Column 12 shows the oscillator strengths, f, taken from Morton (2003) or the relative strengths of the hyperfine or isotopic components. The latter are taken from Rosman & Taylor (1998). The f coefficients and their uncertainties are from Berengut et al. (2009). Note that uncertainties in the f coefficients are representative not statistical. Wavenumbers are on the Whaling et al. (1995) Ar II calibration scale; the Fe II λ1608/1611 and Ni II wavenumbers have been scaled from their original values to account for the calibration difference between the Ar II scales of Norlén (1973) and Whaling et al. (1995). The exceptions to this are the Mg I/II wavenumbers which are on a highly accurate absolute scale generated using a frequency-comb calibration system. The Whaling et al. (1995) scale best agrees with this absolute scale.

Ion	Tran.	Α	$\omega_0 [\mathrm{cm}^{-1}]$	X	Ref.	λ_0 [Å]	Lower state	Upper state	ID	IP ⁻ , IP ⁺ [eV]	f or %	q [cm ⁻¹]
Mgı	2026	24.31	49346.772611(36)	1		2026.4749792(15)	$3s^2 {}^1S_0$	3s4p ¹ P ₁ ^o	a_1	—, 7.65	0.113	87(7)
		26	49346.854173(40)	0	a	2026.4716298(16)		_			11.0	
		25	49346.807724(40)	0	a	2026.4735372(16)					10.0	
		24	49346.756809(35)	0	a	2026.4756281(14)					79.0	
	2852	24.31	35051.28076(19)	1		2852.962797(15)		3s3p ¹ P ₁ ^o	a_2		1.83	90(10)
		26	35051.32015(25)	0	b	2852.959591(20)		- 1			11.0	
		25	35051.29784(25)	0	b	2852.961407(20)					10.0	
		24	35051.27311(17)	0	b	2852.963420(14)					79.0	
Мдп	2796	24.31	35760.85409(20)	1		2796.353794(16)	$3s\ ^2S_{1/2}$	$3p^{2}P_{3/2}$	b_1	7.65, 15.04	0.6155	212(2)
Č		26	35760.940387(5)	0	c	2796.3470457(4)	-,-	1 -/-			11.0	
		25	35760.85819(64)	3	c	2796.353473(50)	F = 2	F = 1, 2, 3			4.2	
		25	35760.91593(64)	3	c	2796.348958(50)	F = 3	F = 2, 3, 4			5.8	
		24	35760.837397(5)	0	c	2796.3550990(4)					79.0	
	2803	24.31	35669.30439(20)	1		2803.530983(16)		$3p^{2}P_{1/2}$	b_2		0.3058	121(2)
		26	35669.390571(5)	0	c	2803.5242094(4)		1 1/2	-		11.0	. ,
		25	35669.30690(64)	3	c	2803.530786(50)	F = 2	F = 1, 2, 3			4.2	
		25	35669.36657(64)	3	c	2803.526096(50)	F = 3	F = 2, 3, 4			5.8	
		24	35669.287670(5)	0	c	2803.5322972(4)					79.0	
Alп	1670	26.98	59851.976(4)	0	d	1670.78861(11)	$3s^2 {}^1S_0$	3s3p ¹ P ₁	c_1	5.99, 18.83	1.74	270(30)
Аlш	1854	26.98	53916.554(1)	1	d	1854.717941(34)	$3s {}^{2}S_{1/2}$	$3p^{2}P_{3/2}$	d_1	18.83, 28.45	0.559	458(6)
		27	53916.8149(8)	0	d	1854.708966(28)	F=2	2 -7-	-		41.7	
		27	53916.3574(6)	0	d	1854.724704(21)	F = 3				58.3	
	1862	26.98	53682.884(2)	1	d	1862.791127(69)	$3s\ ^2S_{1/2}$	$3p^{2}P_{1/2}$	d_2		0.278	224(8)
		27	53683.1953(15)	0	d	1862.780325(52)	F=2	1 -/-			41.7	
		27	53682.6692(12)	0	d	1862.798581(42)	F = 3				58.3	
