Transition probabilities and radiative lifetimes of Mg III

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ABSTRACT

There have been calculated transition probabilities for 365 lines arising from $2p^5ns$ ($n = 3, 4, 5$), $2p^5np$ ($n = 3, 4$), $2p^5nd$ ($n = 3, 4$), $2p^5nf$ ($n = 4, 5$) and $2p^55g$ configurations of Mg III and radiative lifetimes corresponding to 89 levels. These values were obtained in intermediate coupling (IC) by using ab initio relativistic Hartree-Fock (HFR) calculations. Later, we use the standard method of least square fitting of experimental energy levels for the IC calculations by means of Cowan's computer codes. The vast majority of the calculated transition probabilities correspond to lines lying in the ultraviolet range (UV) which are of high interest in astrophysics. Our results are compared to those previously reported in the literature. Furthermore, the values of transition probabilities of configuration levels $2p^54d$, $2p^5nf$ ($n = 4, 5$) and $2p^55g$ are presented for the first time. In light of these findings, it is possible to extend the range of wavelengths which allows us to estimate the temperature in plasma diagnostic. In addition, our results for radiative lifetimes have been compared to the available experimental values.

1. Introduction

Atomic data, for the neutral and ionized species of the neon isoelectronic sequence, play a significant role in a variety of physical processes occurring in astrophysical applications and also in many industrial applications. Transition probabilities of different lines for several elements have been used in the analysis of stellar abundances. Magnesium has been detected in the solar spectra [1, 2] and is also present in the atmosphere and surface of Europa [3]. It is also one of the best observed elements in late-type stars and magnesium seems to be an important element to study the history of nucleosynthesis in the universe [4]. Przybilla et al. [5] indicate that, more specifically, magnesium is a choice species for the determination of stellar α -elements abundance. It is well known that the ionization equilibrium of Mg I/II is a sensible temperature indicator for early A-stars at all luminosities. Moreover, the determination of the abundance of magnesium in astrophysical plasmas by non-LTE calculations [6] are affected by the depopulation of excited Mg II levels which produce an overpopulation of Mg III states. A good knowledge of the levels and of the atomic parameters of Mg III may shed light into the depopulation processes of Mg II and adjust the load balancing based on Mg I/II. Very recent studies show the presence of the UV lines of Mg I, 285.3 nm, and Mg II, 279.6 nm and 280.3 nm, in galaxies [7]. Then, a further study of the Mg III at extended wavelengths should be performed to estimate the parameters of stellar plasmas.

In addition, it is one of the most abundant elements on earth, with multiple applications. At industrial level, magnesium improves the industrial properties of several materials [8]. It is, therefore, present in many alloys of industrial interest which turns it into a good candidate for the diagnosis of the properties of plasmas produced by laser (LSP) with these materials. The LSP technique has been recently used in the study of biodegradable implants made with Mg-Ca alloys, adding interest to the behavior of the atomic parameters of magnesium species [9].

The spectrum of Mg III has been previously studied by several authors. Andersson and Johannesson [10] completed an earlier work made by Söderqvist [11] and Sulmont and Felenbok [12] using an extended analysis of the spectrum of Mg III. Subsequently, Lundström [13] made the accurate measurements of ns and nd ground term combinations. Autoionization spectra of Mg III were studied by Esteva and Mehlman [14] and Kastner et al. [15]. An exhaustive compilation of experimental wavelengths and energy levels of Mg III was carried out by Martin and Zalubas [16] and Kaufman and Martin [17]. Later, new lines of Mg III between 156 and 166 Å were presented by Brown et al. [18].

According to Moore [19], in their compilation Martin and Zalubas used the most appropriate notation to describe the energy levels: jI coupling or LS coupling. This notation has been adopted in this manuscript.

We have been able to find theoretical values of transition probabilities for the oscillator strengths in the literature. Gruzdev and Loginov [20] obtained oscillator strengths of the resonance series $2p^6-2p^5ns$ of Mg III ions. Later, they calculated [21], by using Hartree-Fock functions, the transition probabilities of $2p^5np-2p^5ms$ ($n = 3, 4; m = 3, 4, 5$) of Mg III. Besides, Ganas and Green [22] obtained oscillator strengths using a potential model. Afterwards, Hibbert et al. [23], Hibbert et al. [24], Verner et al. [25], Das [26], Verner et al. [27], Savukov [28], Froese Fischer and Tachiev [29] calculated oscillator strengths or transition probabilities of some lines of Mg III. Also Kelleher and Podobedova [30] presented a work compiling the different values. Very recently, Jönsson et al. [31], published new relativistic calculations including core-core correlations and core-valence effects.

Theoretical lifetimes of levels of Mg III corresponding to $2p^5ns$ ($n = 3, 4, 5$), $2p^5mp$ ($m = 3, 4, 5$), $2p^5nd$ ($n = 3, 4$) and $2p^54f$ configurations, were calculated by Gruzdev and Loginov [32]. Besides, Bureeva and Safronova [33] and Ceyzeriat [34] have also published several works on this subject. Andersen et al. [35] presented experimental radiative lifetimes, measured by using the beam-foil excitation technique, of eight levels of $2p^53p$ configuration of Mg III. Moreover, in Andersen et al. [36] six of these values were revised and were also provided new measures eliminating the cascade contribution. Five levels of the $2p^54p$ and $2p^53s$ configurations were obtained from the investigation of beam-foil spectra of Mg III by using a heavy ion accelerator by Lundin et al. [37]. Later, Buchet et al. [38] and Träbert [39] made new measures of the levels and lifetimes of the $2p^53s$ configuration. Curtis et al. [40] presented measurements and database predictions for the $\Delta n = 1$ resonance and intercombination transitions in the Ne sequences.

In this work, we present the calculation of the transition probabilities for 365 lines of Mg III arising from levels corresponding to $2p^5ns$ ($n = 3, 4, 5$), $2p^5np$ ($n = 3, 4$), $2p^5nd$ ($n = 3, 4$), $2p^5nf$ ($n = 4, 5$) and $2p^55g$ configurations. The vast majority of the transition probabilities correspond to lines lying in the ultraviolet range (UV) which are of high interest in astrophysics. Then, we have calculated transition probabilities for lines arising from $2p^5nf$ ($n = 4, 5$) and with wavelengths 132.9583, 134.8342, 134.9132, 186.5636, 188.2308, 190.0043 and 193.8249 nm. These lines, with high transition probabilities, are mentioned at NIST [41] and a priori, seem easily measurable and may be, therefore, of high interest for astrophysical and industrial applications.

With the results obtained from these calculations, it is possible to obtain other spectroscopic parameters, such as the Stark broadening parameters. It is well known that the calculations of these parameters, can be carried out using the semiempirical approach if an exhaustive set of the transition probabilities is available. In this way, we have used our results in Moreno-Díaz et al. [42].

We also include the lifetimes of several levels corresponding to the configuration mentioned above. These lifetimes have been compared to the available experimental values.

2. Method of calculation

Fig. 1 displays a portion of the energy levels diagram for Mg III. Further details of the calculation procedure can be found in previous publications of Colón and Alonso-Medina [43,44], Alonso-Medina et al. [45] and Colón et al. [46]. For Intermediate coupling (IC) calculations, there have been calculated ab initio relativistic Hartree-Fock (HFR) wave-functions and matrix elements. Later, we used the standard method of least-square fitting of experimental energy levels, presented by Martin and Zalubas [16], by means of Cowan's computer codes [47]. For the HFR calculations, the Cowan computer code provides not only the radial parts for determination of transition probabilities but also an initial estimation of the parameters for the IC fittings. In this way we have been able to obtain the LS composition at each level. In order to make the calculations we use a basis set as the suggested by Froese Fischer and Tachiev [29]. Our basis set consists of 5 configurations of even parity, namely, $2s^2 2p^6$, $2s^2 2p^5 np$ ($n = 3, 4$) and $2s^2 2p^5 nf$ ($n = 4, 5$) and 18 configurations of odd parity, that is, $2s^2 2p^5 ns$ ($n = 3-6$), $2s^2 2p^5 nd$ ($n = 3-9$), $2s^2 2p^5 5g$ and $2s^1 2p^5 np$ ($n = 3-8$). We have not introduced core polarization effects in this manuscript because magnesium is a light element. The values obtained with the HFR ab initio calculations were used as a starting point in the setting of energy levels. Thus, we obtained the LS composition of each level and the degree of configuration mix considering their interactions and the experimental energy levels.

