§11. Calculation of the High-n Dielectronic Satellites of $K\alpha$ Resonance Lines for Heliumlike Iron

Wang, J.G., Chang, T.Q.[1], Dong, C.Z.[2], Kato, T.

The $K\alpha$ x-ray emission of the transition metals Ti, Cr, Fe, and Ni is extensively used for determining the parameters of high-temperature tokamak plasmas. But it is blended with lithium-like Dielectronic Satellites (DS) due to transitions $1s^2nl - 1s2pnl$ with $n \geq 3$. These unresolved high-n DS lead to a significant increase in both the apparent width and intensity of the resonance line,which must be taken into account for Doppler-broadening and Doppler- shift measurements as well as the evaluation of DS- to -resonance line ratio, which is used for diagnostics of solar flares and tokamak plasmas. However, explicit calculations of the high-n-satellite line strengths are difficult, because the number of resonance doubly excited states increase rapidly with the principal quantum number of the outermost occupied shell of resonance state. As a result, most of the explicit calculations have been limited so far to low-lying resonance doubly excited states with $n \leq 4$, while an approximate $1/n^3$ scaling law has generally been used to extrapolate the satellite intensity factors for $n > 4$.

Recently, a simplified relativistic configuration interaction (SRCI) method have been developed to calculate the dielectronic recombination (DR) cross sections and rate coefficients successfully. In present paper, a similar method are developed to calculate the contributions from high-n DS lines to the resonance line, in which all the high-n DS involving infinite resonant doubly excited states can be calculated conveniently in the frame of QDT. As an example, we study the contributions from high-n DS lines to the $K\alpha$ resonance line in heliumlike iron, and the theoretical results are compared with the experimental measurements. Our calculated spectral contribution of different high-n DS lines as the separation from the $K\alpha$ resonance line is shown in Fig.1(a), which is compared with the relative experimental values in Fig.1(b)[1]. The comparison shows our results are in good agreements with the experimental measurements in positions and relative strength. We can see that the high-n satellites are found mostly on the long wavelength side, and their position approaches the resonance line as the n increases. This means that these high-n DS lines are seriously mixed with resonance line, and it is very difficult to separate them through experiments. In previous works, an approximate $1/n^3$ scaling law has generally been used to extrapolate the satellite intensity factors for high n resonances. But for low Z or low ionization stage ions, the satellite intensity factors don't have a good n^{-3} scaling relation. In our SRCI method, after the renormalized matrix elements of a few bunchmark points (several bound points and one continuum point) have been calculated, we can obtain all the DS strength in a channel by interpolation.

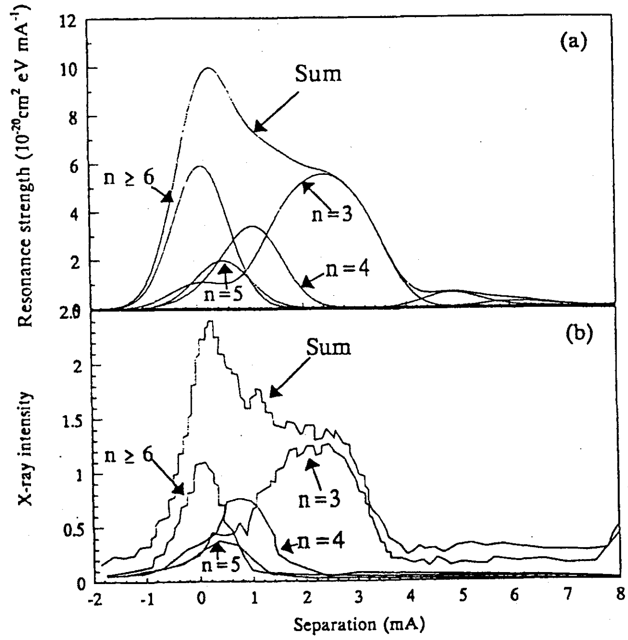

Fig.1(a). Calculated DS cross sections as separation from $K\alpha$ resonance line for the $n = 3, 4, 5, ...\infty$ resonances; (b). Experimental DS intensities[1]

References

[1]Institute of Applied Physics and Computational Mathematics, China

[2]Northwest Normal University, China

[1]. P. Beiersdorfer et al, Rev. Sci. Instrum. **63**, 5029 (1992).