Siп	1526	28.09	65500.4538(7)	0	d	1526.706980(16)	$3s^23p ^2P_{1/2}^o$	$3s^24s ^2S_{1/2}$	e_1	8.15, 16.35	0.133	50(30)
		30	65500.441994	3	e	1526.7072550	1/2	,			3.1	
		29	65500.448002	3	e	1526.7071150					4.7	
		28	65500.454492	3	e	1526.7069637					92.2	
	1808	28.09	55309.3404(4)	0	d	1808.012883(13)		$3s3p^2 {}^2D_{3/2}$	e_2		0.00208	520(30)
		30	55309.435938	3	f	1808.0097601		5/2	- 2		3.1	()
		29	55309.387116	3	f	1808.0113560					4.7	
		28	55309.334806	3	f	1808.0130660					92.2	
Siıv	1393	28.09	71748.355(2)	0	d	1393.760177(39)	$2p^63s ^2S_{1/2}$	$2p^63p^2P_{3/2}$	f_1	33.49, 45.14	0.513	823(40)
		30	71748.551629	3	e	1393.7563579	1 -/-	1 1 -/-	0 -		3.1	` ′
		29	71748.451219	3	e	1393.7583084					4.7	
		28	71748.343484	3	e	1393.7604012					92.2	
	1402	28.09	71287.376(2)	0	d	1402.772912(39)		$2p^63p^2P_{1/2}$	f_2		0.254	361(15)
		30	71287.574290	3	e	1402.7690098		,			3.1	
		29	71287.473031	3	e	1402.7710024					4.7	
		28	71287.364387	3	e	1402.7731402					92.2	
Тіп	3067	47.87	32602.627(2)	0	g	3067.23750(19)	$3d^24s \ a^4F_{3/2}$	$3d^24p z^4D_{3/2}^o$	g_1	6.82, 13.58	0.0489	791(50)
		50	32602.651577	3	h	3067.2351837		- 3/2			5.2	
		49	32602.640059	3	h	3067.2362673					5.4	
		48	32602.628061	3	h	3067.2373961					73.7	
		47	32602.603236	3	h	3067.2397316					7.4	
		46	32602.615933	3	h	3067.2385371					8.3	
	3073	47.87	32532.355(1)	0	g	3073.86293(9)		$3d^24p\;z^4D^o_{1/2}$	g_2		0.121	677(50)
		50	32532.379612	3	h	3073.8606027		- 1/2	J-		5.2	• •
		49	32532.368077	3	h	3073.8616926					5.4	
		48	32532.356062	3	h	3073.8628278					73.7	
		47	32532.331204	3	h	3073.8651766					7.4	
		46	32532.343917	3	h	3073.8639753					8.3	

 $\textbf{Table 1} - \textit{continued}. \ \, \textbf{Atomic data for transitions usable in many-multiplet or alkali-doublet analyses}$

59 30958-606542 3 h 32301191322 524 552 54 54 54 54 54 54 54 54 54 54 54 54 54	Ion	Tran.	A	ω_0 [cm ⁻¹]	X	Ref.	λ ₀ [Å]	Lower state	Upper state	ID	$IP^-, IP^+ [eV]$	f or %	q [cm ⁻¹]
49 30988,39904 3 h 3201,20251 5.4 47 30988,30298 3 h 3201,215753 7.7 48 30988,30298 3 h 3201,215753 7.8 48 30988,30298 3 h 3201,221899 8.3 49 30856,42011 0 g 3042,9157101 3d ² 4p x ⁴ F _{3/2} g ₄ 0.232 541(50) 49 30856,430283 3 h 3202,9157502 7.37 49 30856,430283 3 h 3202,9157502 7.37 47 30856,401821 3 h 3242,9107502 7.37 47 30856,401821 3 h 3242,9107502 7.37 47 30856,401821 3 h 3242,9107502 7.37 48 30856,401821 3 h 3242,9107500 8.3 47 30856,401821 3 h 3242,9107500 8.3 48 20544,45811 3 h 3347,200716 8.3 49 20544,408410 3 h 3348,7200716 7.4 49 20544,408410 3 h 3348,7200712 7.37 47 20544,408410 3 h 3348,7200712 7.4 48 20544,408410 3 h 3348,7200712 7.3 47 20546,408410 3 h 3348,7200712 7.3 48 2054,408410 3 h 3348,7200712 7.3 49 2054,408410 3 h 3348,7200712 7.3 2060 5200 4849,05751 3 i 2776,805055 F - 0.5, 15 F - 1.5, 2.5, 3.5 53 3386,607310 3 i 2776,805055 F - 0.5, 15 F - 1.5, 2.5, 3.5 53 3386,607310 3 i 2776,805055 F - 0.5, 15 F - 1.5, 2.5, 3.5 53 3386,607310 3 i 2776,805055 F - 0.5, 15 F - 1.5, 2.5, 3.5 54 3448,805210 3 i 2776,805055 F - 0.5, 15 F - 1.5, 2.5, 3.5	Тіп	3230							$3d^24p z^4F_{5/2}^0$	g_3			673(50)