As usual, the number of parameters deduced from the ab initio analysis, using the above mentioned configurations, is excessive (it exceeds the number of experimental levels). This is the main reason why all these cannot be included in the adjustment process. Following the procedure indicated by Cowan we have excluded a certain number of these parameters. In fact, we have excluded the same parameters which had already been excluded by Andersson and Johannesson [10]. In light of this, we used, in the calculations for the F_k , G_k and R_k excluded, the HFR ab initio values scaled down by a factor of 0.85 (as suggested by Cowan). For the spin-orbit integrals ζnl characterized by small numerical values, that have not been adjusted in the fitting procedures, we used the HFR ab initio values without scaling. As expected, our results for these parameters are not essentially different from those previously published by Andersson and Johannesson [10].

The wavefunctions obtained in the Cowan's code were used in the calculations to obtain the matrix elements required. The transition probabilities are obtained from the matrix elements by using the standard expression of Martin and Wiese [48]:

$$A_{ki} = \frac{2\pi e^2}{m_e c \epsilon_0 \lambda^2} \frac{g_i}{g_k} f_{ik} = \frac{16\pi^3}{3h \epsilon_0 \lambda^3 g_k} |\langle P_k | \vec{r} | P_i \rangle|^2, \quad (1)$$

where A_{ki} and f_{ik} are the transition probability and the oscillator strength, respectively, e and m_e are the electron charge and electron mass, λ is the transition wavelength, c is the light speed, h is the Planck constant, g_i and g_k are the statistical weights and $\langle P_k | \vec{r} | P_i \rangle$ is the calculated matrix element including the modification pointed above. The lifetimes of a level is the inverse of the sum of the transition probabilities arising from this level.

3. Results

There are no available experimental values of transition probabilities to be compared with our results. Then, the only possibility is to compare it to other theoretical works. Discrepancies appear, in certain cases, the moment we compare every author's theoretical approaches. The HFR method and the Cowan's code are optimized for the calculation of energy levels. The fitting method produces

Fig. 1. Partial Grotian diagram of the Mg III energy levels corresponding to some spectral lines which have been calculated in this work.

wavelengths which are very close to the experimental ones. Nevertheless, we can obtain from a set of transition probabilities different from those obtained with the ab initio HFR calculations. That occurs due to small variations introduced by the adjustment process in the LS composition of energy levels. Especially the weakest lines are very sensitive to small changes in the composition of the level. We have compared our results with those obtained by Froese Fischer and Tachiev [29] that represent ab initio calculations without fitting.

Transition probabilities calculated for 365 lines of Mg III are displayed in Tables 1–5. In the first and second columns we present the mentioned transition (the upper and lower level). The third one displays the wavelength in nm (these wavelengths are as indicated in the column observed in the NIST database except in the cases specified in each table [41]). The remaining columns present our values (fourth column) compared when available with the calculated values of other authors. In order to facilitate a comparison between our results with the values provided by other authors, we add in the last column a relationship between our value and the value provided by Froese Fischer and Tachiev [29].

Therefore, there is a good agreement between our results and those reported by other authors with the exception of the resonant lines 23.42631, 23.17333, 18.29717 and 197.9430 nm (Table 1), and 18.65419 nm (Table 3). This mismatch results from the fact that other authors have introduced different non-experimental level energy values in their calculation procedure to find a better fit in the energies of the levels. As already mentioned, this method is good to adjust the levels but may produce less accurate estimates for other parameters, such as transition probabilities. In the absence of experimental values, and since the disagreement does not exceed a factor of 1.9, we estimate that our calculations are appropriate. Also, as expected, there are discrepancies in some other very weak lines.

In Table 6 we present radiative lifetimes of 89 levels of Mg III: Column one displays the level considered, column two shows the experimental energy levels given by Martin and Zalubas [16] and column three shows our calculated values. In the last column we present the experimental values measured by other authors and a relationship between our calculated values and the values provided by Andersen et al. [36] and Buchet et al. [38]. Both authors have made measurements corrected by cascades. As it can be seen, our values are in good agreement with the experimental ones within the exception of the two resonant lines. These deviation of the lines are of the order of a factor 1.6. Also are in good agreement with the values calculated by Gruzdev and Loginov [32].

Fig. 2 shows a plot of the measured lifetimes and our calculated lifetimes versus effective quantum numbers, n^* , of $2p^5 3p$ and

Fig. 2. Measured and calculated lifetime values versus effective quantum numbers for $2p^5 3p$ and $2p^5 4p$ states.

$2p^5 4p$ states. In this figure, we can observe that our values are in good agreement with the experimental values and that the lifetimes of these states display an almost exponential decrease with the increase of effective quantum numbers n^* .

Transition probabilities, calculated in this work, allow us to extend the wavelength range, where we can estimate the plasma temperature by using Mg III lines (under the assumption of local thermodynamic equilibrium (LTE) and by using the Boltzmann plot method). Thus, for example, in the wavelength range of 132–145 nm, we find the lines 132.9583, 134.8342 and 134.9132 nm (arising from levels of $2p^5 5f$ configuration), the lines 135.0156, 136.5788, 137.8700, 139.3391 and 140.5170 nm (arising from levels of $2p^5 4s$ configuration) and the line 144.6254 nm (arising from levels of $2p^5 3p$ configuration) which represent an energy difference between its upper levels of ~ 7.5 eV. Also in the wavelength range of 185 nm at 195 nm, we can find the lines 186.5636, 188.2308, 189.0380, 190.0043 and 193.8249 nm (arising from levels of the $2p^5 4f$ configuration), the lines 185.8186, 187.9492 and 190.8500 nm (arising from levels of the $2p^5 3p$ configuration) and the lines 186.8225, 188.7308 and 191.8777 nm (arising from the $2p^5 3d$ levels of configuration) with an energy difference between its upper levels of ~ 6.5 eV.

Calculated Stark broadening parameters [49] are available for several above mentioned lines. These values and the results of this paper can enable us to extend the wavelength range where there is a possible diagnosis of the temperature as well as the electron density of plasmas in LSP experiments.

4. Conclusions

We present theoretical transition probabilities for 365 lines and lifetimes corresponding to 89 levels of Mg III with focus on the ultraviolet range of wavelengths. Our values for lifetimes are in reasonable agreement with experimental values. We have reported,

for the first time, the values of transition probabilities of levels of $2p^5 4d$, $2p^5 nf$ ($n = 4, 5$) and $2p^5 5g$ configurations. With the values calculated for the $2p^5 nf$ ($n = 4, 5$) we can extend the wavelength range where it is possible to estimate plasma temperature. This is quite important, because the UV range can be required in some experiments, especially when specific experimental equipment is available or when very intense UV lines are present.

Acknowledgment

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Explanation of Tables

Table 1.	Transition probabilities of several spectral lines arising from $2p^5ns$ ($n = 3, 4, 5$) configurations of Mg III.
First and Second columns	Transition levels, the lower and upper levels.
Third column	Wavelength, in nm.
Fourth column	Our transition probabilities in s^{-1} .
Fifth, Sixth, Seventh and Eighth columns	Other authors transition probabilities in s^{-1} .
Ninth column	Relationship between our value and the value provided by Fischer & Tachiev [29].
Table 2.	Transition probabilities of several spectral lines arising from $2p^5np$ ($n = 3, 4$) configurations of Mg III.
First and Second columns	Transition levels, the lower and upper levels.
Third column	Wavelength, in nm.
Fourth column	Our transition probabilities in s^{-1} .
Fifth, Sixth, Seventh and Eighth columns	Other authors transition probabilities in s^{-1} .
Ninth column	Relationship between our value and the value provided by Fischer & Tachiev [29].
Table 3.	Transition probabilities of several spectral lines arising from $2p^5nd$ ($n = 3, 4$) configurations of Mg III.
First and Second columns	Transition levels, the lower and upper levels.
Third column	Wavelength, in nm.
Fourth column	Our transition probabilities in s^{-1} .
Fifth, Sixth, Seventh and Eighth columns	Other authors transition probabilities in s^{-1} .
Ninth column	Relationship between our value and the value provided by Fischer & Tachiev [29].
Table 4.	Transition probabilities of several spectral lines arising from $2p^5nf$ ($n = 4, 5$) configurations of Mg III.
First and Second columns	Transition levels, the lower and upper levels.
Third column	Wavelength, in nm.
Fourth column	Our transition probabilities in s^{-1} .
Table 5.	Transition probabilities of several spectral lines arising from $2p^55g$ configurations of Mg III.
First and Second columns	Transition levels, the lower and upper levels.
Third column	Wavelength, in nm.
Fourth column	Our transition probabilities in s^{-1} .
Table 6.	Radiative lifetimes (τ in ns) of Mg III levels.
First column	Numbers assigned to each level.
Second column	Energy of each level, in cm^{-1} .
Third column	Our radiative lifetimes.
Fourth column	Other authors radiative lifetimes.
Fifth column	Relationship between our calculated values and the values provided by Andersen et al. [36] and Buchet et al. [38].

