Measurement of High-Multipole Forbidden Transitions in Highly-Charged Ions Produced with EBITs

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Studies of high-multipole forbidden transitions in highly charged ions are important not only for testing atomic physics theory describing the interaction with high-multipole radiation fields, but also for several applications, such as plasma diagnostics [1] and atomic clocks [2]. An electron beam ion trap (EBIT) is a powerful device for studying such high-multipole transitions of highly charged ions. In an EBIT, highly charged ions are trapped for many hours while being excited by a relatively low-density (typically 10^{10}-10^{12} cm^{-3}) electron beam. The collision frequency is typically in the order of 10 Hz, so that forbidden transitions with a transition probability down to the order of 10 s^{-1} can be observed with an intensity comparable with that of electric dipole ($E1$) allowed transitions.

In this talk, we present our recent observations mainly performed with a compact electron beam ion trap, called CoBIT [3]. In particular, we have successfully observed electric octupole ($E3$) transitions in Ag-like W [4]. On the other hand, we have found that the existence of a strongly forbidden $E3$ transition in the Pm-like isoelectronic system can result in nearly complete population trapping at the $4f^{13}5s^2$ metastable state even though the ground-state configuration is alkali-metal-like $4f^{14}5s$ [5]. Population kinetics for these systems is discussed through the comparison with the analysis based on a collisional radiative model.

References

[1] Yu. Ralchenko, I. N. Draganic, D. Osin, J. D. Gillaspy, and J. Reader, Phys. Rev. A **83**, 032517 (2011).
[2] J. C. Berengut, V. A. Dzuba, and V. V. Flambaum, Phys. Rev. Lett. **105**, 120801 (2010).
[3] N. Nakamura, H. Kikuchi, H. A. Sakaue, and T. Watanabe, Rev. Sci. Instrum. **79**, 063104 (2008).
[4] H. A. Sakaue, D. Kato, I. Murakami, H. Ohashi, and N. Nakamura, arXiv:1808.10126.
[5] Y. Kobayashi, K. Kubota, K. Omote, A. Komatsu, J. Sakoda, M. Minoshima, D. Kato, J. Li, H. A. Sakaue, I. Murakami, and N. Nakamura, Rhys. Rev. A **92**, 022510 (2015)