14													
147 30958,562268 3 h 3230 128189 3 h 3230 128189 3 h 3230 128189 3 h 3242 14787 30836,42661 0 g 3242 1479711 3 d ² 4p 2 ⁴ F _{3/2} g ₄ 0.232 541(50) 52 49 30886,439083 3 h 3242 915780 5 h 3242 915780 7.7 7													
3424 2787 39334-0450 0 8 3240 19797(11) 36 ² 4p 2 ² F _{3/2} gs 0.232 541(50) 50 30353,459097 3 h 3242,915740													
3242 4787 3986.426(1) 0 g 3242.9179(1) 34 ² 4p x ² F ⁰ _{3/2} g ₄ 0.222 541(50) 49													
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Section Sect		3242							$3d^24p z^4F_{3/2}^0$	g_4			541(50)
48													
147 30866-00821 3 6 3242-9091440 3 6 3242-9091440 3 6 30816-00821 3 6 3 3 6 3 3 3 3 3													
3384 478 29544.49581 3 6 3242.919.540 3244 pt 26° _{5/2} g ₅ 0.358 396(50) 348													
3384 47.87 29544.454(1) 0 g 3384.7300(11) 34°4p 2°0°3; g 5 0.388 396(50) 49 29544.468409 3 h 3384.7280676 49 29544.45781 3 h 3384.728062 49 29544.42984 3 h 3384.728062 40 2954.442984 3 h 3384.728062 40 205 52.00 48625.08802 0 g 2066.25808(85) 36°6 S ₂₇ 3 d ⁴ 4p ⁶ 1°7; h ₁ 6.77, 16.50 0.103 -1110(150 0.206 5.200 48625.08812 0 g 2066.25808(85) 36°4 S ₂₇ 3 d ⁴ 4p ⁶ 1°7; h ₁ 6.77, 16.50 0.103 -1110(150 0.206 5.200 48626.08812) 0 g 2066.25808(85) 36°4 S ₂₇ 3 d ⁴ 4p ⁶ 1°7; h ₁ 6.77, 16.50 0.103 -1110(150 0.206 5.200 4839.85712) 0 g 2066.16389(85) 3 d ⁴ 5 s ₂ s ₂₇ 3 h ₂ 0.0512 -1280(150 0.206 5.200 4839.85712) 0 g 2066.16389(85) 3 d ⁴ 4p ⁶ 1°7; h ₂ h ₂ 0.0512 -1380(150 0.206 5.206 5.200 4839.85712) 0 g 2066.16389(85) 3 d ⁴ 4p ⁶ 1°3; h ₂ h ₂ 0.0512 -1380(150 0.206 5													
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February													
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MnII 2576 54.94 38806.689(3) 0 g 2576.87534(20) 3d ⁴ 4s a ⁷ 8; 3d ⁵ 4p z ⁷ P ² ; i ₁ 7.44, 15.64 0.361 1276(150) 5 38806.879265 3 i 2576.8627082 F = 0.5, 1.5 F = 1.5, 2.5, 3.5 14.3 5 38806.879265 3 i 2576.8700627 F = 3.5 F = 1.5, 2.5, 3.5 14.3 5 38806.0708508 3 i 2576.8700627 F = 3.5 F = 1.5, 2.5, 3.5 19.0 5 38806.052155 3 i 2576.8700627 F = 3.5 F = 2.5, 3.5, 4.5 19.0 5 38806.052155 3 i 2576.8700627 F = 3.5 F = 2.5, 3.5, 4.5 19.0 5 38806.451511 3 i 2576.8911123 F = 5.5 F = 3.5, 4.5, 5.5 22.8 5 38843.39993 3 i 2594.4778464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.3 5 38543.309903 3 i 2594.4778464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.2 5 38543.03607 3 i 2594.4841992 