Table 1

Transition probabilities of several spectral lines arising from $2p^5ns$ ($n = 3, 4, 5$) configurations of Mg III.

Transition		Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})					$\frac{A_{ki}^{[4]}}{A_{ki}^{[6]}}$	
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work	Other authors					
$2p^5 3s^3 P_1$	$2p^6 1S_0$	23.42631	8.53		4.7 ^[4]	4.98 ^[5]	4.8 ^[6]	0.55	
$2p^5 3s^1 P_1$	$2p^6 1S_0$	23.17333	131.54	99.0 ^[3]	91.6 ^[4]	91.2 ^[5]	90.55 ^[6]	0.69	
$2p^5(^2P_{3/2})4s^2[3/2]_2$	$2p^5 3p^3 S_1$	127.4831	2.19		2.52 ^[4]			1.15	
	$2p^5 3p^3 D_3$	139.3391	6.03		6.38 ^[4]			1.06	
	$2p^5 3p^3 D_2$	140.5170	1.45		1.54 ^[4]			1.06	
	$2p^5 3p^3 D_1$	142.2118	0.16		0.18 ^[4]			0.89	
	$2p^5 3p^1 D_2$	146.2305	1.03		1.21 ^[4]			1.17	
	$2p^5 3p^1 P_1$	148.2670	0.19		0.16 ^[4]			0.84	
	$2p^5 3p^3 P_2$	149.3097	1.15		1.02 ^[4]			0.89	
	$2p^5 3p^3 P_1$	150.6826	0.36		0.39 ^[4]			1.08	
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	$2p^6 1S_0$	18.29717	12.45		8.22 ^[4]		0.66	
		$2p^5 3p^3 S_1$	126.3375	1.20		1.47 ^[4]		1.22	
		$2p^5 3p^3 D_2$	139.1271	4.26		4.62 ^[4]		1.08	
		$2p^5 3p^3 D_1$	140.7880	1.86		2.15 ^[4]		1.16	
		$2p^5 3p^1 D_2$	144.7260	2.36		2.21 ^[4]		0.94	
		$2p^5 3p^1 P_1$	146.7188	1.05		0.94 ^[4]		0.89	
$2p^5(^2P_{3/2})4s^2[1/2]_0$	$2p^5 3p^3 P_2$	147.7416	0.22		0.28 ^[4]			1.27	
	$2p^5 3p^3 P_0$	148.6624	0.77		0.80 ^[4]			1.04	
	$2p^5 3p^3 P_1$	149.0855 ^a	0.0017		0.017 ^[4]			10	
	$2p^5 3p^1 S_0$	197.9430	0.73		0.41 ^[4]			0.56	
	$2p^5 3p^3 S_1$	123.9827	1.54		1.82 ^[4]			1.18	
	$2p^5 3p^3 D_1$	137.8700	5.34		5.32 ^[4]			0.99	
	$2p^5 3p^1 P_1$	143.5550	2.95		3.03 ^[4]			1.03	
	$2p^5 3p^3 P_1$	145.8172	2.72		3.21 ^[4]			1.18	
	$2p^5(^2P_{1/2})4s^2[1/2]_1$	$2p^6 1S_0$	18.22415	23.15		17.27 ^[4]		0.75	
		$2p^5 3p^3 S_1$	122.9389	0.54		0.57 ^[4]		1.06	
		$2p^5 3p^3 D_2$	135.0156	0.50		0.35 ^[4]		0.70	
		$2p^5 3p^3 D_1$	136.5788 ^b	0.37		0.28 ^[4]		0.76	
		$2p^5 3p^1 D_2$	140.2820	2.46		2.43 ^[4]		0.99	
		$2p^5 3p^1 P_1$	142.1538	1.03		1.46 ^[4]		1.42	
$2p^5(^2P_{1/2})4s^2[1/2]_1$	$2p^5 3p^3 P_2$	143.1136	3.86		4.29 ^[4]			1.11	
	$2p^5 3p^3 P_0$	143.9770	0.35		0.35 ^[4]			1.00	
	$2p^5 3p^3 P_1$	144.3738	1.84		1.81 ^[4]			0.98	
	$2p^5 3p^1 S_0$	189.7226	1.42		1.02 ^[4]			0.72	
	$2p^5(^2P_{3/2})5s^2[3/2]_2$	$2p^5 3p^3 S_1$	82.3788	1.32					
		$2p^5 3p^3 D_3$	87.1720	2.78					
		$2p^5 3p^3 D_2$	87.6312	0.64					
		$2p^5 3p^1 D_2$	89.8207	0.38					
		$2p^5 3p^3 P_2$	90.9730	0.39					
		$2p^5 3p^3 P_1$	91.4805 ^a	0.12					
		$2p^5(^2P_{3/2})4p^2[1/2]_1$	347.3424	0.72					
		$2p^5(^2P_{3/2})4p^2[5/2]_3$	370.6745	1.64					
		$2p^5(^2P_{3/2})4p^2[5/2]_3$	375.3714	0.43					
		$2p^5(^2P_{3/2})4p^2[3/2]_1$	387.0456	0.49					
$2p^5(^2P_{1/2})4p^2[3/2]_2$		414.7487	0.027						
$2p^5(^2P_{1/2})4p^2[3/2]_1$		415.9041	0.031						
$2p^5(^2P_{1/2})4p^2[1/2]_1$		415.9041	0.031						
$2p^5(^2P_{3/2})5s^2[3/2]_1$		$2p^6 1S_0$	16.97411	0.035					
	$2p^5 3p^3 S_1$	82.1369	0.56						
	$2p^5 3p^3 D_2$	87.3580	1.59						
	$2p^5 3p^3 D_1$	88.0107	0.66						
	$2p^5 3p^1 D_2$	89.5324	1.06						
	$2p^5 3p^1 P_1$	90.2923	0.49						
	$2p^5 3p^3 P_0$	91.0237 ^a	0.17						
	$2p^5 3p^1 S_0$	107.3944 ^a	0.12						
	$2p^5(^2P_{3/2})4p^2[1/2]_1$	343.076	0.28						
	$2p^5(^2P_{3/2})4p^2[5/2]_2$	370.3930	1.09						
	$2p^5(^2P_{3/2})4p^2[3/2]_1$	377.3572	0.73						
	$2p^5(^2P_{3/2})4p^2[3/2]_2$	381.7575	0.67						
	$2p^5(^2P_{1/2})5s^2[1/2]_0$	$2p^5 3p^3 S_1$	80.9024 ^a	1.04					
		$2p^5 3p^3 D_1$	86.5935	2.56					
$2p^5 3p^1 P_1$		88.8023 ^a	1.16						
$2p^5 3p^3 P_1$		89.6640	1.01						
$2p^5(^2P_{3/2})4p^2[1/2]_1$		322.5141 ^a	0.31						
$2p^5(^2P_{3/2})4p^2[3/2]_1$		352.6279 ^a	0.34						
$2p^5(^2P_{1/2})4p^2[3/2]_1$		374.5030	1.86						
$2p^5(^2P_{1/2})4p^2[1/2]_1$		380.8073	0.91						
$2p^6 1S_0$		16.91406	0.44						
$2p^5 3p^3 S_1$		80.7479 ^a	0.56						
$2p^5 3p^3 D_2$		85.7885 ^a	0.59						

Table 1 (*continued*)

Transition		Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})		$\frac{A_{ki}^{[4]}}{A_{ki}^{ref}}$
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work	Other authors	
	$2p^5 3p \ ^3D_1$	86.4171 ^a	0.34		
	$2p^5 3p \ ^1D_2$	87.8847	0.62		
	$2p^5 3p \ ^1P_1$	88.6158	0.27		
	$2p^5 3p \ ^3P_2$	88.9888	1.52		
	$2p^5 3p \ ^3P_0$	89.3213 ^a	0.23		
	$2p^5 3p \ ^3P_1$	89.4744	0.68		
	$2p^5(^2P_{3/2})4p \ ^2[1/2]_1$	320.0720 ^a	0.16		
	$2p^5(^2P_{3/2})4p \ ^2[1/2]_0$	371.350	0.12		
	$2p^5(^2P_{3/2})4p \ ^2[3/2]_2$	353.491	0.062		
	$2p^5(^2P_{1/2})4p \ ^2[3/2]_1$	371.2093 ^a	0.36		
	$2p^5(^2P_{1/2})4p \ ^2[3/2]_2$	376.4539	1.65		
	$2p^5(^2P_{1/2})4p \ ^2[1/2]_1$	377.406	0.55		
	$2p^5(^2P_{1/2})4p \ ^2[1/2]_0$	473.6142 ^a	0.13		

Table 2Transition probabilities of several spectral lines arising from $2p^5np$ ($n = 3, 4$) configurations of Mg III.

