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Comparison of theoretical satellite line intensity factors for dielectronic satellites of Li-like ions

ABSTRACT

Wavelengths, satellite line intensity factors and the resonance energies are presented for Be-like nickel. Comparison is made between the present calculations, performed with the Hartree-Fock model, and those based on the scaled Thomas-Fermi model. Significant differences are found in the line intensity factors for many cases.

DESCRIPTION

There have been rather few calculations of atomic parameters of Be-like ions (TFR Group et al. 1985, Bitter et al. 1985, Chen 1985 Bombarda et al. 1989, Bhalla et al. 1989). One atomic model which has been used extensively is the scaled Thomas-Fermi (TF) model. We report here a comparison of our calculations performed with the Hartree-Fock (HF) model with those with TF, and present the results of our calculations for Be-like nickel. The satellite line intensity factor, F_2^* (s-f) is defined as

$$F_2^*(s\text{-}f) = \frac{(2J_s+1)}{(2J_f+1)} \frac{A_a(s)\, A_r(s\text{-}f)}{\Sigma A_a + \Sigma A_r} . \qquad (1)$$

Table I contains the percentage differences of TF values (Bombarda et al. 1989, TFR Group et al. 1985) from HF values for selected cases.

We find that there is a reasonable agreement between HF and TF results for many strong lines, but significant deviations exist between the two calculations for a large number of lines, in particular for the 1s2s2p3p configuration.

Table 1. Percentage differences between the values of F_2^* (s-f) obtained with TF and HF models for initial configuration $1s2s2p^2$ leading to final configuration $1s^22s2p$ for nickel and argon.

1s>	1f>	%	|s>	|f>	%
		Z = 28			
$^1D_2$	$^1P_1$	-13	$^1S_0$	$^1P_1$	10
$^3D_3$	$^3P_2$	3	$^3P_1$	$^3P_2$	12
$^3P_2$	$^1P_1$	18	$^3D_2$	$^3P_2$	6
$^3P_2$	$^3P_1$	2	$^1P_1$	$^1P_1$	15
$^3D_2$	$^3P_1$	7	$^3P_2$	$^3P_1$	40
$^3P_1$	$^3P_0$	3	$^1D_2$	$^3P_2$	16
$^3D_1$	$^3P_1$	3	$^3S_1$	$^3P_2$	16
		Z = 18			
$^3D_1$	$^3P_0$	48	$^3S_1$	$^3P_1$	-7
$^3D_1$	$^3P_2$	-60	$^3S_1$	$^3P_2$	-6
$^3D_2$	$^3P_1$	1	$^1D_2$	$^1P_1$	-18
$^3D_3$	$^3P_2$	1	$^3P_2$	$^1P_1$	78
$^3D_2$	$^3P_2$	-34	$^1S_0$	$^1P_1$	7

Tables 2 and 3 contain our results for strong dielectronic satellite lines for nickel. The notation used in the description of the autoionization state |s> and final state |f> is as follows. 5D3 represents $^5D_3$ in the spectroscopic notation. E_S is the energy of the autoionizing state relative to the ground state, $1s^22s\ ^2S$, of the recombining ion.

ACKNOWLEDGEMENTS

It is a pleasure to thank Dr. R.D. Cowan for many helpful discussions. This work was supported by the Division of Chemical Sciences, Office of Basic Energy Sciences, Office of Energy Research, U.S. Department of Energy and in part by the SERC Rutherford Appleton Laboratory.

Table 2. X-ray wavelengths (in Å), line intensity factors, F_2^*, (in units of 10^{12}/s) and E_s (in keV) for the 1s2s2p3p configuration of nickel. Entries with $\lambda \approx 1.59$ and $\lambda \approx 1.37$ represent respectively 2p to 1s and 3p to 1s x-ray transitions.

|s>	|f>	λ	F_2^*(s-f)	E_s
5D3	3P2	1.6088	6.62	6.737
3D2	1P1	1.6077	3.39	6.745
3D1	1P1	1.6073	5.39	6.747
3D2	3P1	1.6060	2.81	6.745
3P2	3P2	1.6042	5.15	6.759
3S1	3P2	1.6026	3.04	6.767
3D2	1P1	1.6007	7.50	6.779
3D2	3P2	1.6001	10.82	6.779
3D2	3P1	1.5990	6.97	6.779
1D2	1P1	1.5984	6.42	6.790
1D2	3P2	1.5978	3.05	6.790
3D3	3P2	1.5974	62.00	6.792
3P2	1P1	1.5972	11.05	6.795
1P1	1P1	1.5972	8.55	6.796
1S0	1P1	1.5969	3.06	6.798
3P1	3P0	1.5968	3.05	6.789
1D2	3P1	1.5967	47.88	6.790
3P2	3P2	1.5966	8.47	6.796
1P1	3P2	1.5966	2.83	6.796
3D2	1P1	1.5950	13.65	6.807
3D2	3P2	1.5944	18.19	6.807
3P2	1P1	1.5641	3.94	6.811
3D1	3P1	1.5940	20.20	6.804
3D3	3P2	1.5938	3.89	6.809
3D1	3P0	1.5938	10.22	6.804
3P2	3P2	1.5935	5.55	6.811
3S1	3P2	1.5932	11.09	6.813
5P2	3P2	1.3805	3.40	6.751
5P3	3P2	1.3801	15.78	6.754
3P2	3P2	1.3793	19.79	6.759
3P1	3P0	1.3790	9.69	6.739
3D2	3P1	1.3789	22.82	6.745
3D1	3P1	1.3786	17.23	6.747
3D3	3P2	1.3785	78.15	6.764
3S1	3P2	1.3780	7.71	6.767
3P2	1P1	1.3772	3.89	6.811
1D2	1P1	1.3761	28.60	6.819
1S0	1P1	1.3749	4.29	6.827
1D2	3P2	1.3746	2.80	6.790
3D3	3P2	1.3742	4.32	6.792
3D2	3P1	1.3737	2.79	6.779

Table 3. X-ray wavelengths (in Å), line intensity factors (in units of 10^{13}/s) and E_s (in keV) for the $1s2s2p^2$ configuration of nickel.

|s>	|f>	λ	F_2^*(s-f)	E_s
5P2	3P2	1.6184	0.262	5.431
5P1	3P1	1.6173	0.236	5.420
5P3	3P2	1.6163	2.217	5.441
3D2	1P1	1.6162	0.303	5.480
3D1	1P1	1.6151	0.202	5.485
3P2	1P1	1.6132	0.535	5.494
3P1	1P1	1.6117	0.441	5.501
1D2	1P1	1.6090	8.080	5.514
3P1	3P2	1.6089	1.177	5.476
3D2	3P2	1.6081	1.901	5.480
3D1	3P2	1.6071	2.494	5.485
3P0	3P1	1.6069	0.220	5.469
3D3	3P2	1.6065	33.760	5.488
3P2	1P1	1.6058	4.048	5.530
3P1	3P1	1.6055	0.695	5.476
3D1	3P1	1.6037	10.620	5.494
3D1	3P1	1.6048	20.680	5.480
3P1	3P0	1.6044	4.094	5.476
3D1	3P1	1.6037	10.130	5.485
3P1	3P1	1.6036	1.140	5.501
1P1	1P1	1.6034	0.815	5.541
3D1	3P0	1.6026	0.219	5.485
1S0	1P1	1.6020	1.705	5.548
3P2	3P1	1.6017	0.530	5.494
1D2	3P2	1.6009	7.500	5.514
3P1	3P1	1.6003	0.572	5.501
3S1	3P2	1.5995	3.634	5.522

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