F = 2.5 F = 1.5, 2.5, 3.5 14.3 5 38543.03607 3 i 2594.4841992 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 38543.03607 3 i 2594.4914294 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 38543.036012 3 i 2594.5914294 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 38543.036013 0 g 2006.435800 F = 4.5 F = 3.5, 4.5, 5.5 22.8 5 38543.036013 0 g 2006.435800 F = 4.5 F = 3.5, 4.5, 5.5 22.8 5 38543.036013 0 g 2006.435800 F = 5.5 F = 4.5, 5.5 5 2.5 2.8 5 38543.036013 0 g 2006.435800 F = 5.5 F = 5.5, 5.5 14.3 5 38566.573964 3 i 2606.4352603 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.3 5 38366.573964 3 i 2606.4352603 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.3 5 38366.325813 3 i 2606.4352603 F = 5.5 F = 4.5, 5.5 14.3 5 38366.325813 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 38366.325813 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38366.325813 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 5 38365.3395 3 i 2606.4352603 F = 3.5 F = 3.5, 4.5 5 2.8 6 62171.632192 3 k 1608.4953536 F = 3.5 F = 2.5, 3.5, 4.5 19.1 5 6 62171.632192 3 k 1608.4953536 F = 3.5 F = 3.5, 4.5 5 2.8 6 6205.530340 3 k 1608.4953536 F = 3.5		2062		48491.057(2)	0	g	2062.235929(85)		3d ⁴ 4p ⁶ P ⁶ _{5/2}	h_2			-1280(150)
55 38806,974333		2066	52.00	48398.871(2)	0	g	2066.163899(85)		$3d^44p\ ^6P_{3/2}^{o}$	h_3		0.0512	-1360(150)
55 38806,879265 3 i 2576,8627082 F = 2.5 F = 1.5, 2.5, 3.5 14.3 55 38806,068508 3 i 2576,8795818 F = 4.5 F = 3.5, 4.5, 5.5 55 38806,062155 3 i 2576,8795818 F = 4.5 F = 3.5, 4.5, 5.5 2594 5494 38843,121(3) 0 g 2594,4478464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 55 38543,399993 3 i 2594,4478464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 55 38543,198206 3 i 2594,4478464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 55 38543,198206 3 i 2594,441392 F = 2.5 F = 1.5, 2.5, 3.5 55 38543,198206 3 i 2594,5491294 F = 3.5 F = 2.5, 3.5, 4.5 55 38543,89806 3 i 2594,5491294 F = 3.5 F = 2.5, 3.5, 4.5 55 38543,89806 3 i 2594,5491294 F = 3.5 F = 2.5, 3.5, 4.5 2606 54.94 38366,230(3) 0 g 2606,4354808 F = 3.5 F = 4.5, 5.5 38366,35981 3 i 2606,4354808 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 55 38366,35981 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 57 38366,359815 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 58 38366,359300 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 58 38366,359300 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 58 38366,359300 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 58 38366,359313 3 i 2606,4493603 F = 2.5 F = 2.5, 3.5, 4.5 59 38366,353305 3 i 2606,4432603 F = 2.5 F = 2.5, 3.5, 4.5 50 38366,353305 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 