Higher-order relativistic contributions to the Zeeman effect in helium and heliumlike ions*

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The higher-order relativistic contributions to the Zeeman effect in triplet states in helium and heliumlike ions have been calculated to order $\alpha^3\mu_B H$.

We have recently given a calculation of higher-order relativistic contributions to the Zeeman effect, to order $\alpha^2\mu_B H$, in the $2\,^3P$, $2\,^3S$, $3\,^3P$, $4\,^3P$, and $5\,^3P$ states of helium and the $2\,^3P_1$, $3\,^3P_1$, $4\,^3P_1$, and $5\,^3P_1$ states of the helium isoelectronic series from Li II through Ne IX.[1] In this addendum we calculate the contributions to the Zeeman effect of order $\alpha^3\mu_B H$.

The higher-order corrections to the g factor are contained in g_S'. To order α^2, we find[1,2]

$$g_S' = g_S - 2\alpha^2(\tfrac{1}{3}\langle T\rangle + \tfrac{1}{6}\langle 1/r_{12}\rangle), \tag{1.1}$$

where g_S is the gyromagnetic ratio of the free electron, T is the total kinetic energy of both electrons, and r_{12} is the interelectron distance. Equation (1.1) agrees to order α^2 with a new result,[3] including terms to order α^3:

$$g_S' = g_S[1 - \alpha^2(\tfrac{1}{3}\langle T\rangle + \tfrac{1}{6}\langle 1/r_{12}\rangle) - (\alpha^3/4\pi)E], \tag{1.2}$$

where E is the nonrelativistic energy eigenvalue. Table I presents the relativistic corrections to the g factors in helium and heliumlike ions calculated from Eq. (1.2) with the matrix elements of T and $1/r_{12}$ computed by Accad, Pekeris, and Schiff.[4] We have neglected terms of order $\alpha^2(m/M)$ because they contribute less than $10^{-9}g_S$ to g_S'.

TABLE I. Relativistic contributions, to order α^3, to the g factors of helium and heliumlike ions. $[(g_S'/g_S)-1]\times 10^6$ is tabulated.

		α^2	α^3	Total
He	2^3S	−40.991 61	0.067 27	−40.924 34
	2^3P	−40.231 12	0.065 96	−40.165 16
	3^3P	−37.560 75	0.063 64	−37.497 11
	4^3P	−36.647 17	0.062 85	−36.584 32
	5^3P	−36.229 79	0.062 48	−36.167 31
Li^7 II	2^3P_1	−93.760 64	0.155 47	−93.605 17
	3^3P_1	−85.958 23	0.146 28	−85.811 95
	4^3P_1	−83.273 75	0.143 13	−83.130 62
	5^3P_1	−82.041 95	0.141 68	−81.900 27
Be^9 III	2^3P_1	−169.440 1	0.283 7	−169.156 4
	3^3P_1	−154.068 0	0.263 3	−153.804 7
	4^3P_1	−148.756 0	0.256 3	−148.499 7
	5^3P_1	−146.312 8	0.253 1	−146.059 7
B^{11} IV	2^3P_1	−267.295 8	0.450 7	−266.845 1
	3^3P_1	−241.897 6	0.414 7	−241.482 9
	4^3P_1	−233.096 8	0.402 3	−232.694 5
	5^3P_1	−229.043 0	0.396 6	−228.646 4
C^{12} V	2^3P_1	−387.334 4	0.656 3	−386.678 1
	3^3P_1	−349.448 6	0.600 4	−348.848 2
	4^3P_1	−336.297 1	0.581 1	−335.716 0
	5^3P_1	−330.223 6	0.572 3	−329.651 3
N^{14} VI	2^3P_1	−529.558 5	0.900 5	−528.658 0
	3^3P_1	−476.721 8	0.820 5	−475.901 3
	4^3P_1	−458.356 9	0.792 9	−457.564 0
	5^3P_1	−449.884 5	0.780 1	−449.104 4
O^{16} VII	2^3P_1	−693.969 2	1.183 4	−692.785 8
	3^3P_1	−623.717 4	1.070 0	−622.647 4
	4^3P_1	−599.276 6	1.037 4	−598.239 2
	5^3P_1	−587.995 9	1.020 1	−586.975 8
F^{19} VIII	2^3P_1	−880.567 0	1.505 0	−879.062 0
	3^3P_1	−790.435 4	1.363 8	−789.071 6
	4^3P_1	−759.055 9	1.314 9	−757.741 0
	5^3P_1	−744.567 7	1.292 3	−743.275 4
Ne^{20} IX	2^3P_1	−1089.352	1.865	−1087.487
	3^3P_1	−976.876 1	1.687 0	−975.189 1
	4^3P_1	−937.695 1	1.625 2	−936.069 9
	5^3P_1	−919.600 0	1.596 6	−918.003 4

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