Transition		Wavelength	Transition Probabilities, A_{ki} (10^8 s^{-1})				$\frac{A_{ki}^{[4]}}{A_{ki}^{[6]}}$
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work	Other authors			
$2p^53p^3S_1$	$2p^53s^3P_2$	239.5149	1.89	1.67 ^[4]	1.67 ^[5]	1.74 ^[6]	0.88
	$2p^53s^3P_1$	246.7751	0.78	0.69 ^[4]	0.69 ^[5]	0.72 ^[6]	0.88
	$2p^53s^3P_0$	252.9190	0.22	0.19 ^[4]	0.19 ^[5]	0.20 ^[6]	0.86
	$2p^53s^1P_1$	278.869 ^b	0.017	0.0097 ^[4]	0.0097 ^[5]	0.010 ^[6]	0.57
$2p^53p^3D_3$	$2p^53s^3P_2$	206.4902	4.27	4.21 ^[4]	4.21 ^[5]	4.26 ^[6]	0.99
$2p^53p^3D_2$	$2p^53s^3P_2$	203.9553	1.54	1.54 ^[4]	1.54 ^[5]	1.55 ^[6]	1.00
	$2p^53s^3P_1$	209.1963	2.69	2.58 ^[4]	2.57 ^[5]	2.61 ^[6]	0.96
$2p^53p^3D_1$	$2p^53s^1P_1$	231.8125	0.018	0.044 ^[4]	0.044 ^[5]	0.045 ^[6]	2.44
	$2p^53s^3P_2$	200.4860	0.31	0.33 ^[4]	0.33 ^[5]	0.34 ^[6]	1.06
	$2p^53s^3P_1$	205.5491	2.33	2.35 ^[4]	2.35 ^[5]	2.38 ^[6]	1.01
	$2p^53s^3P_0$	209.7936	1.63	1.50 ^[4]	1.50 ^[5]	1.51 ^[6]	0.92
$2p^53p^1D_2$	$2p^53s^1P_1$	227.3414	0.00064	0.013 ^[4]	0.013 ^[5]	0.013 ^[6]	203
	$2p^53s^3P_2$	193.0672	1.54	1.69 ^[4]	1.70 ^[5]	1.72 ^[6]	1.09
	$2p^53s^3P_1$	197.7554	0.53	0.49 ^[4]	0.49 ^[5]	0.51 ^[6]	0.92
	$2p^53s^1P_1$	217.7694	2.40	2.12 ^[4]	2.12 ^[5]	2.11 ^[6]	0.88
$2p^53p^1P_1$	$2p^53s^3P_2$	189.6304	0.56	0.42 ^[4]	0.42 ^[5]	0.41 ^[6]	0.75
	$2p^53s^3P_1$	194.1500	0.54	0.33 ^[4]	0.33 ^[5]	0.32 ^[6]	0.61
	$2p^53s^3P_0$	197.9327	1.31	1.22 ^[4]	1.22 ^[5]	1.23 ^[6]	0.93
	$2p^53s^1P_1$	213.4054	2.24	2.36 ^[4]	2.36 ^[5]	2.36 ^[6]	1.05
$2p^53p^3P_2$	$2p^53s^3P_2$	187.9492	2.09	1.76 ^[4]	1.76 ^[5]	1.72 ^[6]	0.84
	$2p^53s^3P_1$	192.3896	1.32	1.38 ^[4]	1.37 ^[5]	1.36 ^[6]	1.05
	$2p^53s^1P_1$	211.2773	1.67	1.68 ^[4]	1.69 ^[5]	1.73 ^[6]	1.01
	$2p^53s^3P_1$	190.8500	5.32	5.16 ^[4]	5.15 ^[5]	5.16 ^[6]	0.97
$2p^53p^3P_0$	$2p^53s^1P_1$	209.4207	0.16	0.12 ^[4]	0.12 ^[5]	0.12 ^[6]	0.75
	$2p^53s^3P_2$	185.8186	1.22	1.28 ^[4]	1.28 ^[5]	1.27 ^[6]	1.05
$2p^53p^3P_1$	$2p^53s^3P_1$	190.1572	0.47	0.55 ^[4]	0.55 ^[5]	0.55 ^[6]	1.17
	$2p^53s^3P_0$	193.7843	1.36	1.46 ^[4]	1.46 ^[5]	1.46 ^[6]	1.07
	$2p^53s^1P_1$	208.5891	2.02	1.61 ^[4]	1.61 ^[5]	1.61 ^[6]	0.80
	$2p^53s^3P_1$	144.6254	0.52	0.42 ^[2]	0.41 ^[5]	0.44 ^[6]	
$2p^53p^1S_0$	$2p^53s^1P_1$	155.082	10.68	10.54 ^[2]	10.40 ^[5]	11.14 ^[6]	
$2p^5(^2P_{3/2})4p^2[1/2]_1$	$2p^53s^3P_2$	74.4342	0.72				
	$2p^53s^3P_1$	75.1207	0.29				
	$2p^53s^3P_0$	75.6808	0.077				
	$2p^53d^3P_0$	335.3729	0.19				
	$2p^53d^3P_1$	338.1236	0.48				
	$2p^53d^3P_2$	344.4409	0.52				
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	705.6876	0.39				
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	742.9846	0.095				
	$2p^53d^3P_1$	295.0773	0.37				
	$2p^53d^3D_1$	332.1060	1.07				
	$2p^53d^1P_1$	355.1638	0.26				
	$2p^5(^2P_{3/2})4s^2[1/2]_1$	641.7036	0.14				
$2p^5(^2P_{3/2})4p^2[5/2]_3$	$2p^53s^3P_2$	73.4441	0.72				
	$2p^53d^3F_4$	330.6392	1.15				
	$2p^53d^3F_3$	333.6190	0.096				
	$2p^53d^3F_2$	343.8623	0.0096				
	$2p^53d^1F_3$	346.7912	0.15				
	$2p^53d^3D_3$	371.9838	0.039				
	$2p^53d^3D_2$	375.5606	0.012				
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	625.6750	0.69				
	$2p^53s^3P_2$	73.2625	0.25				
	$2p^53s^3P_1$	73.9276	0.42				
	$2p^53s^1P_1$	76.5655	0.074				
	$2p^53d^3P_2$	320.6948	0.037				
$2p^5(^2P_{3/2})4p^2[5/2]_2$	$2p^53d^3F_3$	329.9050	1.09				
	$2p^53d^3F_2$	339.9188	0.26				
	$2p^53d^1F_3$	342.7794	0.00034				
	$2p^53d^3D_1$	357.8273	0.022				
	$2p^53d^3D_2$	370.8609	0.019				
	$2p^53d^1D_2$	365.4040	0.032				
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	612.7392	0.29				
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	640.6619	0.40				
	$2p^53s^3P_1$	73.6563	0.41				
	$2p^53s^3P_0$	74.1932	0.082				
	$2p^53s^1P_1$	76.2756	0.14				
	$2p^53d^3P_0$	308.0208	0.037				
$2p^5(^2P_{3/2})4p^2[3/2]_1$	$2p^53d^3P_2$	315.6506	0.069				
	$2p^53d^3F_2$	334.2577	0.99				
	$2p^53d^3D_1$	351.5602	0.40				

Table 2 (continued)