50 38366,353305 3 i 2606,4432603 F = 2.5 F = 1.5, 2.5, 3.5 50 38366,353305 3 i 2606,4432603 F = 2.5 F = 2.5, 3.5, 4.5 50 38366,353305 3 i 2606,4432603 F = 2.5 F = 4.5, 5.5 50 38366,353305 3 i 2606,4432603 F = 5.5 F = 2.5, 3.5, 4.5 50 38366,353305 3 i 2606,4432603 F = 5.5 F = 4.5, 5.5 50 38366,353305 3 i 2606,4432603 F = 5.5 F = 4.5, 5.5 50 38366,353030 3 i 2606,4432603 F = 5.5 F = 4.5 50 38366,35	Mnп	2576	54.94	38806.689(3)	0	g	2576.87534(20)	$3d^54s a^7S_3$	$3d^{5}4p z^{7}P_{4}^{o}$	i_1	7.44, 15.64	0.361	1276(150)
55			55	38806.974333	3	i	2576.8563955	F = 0.5, 1.5	F = 1.5, 2.5			14.3	
55 38806.625155 3 i 2576.8795818 F = 4.5 F = 3.5, 4.5, 5.5 22.8 2594 54.94 38543.121(3) 0 g 2594.49669(20) 304 p r p p i i 0.280 1030(150 55 38543.399903 3 i 2594.476844 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.2 55 38543.399903 3 i 2594.478464 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.3 55 38543.398026 3 i 2594.49614294 F = 3.5 F = 2.5, 3.5, 4.5 19.1 55 38543.058012 3 i 2594.5008260 F = 4.5 F = 3.5, 4.5, 5.5 2606 54.94 38366.230(3) 0 g 2606.45886(20) 55 38543.6439582 3 i 2594.5008260 F = 4.5 F = 3.5, 4.5, 5.5 22.8 2606 54.94 38366.230(3) 0 g 2606.45886(20) 55 38366.345813 3 i 2606.4435489 F = 0.5, 1.5 F = 0.5, 1.5, 2.5 14.3 55 38366.439582 3 i 2606.4432603 F = 2.5 F = 1.5, 2.5, 3.5 14.3 55 38366.439582 3 i 2606.4432640 F = 5.5 F = 2.5, 3.5, 4.5 19.1 55 38366.35813 3 i 2606.4432640 F = 5.5 F = 2.5, 3.5, 4.5 19.1 55 38366.35813 3 i 2606.4783550 F = 5.5 F = 2.5, 3.5, 4.5 19.1 55 38366.35813 3 i 2606.4783550 F = 5.5 F = 2.5, 3.5, 4.5 19.1 55 38366.53092 3 i 2606.4783550 F = 5.5 F = 3.5, 4.5 19.1 55 38366.53092 3 i 2606.4783550 F = 5.5 F = 3.5, 4.5 19.1 56 62171.63199 3 k 1608.450697(8) 3d ⁶ 48 aa ⁶ D _{9/2} 3d ² 484p y ⁶ P _{9/2} j 7.87, 16.18 0.0577 -1030(300 1.050 1.0			55	38806.879265	3	i	2576.8627082	F = 2.5	F = 1.5, 2.5, 3.5			14.3	
55 38806.451511 3 i i 2576.8911123 F = 5.5 F = 4.5,5.5,6.5 28.6			55	38806.768508	3		2576.8700627	F = 3.5	F = 2.5, 3.5, 4.5			19.0	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				38806.625155	3	i	2576.8795818	F = 4.5	F = 3.5, 4.5, 5.5			23.8	
55			55	38806.451511	3	i	2576.8911123	F = 5.5				28.6	
55		2594	54.94		0	g	2594.49669(20)		$3d^54p z^7P_3^0$	i_2		0.280	1030(150)
55 38543.058012 3 i 2594.4914294 F = 3.5 F = 2.5, 3.5, 4.5							2594.4778464						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$							2594.4841392						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$							2594.4914294						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$													
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						i		F = 5.5					
