Role of M2 and E3 Transitions for $4p^5 4d^{N+1}$ and $4p^6 4d^{N-1} 4f$ Configurations Level Lifetimes

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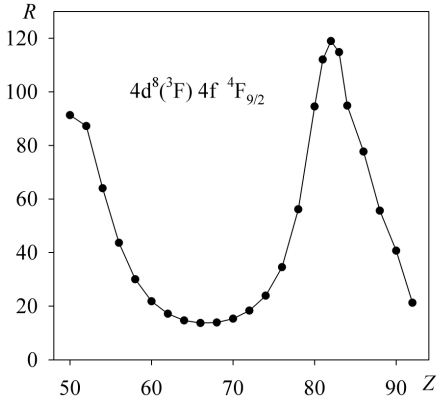
Theoretical investigation of spectral parameters for multicharged tungsten ions with an open 4d-shell [1] has demonstrated that electric octupole E3 transitions from some levels of the excited configurations $4p^5 4d^{N+1}$ and $4p^6 4d^{N-1} 4f$ to the ground configuration $4p^6 4d^N$ play very important role in determining their lifetimes. This is caused by fact that these are metastable levels with high values of total momentum J. Hence electric dipole E1 transitions to the ground configuration are forbidden. Furthermore, if magnetic dipole M1 or electric quadrupole E2 transitions from these levels are weak, their radiative lifetimes are strongly influenced by magnetic quadrupole M2 and E3 transitions to the ground state.

In present work we investigate the influence of M2 and E3 transitions on the radiative lifetimes of metastable levels in extended isoelectronic sequences. We use parameter $R = \tau_{E2+M1}/\tau_{TOT}$ as a measure, where τ_{TOT} is a lifetime determined from all (E2, M1, E3, M2) transition probabilities (E1 transition is forbidden), τ_{E2+M1} is a lifetime determined from transitions inside configuration. The ratio R shows how much a lifetime decreases when M2 and E3 transitions are included. The calculations were performed in quasirelativistic approximation [2]. Preliminary calculations have proved that correlation corrections are not important for the studied parameter R. Therefore the ground configuration $4p^6 4d^N$ was investigated in a single-configuration approximation; only interaction between two excited configurations $4p^5 4d^{N+1}$ and $4p^6 4d^{N-1} 4f$, which is very strong in multicharged ions, was included for the odd states.

In figure we present dependence of parameter R on nuclear charge Z for the $4d^8 4f\ ^4F_{9/2}$ level. It is evident that M2 and E3 transitions can reduce calculated radiative lifetimes significantly. If M2 transitions are allowed, they give the main contribution to value of parameter R. Behaviour of R presented in this figure is quite representative. Curve bending is caused by different Z-dependence of non-relativistic and relativistic energy contributions inside and between the configurations. This significantly affects transition probabilities. There is a prominent break of curve when $Z > 82$. This behaviour is caused by the situation when investigated level energy becomes higher comparing to other levels of the same parity. Therefore new M1 and E2 transitions become available and their probabilities are increasing.

During calculations we additionally investigated tendencies of interaction between excited configurations along the isoelectronic sequences. Performed investigation confirmed that forbidden M2 and E3 transitions must be included along with transitions inside configurations when the radiative lifetimes of metastable energy levels are determined. We plan to place these transition probability values into our newly created atomic database for astrophysical, technological and laboratory plasma modelling.



REFERENCES

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2. P. Bogdanovich and O. Rancova, *Physica Scripta*. **78** 045301 (2008).