Transition		Wavelength	Transition Probabilities, A_{ki} (10^8 s^{-1})		$\frac{A_{ki}^{[A]}}{A_{ki}^{diff}}$
Upper level	Lower level	λ_i (nm) ^[1]	This work	Other authors	
$2p^5(^2P_{3/2})4p^2[3/2]_2$	$2p^53d^3D_2$	364.1320	0.022		
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	594.5873	0.11		
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	620.8440	0.55		
	$2p^53s^3P_2$	72.8337	0.24		
	$2p^53s^1P_1$	76.0981	0.23		
	$2p^53d^3P_1$	307.423	0.10		
	$2p^53d^3P_2$	312.6380	0.40		
	$2p^53d^3F_3$	321.3845	0.040		
	$2p^53d^1F_3$	333.5905	0.97		
	$2p^53d^3D_3$	356.8385	0.049		
	$2p^53d^3D_2$	360.1288	0.084		
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	583.9820	0.45		
$2p^5(^2P_{1/2})4p^2[3/2]_1$	$2p^5(^2P_{3/2})4s^2[3/2]_1$	609.2912	0.29		
	$2p^53s^1P_1$	75.3247	0.34		
	$2p^53d^3P_2$	299.9710	0.033		
	$2p^53d^3F_2$	316.7251	0.042		
	$2p^53d^3D_2$	343.4236	0.0041		
	$2p^53d^1D_2$	338.7368	1.25		
	$2p^53d^1P_1$	355.2933	0.16		
	$2p^5(^2P_{1/2})4s^2[1/2]_0$	615.0082	0.41		
	$2p^5(^2P_{1/2})4s^2[1/2]_1$	642.1224	0.25		
	$2p^53s^1P_1$	75.1121	0.53		
	$2p^53d^3P_1$	291.9351	0.035		
	$2p^53d^3P_2$	296.6338	0.094		
$2p^5(^2P_{1/2})4p^2[3/2]_2$	$2p^53d^1F_3$	315.4336	0.11		
	$2p^53d^3D_3$	336.1412	1.16		
	$2p^53d^3D_2$	339.0577	0.072		
	$2p^53d^1D_2$	334.4899	0.11		
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	530.5206	0.051		
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	551.3255	0.022		
	$2p^5(^2P_{3/2})4s^2[1/2]_1$	627.0250	0.66		
	$2p^53s^3P_1$	72.5347	0.062		
	$2p^53d^3P_0$	289.3221	0.070		
	$2p^53d^3P_1$	291.3657	0.059		
	$2p^53d^3P_2$	296.0453	0.079		
	$2p^53d^3D_2$	338.2901	1.16		
$2p^5(^2P_{1/2})4p^2[1/2]_1$	$2p^53d^1P_1$	349.7994	0.28		
	$2p^5(^2P_{3/2})4s^2[3/2]_2$	528.6389	0.12		
	$2p^5(^2P_{3/2})4s^2[1/2]_0$	598.7370	0.24		
	$2p^5(^2P_{3/2})4s^2[1/2]_1$	624.4024	0.40		
	$2p^53s^1P_1$	72.1592	1.22		
	$2p^53d^3D_1$	278.352	0.20		
	$2p^53d^1P_1$	294.3707	1.07		
	$2p^5(^2P_{3/2})4s^2[3/2]_1$	423.9468	0.48		
	$2p^5(^2P_{3/2})4s^2[1/2]_1$	467.3303	1.27		

Table 3

Transition probabilities of several spectral lines arising from $2p^5nd$ ($n = 3, 4$) configurations of Mg III.

Transition		Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})					$\frac{A_{ki}^{[4]}}{A_{ki}^{[6]}}$
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work	Other authors				
$2p^53d \ ^3P_0$	$2p^53p \ ^3S_1$	159.2360	8.57	8.53 ^[4]	8.53 ^[5]	8.51 ^[6]	0.99	
	$2p^53p \ ^3D_1$	182.8974	0.47	0.50 ^[4]	0.49 ^[5]	0.57 ^[6]	1.06	
	$2p^53p \ ^1P_1$	193.0374	1.04	0.83 ^[4]	0.83 ^[5]	0.78 ^[6]	0.8	
	$2p^53p \ ^3P_1$	197.1514	1.90	2.06 ^[4]	2.06 ^[5]	1.99 ^[6]	1.08	
$2p^53d \ ^3P_1$	$2p^6 \ ^1S_0$	18.85296	2.69	2.0 ^[4]	2.5 ^[5]	1.9 ^[6]	0.74	
	$2p^53p \ ^3S_1$	158.6237	8.05	8.01 ^[4]	8.02 ^[5]	8.01 ^[6]	0.99	
	$2p^53p \ ^3D_2$	179.3207	0.36	0.33 ^[4]	0.34 ^[5]	0.41 ^[6]	0.92	
	$2p^53p \ ^3D_1$	182.0896	0.026	0.030 ^[4]	0.031 ^[5]	0.023 ^[6]	1.15	
	$2p^53p \ ^1D_2$	188.7308	0.67	0.76 ^[4]	0.76 ^[5]	0.76 ^[6]	1.13	
	$2p^53p \ ^1P_1$	192.1374	0.30	0.23 ^[4]	0.23 ^[5]	0.23 ^[6]	0.77	
	$2p^53p \ ^3P_2$	193.8936	1.004	0.89 ^[4]	0.89 ^[5]	0.83 ^[6]	0.89	
	$2p^53p \ ^3P_0$	195.4831	0.77	0.80 ^[4]	0.79 ^[5]	0.74 ^[6]	1.04	
	$2p^53p \ ^3P_1$	196.2145	0.72	0.78 ^[4]	0.78 ^[5]	0.76 ^[6]	1.08	
	$2p^53p \ ^1S_0$	290.5419	0.0056	0.0068 ^[2]	0.0068 ^[5]	0.0052 ^[6]		
	$2p^53p \ ^3S_1$	157.2712	6.52	6.92 ^[4]	6.92 ^[5]	6.93 ^[6]	0.94	
	$2p^53p \ ^3D_3$	175.7176	0.23	0.20 ^[4]	0.20 ^[5]	0.28 ^[6]	0.87	
$2p^53d \ ^3P_2$	$2p^53p \ ^3D_2$	177.5942	0.13	0.13 ^[4]	0.13 ^[5]	0.11 ^[6]	1.00	
	$2p^53p \ ^3D_1$	180.3087	0.084	0.10 ^[4]	0.10 ^[5]	0.10 ^[6]	1.19	
	$2p^53p \ ^1D_2$	186.8225	1.78	1.94 ^[4]	1.94 ^[5]	1.94 ^[6]	1.09	
	$2p^53p \ ^1P_1$	190.1572	0.39	0.38 ^[4]	0.38 ^[5]	0.37 ^[6]	0.97	
	$2p^53p \ ^3P_2$	191.8777	2.21	1.98 ^[4]	1.98 ^[5]	1.88 ^[6]	0.89	
	$2p^53p \ ^3P_1$	194.1500	0.082	0.12 ^[4]	0.12 ^[5]	0.099 ^[6]	1.46	
	$2p^53p \ ^3D_3$	173.8835	11.93	11.37 ^[4]	11.4 ^[5]	11.40 ^[6]	0.95	
	$2p^53d \ ^3F_4$	173.0733	1.32	1.03 ^[2]	1.04 ^[5]			
	$2p^53d \ ^3F_3$	174.8932	9.29	8.71 ^[4]	8.71 ^[5]	8.73 ^[6]	0.94	
	$2p^53p \ ^1D_2$	183.8336	0.81	1.09 ^[4]	1.09 ^[5]	1.08 ^[6]	1.35	
$2p^53d \ ^3F_2$	$2p^53p \ ^3P_2$	188.7255 ^a	0.24			0.25 ^[6]		
	$2p^53p \ ^3D_3$	170.4368	0.19	0.18 ^[4]	0.18 ^[5]	0.18 ^[6]	0.95	
	$2p^53p \ ^3D_2$	172.2041	3.44	3.23 ^[4]	3.23 ^[5]	3.26 ^[6]	0.94	
	$2p^53p \ ^3D_1$	174.7561	7.22	7.38 ^[4]	7.38 ^[5]	7.35 ^[6]	1.02	
	$2p^53p \ ^1D_2$	180.865 ^b	0.0050	0.00085 ^[4]	0.00086 ^[5]	0.0007 ^[6]	0.17	
	$2p^53p \ ^1P_1$	183.9878	0.76	0.45 ^[4]	0.46 ^[5]	0.47 ^[6]	0.60	
$2p^53d \ ^1F_3$	$2p^53p \ ^3P_2$	185.599	0.13		0.093 ^[5]	0.094 ^[6]		
	$2p^53p \ ^3D_3$	169.7282	2.22	2.14 ^[4]	2.14 ^[5]	2.19 ^[6]	0.96	
	$2p^53p \ ^3D_2$	171.4783	0.20	0.47 ^[4]	0.48 ^[5]	0.45 ^[6]	2.35	
	$2p^53p \ ^1D_2$	180.0662	8.74	8.21 ^[4]	8.21 ^[5]	8.24 ^[6]	0.94	
	$2p^53p \ ^3P_2$	184.7561	0.042	0.037 ^[4]	0.037 ^[5]	0.029 ^[6]	0.88	
	$2p^6 \ ^1S_0$	18.71977	148.13	125.7 ^[4]	125.7 ^[5]	121.3 ^[6]	0.85	
$2p^53d \ ^3D_1$	$2p^53p \ ^3D_2$	167.9470	0.63	0.59 ^[4]	0.59 ^[5]	0.60 ^[6]	0.94	
	$2p^53p \ ^3D_1$	170.3731	3.06	2.98 ^[4]	2.98 ^[5]	3.02 ^[6]	0.97	
	$2p^53p \ ^1D_2$	176.1740	0.0072	0.0031 ^[4]	0.0032 ^[5]	0.0018 ^[6]	2.32	
	$2p^53p \ ^1P_1$	179.1375	2.24	2.33 ^[4]	2.32 ^[5]	2.20 ^[6]	1.04	
	$2p^53p \ ^3P_2$	180.663 ^b	0.037	0.044 ^[4]	0.044 ^[5]	0.045 ^[6]	1.19	
	$2p^53p \ ^3P_0$	182.0421	3.56	2.98 ^[4]	2.98 ^[5]	3.10 ^[6]	0.84	
	$2p^53p \ ^3P_1$	182.6750	0.20	0.13 ^[4]	0.13 ^[5]	0.16 ^[6]	0.65	
	$2p^53p \ ^1S_0$	261.8011	0.62	0.87 ^[4]	0.88 ^[5]	0.69 ^[6]	1.40	
	$2p^53p \ ^3S_1$	148.3715 ^b	0.00028	0.0095 ^[4]	0.0095 ^[5]	0.011 ^[6]	33.9	
	$2p^53d \ ^3D_3$	164.6803 ^b	0.059	0.039 ^[4]	0.039 ^[5]	0.039 ^[6]	0.66	
	$2p^53p \ ^3D_2$	166.3287	0.18	0.17 ^[4]	0.17 ^[5]	0.15 ^[6]	0.94	
	$2p^53p \ ^3D_1$	168.7091	2.31	1.41 ^[4]	1.41 ^[5]	1.44 ^[6]	0.61	
	$2p^53p \ ^1D_2$	174.3947	0.26	0.38 ^[4]	0.37 ^[5]	0.38 ^[6]	1.46	
	$2p^53p \ ^1P_1$	177.2982	7.34	7.67 ^[4]	7.67 ^[5]	7.66 ^[6]	1.04	
	$2p^53p \ ^3P_2$	178.7927	1.31	1.46 ^[4]	1.46 ^[5]	1.47 ^[6]	1.11	
$2p^53d \ ^3D_3$	$2p^53p \ ^3D_3$	164.2826	0.69	0.91 ^[4]	0.92 ^[5]	0.90 ^[6]	1.32	
	$2p^53p \ ^3D_2$	165.9244	1.10	0.85 ^[4]	0.85 ^[5]	0.86 ^[6]	0.77	
	$2p^53p \ ^1D_2$	173.9475	0.20	0.0032 ^[4]	0.0032 ^[5]	0.085 ^[6]	0.02	
	$2p^53p \ ^3P_2$	178.3253	9.35	9.38 ^[4]	9.39 ^[5]	9.42 ^[6]	1.01	
$2p^53d \ ^3D_2$	$2p^53p \ ^3S_1$	147.4898	0.28		0.24 ^[5]	0.27 ^[6]		
	$2p^53p \ ^3D_3$	163.5946	0.20	0.24 ^[4]	0.24 ^[5]	0.21 ^[6]	1.2	
	$2p^53p \ ^3D_2$	165.2218	0.80	0.91 ^[4]	0.91 ^[5]	0.94 ^[6]	1.14	
	$2p^53p \ ^3D_1$	167.5710	0.27	0.42 ^[4]	0.42 ^[5]	0.43 ^[6]	1.56	
	$2p^53p \ ^1D_2$	173.1786	1.78	1.60 ^[4]	1.60 ^[5]	1.59 ^[6]	0.90	
	$2p^53p \ ^1P_1$	176.0405	0.00092	0.041 ^[4]	0.041 ^[5]	0.052 ^[6]	44.6	
	$2p^53p \ ^3P_2$	177.5143 ^b	0.099	0.045 ^[4]	0.045 ^[5]	0.046 ^[6]	0.45	
	$2p^53p \ ^3P_1$	179.4582	7.83	7.73 ^[4]	7.73 ^[5]	7.72 ^[6]	0.99	
	$2p^6 \ ^1S_0$	18.65149	335.0	167.9 ^[2]	186.1 ^[4]	188.3 ^[6]	0.56	
	$2p^53p \ ^3S_1$	145.4048 ^b	0.045	0.050 ^[4]	0.050 ^[5]	0.055 ^[6]	1.11	
$2p^53d \ ^1P_1$	$2p^53p \ ^3D_2$	162.6093	0.13	0.18 ^[4]	0.18 ^[5]	0.14 ^[6]	1.38	
	$2p^53p \ ^3D_1$	164.8822	0.37	0.54 ^[4]	0.54 ^[5]	0.53 ^[6]	1.46	