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		2606								i_3			869(150)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$													
Fe II													
Fe II 1608 55.85 38365.943000 3 i 2606.4783550 $F = 5.5$ $F = 4.5$ 28.6 Fe II 1608 55.85 62171.629(3) 0 j 1608.450697(78) 3d 6 4s aa 6 D _{9/2} 3d 5 4s4p y 6 P 0 _{7/2} j ₁ 7.87, 16.18 0.0577 -1030(300 58 62171.63196 3 k 1608.4590892 2.1 56 62171.631049 3 k 1608.4596440 91.8 54 62171.585779 3 k 1608.4596440 54 62171.585779 3 k 1608.4518152 58 62065.532(3) 0 j 1611.200239(78) 58 62065.532(3) 0 j 1611.200239(78) 58 62065.53640 3 k 1611.200239(78) 57 62065.516819 3 k 1611.2002332 57 62065.559929 3 k 1611.2002332 54 62065.559929 3 k 1611.2002375 58 62065.559929 3 k 1611.2002375 58 4258.243(2) 0 g 2260.77936(31) 58 42658.243(2) 0 g 2344.21282(11) 58 42658.241832 3 k 2344.2142020 58 42114.804727 3 k 2374.46015(11) 58 42114.804727 3 k 2374.4601918 59 42114.804727 3 k 2374.4601918 50 6 42114.834550 3 k 2374.4610918 50 7 62114.834550 3 k 2374.4610918 50 7 7 62114.834550 3 k 2374.4610918													
Fe II 1608 55.85 62171.629(3) 0 j 1608.450697(78) $3d^64s$ $aa^6D_{9/2}$ $3d^54s4p$ $y^6P_{7/2}^o$ j_1 7.87, 16.18 0.0577 $-1030(300^6+1)$ 58 62171.63196 3 k 1608.4495536 0.3													
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	_	1.000									7.07.16.10		1020/200
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	ге п	1608					* *	$3d^{6}4s \ aa^{6}D_{9/2}$	$3d^34s4p \ y^0 P_{7/2}^0$	J1	7.87, 16.18		-1030(300)
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$													
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$					_								
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$		1611							2.16.4 450				1560(500)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		1611							$3d^{6}4p \ y^{4}F_{7/2}^{6}$	J_2			1560(500)
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$		22.50							2.16.4 1770				1.10.5(1.50)
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						g			$3d^{6}4p z^{4}F_{9/2}^{6}$				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		2344		42658.243(2)	0	g	2344.21282(11)		$3d^{6}4p z^{6}P_{7/2}^{o}$	\dot{J}_4			1540(400)
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58 42114.804727 3 k 2374.4619178 0.3 57 42114.819377 3 k 2374.4610918 2.1 56 42114.834550 3 k 2374.4602364 91.8					3	k							
57 42114.819377 3 k 2374.4610918 2.1 56 42114.834550 3 k 2374.4602364 91.8		2374	55.85	42114.836(2)	0	g	2374.46015(11)		$3d^64p \ z^6F^o_{9/2}$	j_5			1660(60)
56 42114.834550 3 k 2374.4602364 91.8			58	42114.804727	3	k	2374.4619178		• ,				
			57	42114.819377	3	k	2374.4610918					2.1	
54 42114.866583 3 k 2374.4584303 5.8			56	42114.834550	3	k	2374.4602364					91.8	
			54	42114.866583	3	k	2374.4584303					5.8	