Table 3 (continued)

Transition	Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})					$\frac{A_{ki}^{[4]}}{A_{ki}^{\text{Dir}}}$	
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work	Other authors				
	$2p^5 3p^1 D_2$	170.3108	0.15		0.17 ^[4]	0.17 ^[5]	0.20 ^[6]	1.13
	$2p^5 3p^1 P_1$	173.0778	1.54		1.44 ^[4]	1.44 ^[5]	1.44 ^[6]	0.94
	$2p^5 3p^3 P_2$	174.5009	0.045		0.053 ^[4]	0.054 ^[5]	0.061 ^[6]	1.18
	$2p^5 3p^3 P_0$	175.7888	1.57		2.09 ^[4]	2.10 ^[5]	1.99 ^[6]	1.33
	$2p^5 3p^3 P_1$	176.3805	3.33		3.17 ^[4]	3.17 ^[5]	3.11 ^[6]	0.95
	$2p^5 3p^1 S_0$	249.0534	1.96	1.81 ^[2]	1.61 ^[4]		1.50 ^[6]	0.82
$2p^5(^2P_{3/2})4d^2[1/2]_0$	$2p^5(^2P_{3/2})4p^2[1/2]_1$	463.2531	1.79					
$2p^5(^2P_{3/2})4d^2[1/2]_1$	$2p^6^1S_0$	17.18984	3.50					
	$2p^5(^2P_{3/2})4p^2[1/2]_1$	459.6916	1.58					
$2p^5(^2P_{3/2})4d^2[3/2]_2$	$2p^5(^2P_{3/2})4p^2[1/2]_1$	452.6223	1.13					
	$2p^5(^2P_{3/2})4p^2[3/2]_2$	522.4593	0.74					
$2p^5(^2P_{3/2})4d^2[3/2]_1$	$2p^6^1S_0$	17.13946	133.33					
	$2p^5 3p^1 S_0$	114.3662 ^a	1.39					
	$2p^5(^2P_{3/2})4p^2[3/2]_1$	480.2601	0.94					
$2p^5(^2P_{3/2})4d^2[7/2]_3$	$2p^5(^2P_{3/2})4p^2[5/2]_4$	491.6002	2.18					
$2p^5(^2P_{3/2})4d^2[7/2]_3$	$2p^5(^2P_{3/2})4p^2[5/2]_3$	487.8729	0.25					
	$2p^5(^2P_{3/2})4p^2[5/2]_2$	496.0409	1.77					
$2p^5(^2P_{3/2})4d^2[5/2]_2$	$2p^5(^2P_{3/2})4p^2[5/2]_2$	485.0385	0.73					
	$2p^5(^2P_{3/2})4p^2[3/2]_1$	497.0511	1.28					
$2p^5(^2P_{3/2})4d^2[5/2]_3$	$2p^5(^2P_{3/2})4p^2[3/2]_2$	502.3668	1.52					
$2p^5(^2P_{1/2})4d^2[5/2]_2$	$2p^5(^2P_{1/2})4p^2[3/2]_1$	491.5349	1.81					
	$2p^5(^2P_{1/2})4p^2[3/2]_2$	500.7638	0.21					
$2p^5(^2P_{1/2})4d^2[5/2]_3$	$2p^5(^2P_{3/2})4p^2[5/2]_3$	435.8979	0.022					
	$2p^5(^2P_{3/2})4p^2[5/2]_2$	442.4071	0.076					
	$2p^5(^2P_{1/2})4p^2[3/2]_2$	498.1452	1.96					
$2p^5(^2P_{1/2})4d^2[3/2]_2$	$2p^5(^2P_{3/2})4p^2[1/2]_1$	403.9135	0.090					
	$2p^5(^2P_{3/2})4p^2[5/2]_3$	435.8138	0.024					
	$2p^5(^2P_{3/2})4p^2[5/2]_2$	442.3182	0.048					
	$2p^5(^2P_{3/2})4p^2[3/2]_2$	458.6200	0.089					
	$2p^5(^2P_{1/2})4p^2[3/2]_2$	498.0248 ^a	0.23					
	$2p^5(^2P_{1/2})4p^2[1/2]_1$	499.7038	1.56					
$2p^5(^2P_{1/2})4d^2[3/2]_1$	$2p^6^1S_0$	17.08050	213.8					
	$2p^5 3p^1 S_0$	111.7892 ^a	2.25					
	$2p^5(^2P_{1/2})4p^2[3/2]_1$	472.0936	0.39					
	$2p^5(^2P_{3/2})4p^2[1/2]_0$	472.3204	0.32					
	$2p^5(^2P_{1/2})4p^2[1/2]_1$	482.1516	0.61					
	$2p^5(^2P_{1/2})4p^2[1/2]_0$	651.1429	0.34					

Table 4Transition probabilities of several spectral lines arising from $2p^5nf$ ($n = 4, 5$) configurations of Mg III.