4 M. T. Murphy

 $\textbf{Table 1} - continued. \ \, \textbf{Atomic data for transitions usable in many-multiplet or alkali-doublet analyses}$

Ion	Tran.	A	ω_0 [cm ⁻¹]	X	Ref.	λ_0 [Å]	Lower state	Upper state	ID	IP ⁻ , IP ⁺ [eV]	f or %	$q [\text{cm}^{-1}]$
Feп	2382	55.85	41968.065(2)	0	g	2382.76413(11)		3d ⁶ 4p z ⁶ F ^o _{11/2}	j_6		0.320	1550(60)
		58	41968.040382	3	\boldsymbol{k}	2382.7655304		,			0.3	
		57	41968.051914	3	k	2382.7648756					2.1	
		56	41968.063859	3	k	2382.7641975					91.8	
		54	41968.089075	3	k	2382.7627658					5.8	
	2586	55.85	38660.052(2)	0	g	2586.64939(13)		$3d^64p \ z^6D_{7/2}^o$	j_7		0.0691	1540(40)
		58	38660.025896	3	k	2586.6511386		,			0.3	
		57	38660.038124	3	\boldsymbol{k}	2586.6503204					2.1	
		56	38660.050790	3	k	2586.6494730					91.8	
		54	38660.077528	3	k	2586.6476840					5.8	
	2600	55.85	38458.991(2)	0	g	2600.17222(14)		$3d^64p \ z^6D_{9/2}^o$	j_8		0.239	1410(60)
		58	38458.965068	3	k	2600.1739730		-7-			0.3	
		57	38458.977216	3	k	2600.1731517					2.1	
		56	38458.989798	3	k	2600.1723011					91.8	
		54	38459.016359	3	k	2600.1705053					5.8	
Niп	1709	58.69	58493.075(4)	0	l	1709.60409(12)	$3d^9 {}^2D_{5/2}$	$3d^84p \ z^2F_{5/2}^o$	k_1	7.64, 18.17	0.0324	-20(250)
	1741	58.69	57420.017(4)	0	1	1741.55295(12)		$3d^84p z^2D_{5/2}^0$	k_2		0.0427	-1400(250)
	1751	58.69	57080.377(4)	0	1	1751.91555(12)		$3d^84p \ z^2F_{7/2}^{o}$	k_3		0.0277	-700(250)
Znπ	2026	65.41	49355.005(2)	0	g	2026.136964(82)	$3d^{10}4s$ $^{2}S_{1/2}$	$3d^{10}4p ^{2}P_{3/2}^{o}$	l_1	9.39, 17.96	0.501	2470(25)
		70	49355.0523(21)	2	m	2026.135024(87)		5/2			0.6	
		68	49355.0333(20)	2	m	2026.135802(83)					18.8	
		67	49355.1578(64)	3	n, o	2026.13069(26)	F = 2	F = 1, 2, 3			1.7	
		67	49354.9288(29)	3	n, o	2026.14009(12)	F = 3	F = 2, 3, 4			2.4	
		66	49355.0110(20)	2	m	2026.136719(83)					27.9	
		64	49354.9884(22)	2	m	2026.137645(90)					48.6	
	2062	65.41	48481.081(2)	0	g	2062.660278(85)		$3d^{10}4p ^{2}P_{1/2}^{o}$	l_2		0.246	1560(25)
		70	48481.1293(54)	3	e, m	2062.65822(23)		1/2			0.6	
		68	48481.1099(39)	3	e, m	2062.65905(17)					18.8	
		67	48481.2382(95)	3	e, m, n	2062.65359(40)	F = 2	F = 2, 3			1.7	
		67	48481.0040(38)	3	e, m, n	2062.66355(16)	F = 3	F = 2, 3			2.4	
		66	48481.0872(26)	3	e, m	2062.66001(11)					27.9	
		64	48481.0639(30)	3	e, m	2062.66101(13)					48.6	

^aHannemann et al. (2006); ^bSalumbides et al. (2006); ^cBatteiger et al. (2009); ^dGriesmann & Kling (2000); ^eBerengut et al. (2003); ^f1.4 × (Mass shift); ^gAldenius et al. (2006); ^hBerengut et al. (2008); ⁱBlackwell-Whitehead et al. (2005); ^jS. Johansson (priv. comm.); ^kPorsev et al. (2009); ^lPickering et al. (2000); ^mMatsubara et al. (2003); ⁿDixit et al. (2008); ^oMatsubara et al. (2003).