Transition		Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work
$2p^5(^2P_{3/2})4f^2[3/2]_1$	$2p^53d^3P_0$	184.6121	5.71
	$2p^53d^3P_1$	185.4424 ^a	4.83
$2p^5(^2P_{3/2})4f^2[3/2]_2$	$2p^53d^3P_1$	185.4139	5.19
	$2p^53d^3P_2$	187.2956	2.46
	$2p^53d^3D_1$	199.3759	2.16
	$2p^53d^1P_1$	207.3976 ^a	1.16
	$2p^53d^3F_4$	189.0380	11.94
$2p^5(^2P_{3/2})4f^2[9/2]_5$	$2p^53d^3F_3$	190.0043	10.63
$2p^5(^2P_{3/2})4f^2[5/2]_3$	$2p^53d^3P_2$	186.5636	7.62
	$2p^53d^1F_3$	193.8249	2.14
	$2p^53d^3D_2$	202.4285	1.32
	$2p^53d^3P_1$	184.6707	1.59
$2p^5(^2P_{3/2})4f^2[5/2]_2$	$2p^53d^3F_2$	192.8811	1.99
	$2p^53d^3D_1$	198.5173	5.89
	$2p^53d^3F_3$	189.1970	1.93
	$2p^53d^3F_2$	192.4479	7.93
$2p^5(^2P_{3/2})4f^2[7/2]_3$	$2p^53d^1D_2$	200.2917	1.59
	$2p^53d^3F_4$	188.2308	1.65
	$2p^53d^1F_3$	193.3563	8.76
	$2p^53d^3D_3$	200.87714	1.00
$2p^5(^2P_{1/2})4f^2[7/2]_3$	$2p^53d^3F_2$	185.0060	2.08
	$2p^53d^1D_2$	192.3042	9.18
	$2p^53d^1F_3$	185.8451	1.12
$2p^5(^2P_{1/2})4f^2[7/2]_4$	$2p^53d^3D_3$	192.8424	10.31
	$2p^53d^3P_2$	179.1402 ^b	2.00
	$2p^53d^3D_2$	193.7778 ^b	9.02
$2p^5(^2P_{1/2})4f^2[5/2]_2$	$2p^53d^3D_1$	190.1360	1.21
	$2p^53d^1P_1$	197.4737	7.95
$2p^5(^2P_{3/2})5f^2[3/2]_1$	$2p^53d^3P_0$	130.659	2.17
	$2p^53d^3P_1$	131.0720	1.83
	$2p^53d^3P_1$	131.0633	2.00
$2p^5(^2P_{3/2})5f^2[3/2]_2$	$2p^53d^3F_4$	132.9583	4.49
$2p^5(^2P_{3/2})5f^2[9/2]_5$	$2p^5(^2P_{3/2})4d^2[7/2]_4$	405.7350	2.01
	$2p^53d^3F_3$	133.4359	3.97
$2p^5(^2P_{3/2})5f^2[9/2]_4$	$2p^5(^2P_{3/2})4d^2[7/2]_3$	408.2939	1.86
	$2p^53d^3P_2$	131.8078	2.77
$2p^5(^2P_{3/2})5f^2[5/2]_3$	$2p^5(^2P_{3/2})4d^2[3/2]_2$	403.8255	1.42
	$2p^53d^3D_1$	137.6713	2.27
$2p^5(^2P_{3/2})5f^2[5/2]_2$	$2p^5(^2P_{3/2})4d^2[3/2]_1$	427.5201	1.10
	$2p^53d^3F_2$	134.8342	2.88
$2p^5(^2P_{3/2})5f^2[7/2]_3$	$2p^5(^2P_{3/2})4d^2[5/2]_2$	414.0688	1.63
	$2p^53d^1F_3$	135.280	3.21
$2p^5(^2P_{3/2})5f^2[7/2]_4$	$2p^5(^2P_{3/2})4d^2[5/2]_3$	415.6475	1.71
	$2p^53d^3D_2$	135.3804	3.28
$2p^5(^2P_{1/2})5f^2[5/2]_3$	$2p^5(^2P_{1/2})4d^2[3/2]_2$	411.2835	1.78
	$2p^53d^1P_1$	137.1769	2.91
$2p^5(^2P_{1/2})5f^2[5/2]_2$	$2p^5(^2P_{1/2})4d^2[3/2]_1$	423.8916	1.57
	$2p^53d^1D_2$	134.646	3.37
$2p^5(^2P_{1/2})5f^2[7/2]_3$	$2p^5(^2P_{1/2})4d^2[5/2]_2$	409.4375	1.88
	$2p^53d^3D_3$	134.9132	3.79
$2p^5(^2P_{1/2})5f^2[7/2]_4$	$2p^5(^2P_{1/2})4d^2[5/2]_3$	411.1992	2.00

Table 5Transition probabilities of several spectral lines arising from $2p^5 5g$ configurations of Mg III.

Transition		Wavelength	Transition probabilities, A_{ki} (10^8 s^{-1})
Upper level	Lower level	$\lambda(\text{nm})^{[1]}$	This work
$2p^5(^2P_{3/2})5g^2[5/2]_2$	$2p^5(^2P_{3/2})4f^2[3/2]_1$	444.3947	2.66
$2p^5(^2P_{3/2})5g^2[5/2]_3$	$2p^5(^2P_{3/2})4f^2[3/2]_2$	444.5577	2.92
$2p^5(^2P_{3/2})5g^2[11/2]_5$	$2p^5(^2P_{3/2})4f^2[9/2]_4$	446.3404	3.37
$2p^5(^2P_{3/2})5g^2[11/2]_6$	$2p^5(^2P_{3/2})4f^2[9/2]_5$	446.3404	3.43
$2p^5(^2P_{3/2})5g^2[7/2]_3$	$2p^5(^2P_{3/2})4f^2[5/2]_2$	447.7853	2.79
$2p^5(^2P_{3/2})5g^2[7/2]_4$	$2p^5(^2P_{3/2})4f^2[5/2]_3$	447.6490	2.93
$2p^5(^2P_{3/2})5g^2[9/2]_4$	$2p^5(^2P_{3/2})4f^2[7/2]_3$	449.7566	3.03
$2p^5(^2P_{3/2})5g^2[9/2]_5$	$2p^5(^2P_{3/2})4f^2[7/2]_4$	449.7566	3.12
$2p^5(^2P_{1/2})5g^2[9/2]_4$	$2p^5(^2P_{1/2})4f^2[7/2]_3$	447.6490	3.32
$2p^5(^2P_{1/2})5g^2[9/2]_5$	$2p^5(^2P_{1/2})4f^2[7/2]_4$	447.6490	3.42
$2p^5(^2P_{1/2})5g^2[7/2]_3$	$2p^5(^2P_{1/2})4f^2[5/2]_2$	447.9030	3.13
$2p^5(^2P_{1/2})5g^2[7/2]_4$	$2p^5(^2P_{1/2})4f^2[5/2]_3$	447.7853	3.29

Table 6Radiative lifetimes (τ in ns) of Mg III levels.

Level	Energy (cm ⁻¹) ^[a]	This work	Other authors	$\tau_{\text{exp}}/\tau_{\text{this work}}$
2p ⁵ 3s ³ P ₁	426 868.1	1.17	3.8 ± 0.3 ^[c] , 1.9 ± 0.1 ^[e] , 1.9 ± 0.19 ^[f]	1.62 ^[e]
2p ⁵ 3s ¹ P ₁	431 530.0	0.076	2.8 ± 0.3 ^[c] , 0.1 ± 0.1 ^[e] , 0.11 ± 0.15 ^[f]	1.32 ^[e]
2p ⁵ (² P _{3/2})4s ² [1/2] ₁	548 720.7	0.43		
2p ⁵ (² P _{3/2})4s ² [3/2] ₂	545 820.4	0.79		
2p ⁵ (² P _{3/2})4s ² [3/2] ₁	546 531.6	0.40		
2p ⁵ (² P _{1/2})4s ² [1/2] ₀	548 034.4	0.80		
2p ⁵ (² P _{3/2})5s ² [3/2] ₂	588 768.9	1.09		
2p ⁵ (² P _{3/2})5s ² [3/2] ₁	589 126.8	1.29		
2p ⁵ (² P _{1/2})5s ² [1/2] ₀	590 984.2	1.09		
2p ⁵ (² P _{1/2})5s ² [1/2] ₁	591 220.7	1.18		
2p ⁵ 3p ³ S ₁	467 378.5	3.44	4.95 ± 0.1 ^[b] , 5.1 ± 0.15 ^[b]	
2p ⁵ 3p ³ D ₃	474 053.2	2.34	3.6 ± 0.15 ^[b] , 2.4 ± 0.4 ^[d]	1.03 ^[d]
2p ⁵ 3p ³ D ₂	474 655.0	2.35	3.35 ± 0.15 ^[b] , 2.3 ± 0.3 ^[d]	0.98 ^[d]
2p ⁵ 3p ³ D ₁	475 502.9	2.34	3.10 ± 0.15 ^[b] , 3.30 ± 0.15 ^[b]	
2p ⁵ 3p ¹ D ₂	477 435.7	2.24	3.35 ± 0.10 ^[b] , 2.2 ± 0.3 ^[d]	0.98 ^[d]
2p ⁵ 3p ¹ P ₁	478 374.5	2.15	3.0 ± 0.10 ^[b] , 2.1 ± 0.2 ^[d]	0.98 ^[d]
2p ⁵ 3p ³ P ₂	478 846.1	1.97	3.0 ± 0.10 ^[b] , 2.1 ± 0.2 ^[d]	1.07 ^[d]
2p ⁵ 3p ³ P ₀	479 265.3	1.82	3.1 ± 0.10 ^[b]	
2p ⁵ 3p ³ P ₁	479 456.0	1.97		
2p ⁵ 3p ¹ S ₀	496 012.1	0.89		
2p ⁵ (² P _{3/2})4p ² [1/2] ₁	559 987.1	5.86		
2p ⁵ (² P _{3/2})4p ² [1/2] ₀	564 300.0	3.33		
2p ⁵ (² P _{3/2})4p ² [5/2] ₃	561 798.7	3.49	7.6 ± 0.7 ^[c]	
2p ⁵ (² P _{3/2})4p ² [5/2] ₂	562 136.1	3.43	6.6 ± 0.5 ^[c]	
2p ⁵ (² P _{3/2})4p ² [3/2] ₁	562 634.2	3.41		
2p ⁵ (² P _{3/2})4p ² [3/2] ₂	562 939.5	3.33	7.9 ± 0.8 ^[c]	
2p ⁵ (² P _{1/2})4p ² [3/2] ₁	564 289.8	3.37		
2p ⁵ (² P _{1/2})4p ² [3/2] ₂	564 664.6	3.34		
2p ⁵ (² P _{1/2})4p ² [1/2] ₁	564 731.6	3.32		
2p ⁵ (² P _{1/2})4p ² [1/2] ₀	570 112.8	2.27		
2p ⁵ 3d ³ P ₀	530 178.2	0.834		
2p ⁵ 3d ³ P ₁	530 420.6	0.68		
2p ⁵ 3d ³ P ₂	530 962.9	0.84		
2p ⁵ 3d ³ F ₄	531 563.0	0.84		
2p ⁵ 3d ³ F ₃	531 833.1	0.86		
2p ⁵ 3d ³ F ₂	532 725.7	0.89		
2p ⁵ 3d ¹ F ₃	532 971.2	0.90		
2p ⁵ 3d ³ D ₁	534 197.7	0.063		
2p ⁵ 3d ¹ D ₂	534 776.9	0.87		
2p ⁵ 3d ³ D ₃	534 923.6	0.882		
2p ⁵ 3d ³ D ₂	535 179.6	0.89		
2p ⁵ 3d ¹ P ₁	536 152.0	0.029		
2p ⁵ (² P _{3/2})4d ² [1/2] ₀	581 567.5	4.21		
2p ⁵ (² P _{3/2})4d ² [1/2] ₁	581 734.7	1.7		
2p ⁵ (² P _{3/2})4d ² [3/2] ₂	582 074.4	4.39		
2p ⁵ (² P _{3/2})4d ² [3/2] ₁	583 450.5	0.0073		
2p ⁵ (² P _{3/2})4d ² [7/2] ₄	582 134.8	4.56		
2p ⁵ (² P _{3/2})4d ² [7/2] ₃	582 290.1	4.74		
2p ⁵ (² P _{3/2})4d ² [5/2] ₂	582 747.3	4.77		
2p ⁵ (² P _{3/2})4d ² [5/2] ₃	582 839.7	4.87		
2p ⁵ (² P _{1/2})4d ² [5/2] ₂	584 628.5	4.68		
2p ⁵ (² P _{1/2})4d ² [5/2] ₃	584 733.4	4.82		
2p ⁵ (² P _{1/2})4d ² [3/2] ₂	584 737.9	4.74		
2p ⁵ (² P _{3/2})4f ² [3/2] ₁	584 345.7	0.82		
2p ⁵ (² P _{3/2})4f ² [3/2] ₂	584 354.1	0.84		
2p ⁵ (² P _{3/2})4f ² [9/2] ₅	584 462.4	0.84		
2p ⁵ (² P _{3/2})4f ² [9/2] ₄	584 463.5	0.84		
2p ⁵ (² P _{3/2})4f ² [5/2] ₃	584 563.9	0.84		
2p ⁵ (² P _{3/2})4f ² [5/2] ₂	584 571.1	0.86		
2p ⁵ (² P _{3/2})4f ² [7/2] ₃	582 290.1	1.55		
2p ⁵ (² P _{3/2})4f ² [7/2] ₄	582 134.8	0.86		
2p ⁵ (² P _{1/2})4f ² [7/2] ₃	584 687.9	1.54		
2p ⁵ (² P _{1/2})4f ² [7/2] ₄	584 689.2	1.55		
2p ⁵ (² P _{1/2})4f ² [5/2] ₃	584 733.4	0.84		
2p ⁵ (² P _{1/2})4f ² [5/2] ₂	584 628.5	0.85		
2p ⁵ (² P _{3/2})5f ² [3/2] ₁	606 713.1	1.52		
2p ⁵ (² P _{3/2})5f ² [3/2] ₂	606 719.4	1.56		
2p ⁵ (² P _{3/2})5f ² [9/2] ₅	606 774.5	1.54		
2p ⁵ (² P _{3/2})5f ² [9/2] ₄	606 775.4	1.55		
2p ⁵ (² P _{3/2})5f ² [5/2] ₃	606 830.7	1.54		
2p ⁵ (² P _{3/2})5f ² [5/2] ₂	606 834.7	1.57		

Table 6 (continued)

Level	Energy (cm ⁻¹) ^[a]	This work	Other authors	$\tau_{\text{exp}}/\tau_{\text{this work}}$
$2p^5(^2P_{3/2})5f^2[7/2]_3$	606 891.1	1.55		
$2p^5(^2P_{3/2})5f^2[7/2]_4$	606 891.8	1.55		
$2p^5(^2P_{1/2})5f^2[5/2]_3$	609 045.2	1.54		
$2p^5(^2P_{1/2})5f^2[5/2]_2$	609 050.5	1.57		
$2p^5(^2P_{1/2})5f^2[7/2]_3$	609 045.4	1.54		
$2p^5(^2P_{1/2})5f^2[7/2]_4$	609 045.7	1.55		
$2p^5(^2P_{3/2})5g^2[5/2]_2$	606 841.9	2.91		
$2p^5(^2P_{3/2})5g^2[5/2]_3$	606 841.9	2.91		
$2p^5(^2P_{3/2})5g^2[11/2]_5$	606 861.0	2.91		
$2p^5(^2P_{3/2})5g^2[11/2]_6$	606 861.0	2.91		
$2p^5(^2P_{3/2})5g^2[7/2]_3$	606 896.8	2.92		
$2p^5(^2P_{3/2})5g^2[7/2]_4$	606 896.8	2.93		
$2p^5(^2P_{3/2})5g^2[9/2]_4$	606 916.6	2.93		
$2p^5(^2P_{3/2})5g^2[9/2]_5$	606 916.6	2.93		
$2p^5(^2P_{1/2})5g^2[9/2]_4$	606 111.4	2.92		
$2p^5(^2P_{1/2})5g^2[9/2]_5$	606 111.4	2.92		
$2p^5(^2P_{1/2})5g^2[7/2]_3$	606 111.6	2.92		
$2p^5(^2P_{1/2})5g^2[7/2]_4$	606 111.6	2.92		