4 - 4 Determination of the $2s^22p^5 \rightarrow 2s2p^6$ Transition Energy in Fluorine-like Nickel Utilizing a Low-lying Dielectronic Resonance*

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The electron-ion recombination spectrum of fluorine-like nickel (Ni^{19+}) has been measured at the heavy-ion storage ring HIRFL-CSRm[1]. The measured DR resonances are identified by comparing the experimental data with relativistic calculations utilizing the flexible atomic code (FAC). As shown in Fig. 1(a), the experimental determination of the collision energy for the first resonance via the $(2s2p^6[^2S_{1/2}]6s)_J = 1$ intermediate state at 86 meV reaches an uncertainty as low as ±4 meV. By employing the Multi-Configuration Dirac-Hartree-Fock (MCDHF) approach and stabilization method (SM), the binding energies of the $6s$ electron in the $(2s2p^6[^2S_{1/2}]6s)_J = 1$ state are calculated, and yielding the following values of $149.056(4)_{\rm exp}(20)_{\rm MCDHF}$ eV and $149.032(4)_{\rm exp}(6)_{\rm SM}$ eV, respectively, for the $2s^22p^5\ ^2P_{3/2} \rightarrow 2s2p^6\ ^2S_{1/2}$ transition energy in fluorine-like nickel. Figure 1(b) displays a comparison of the present experimental and theoretical transition energies with previous plasma observations and the NIST recommended data. In addition, *ab-initio* theoretical calculations with two different starting potentials, reveal that second-order QED contributes by about −0.03 eV to the total transition energy, and can, thus, be assessed by the present precision DR spectroscopic measurement[2]. The present study establishes precision DR spectroscopy with highly charged ions at the CSRm and paves the way for future precision studies with highly charged ions at the CSRe and the upcoming High-Intensity heavy-ion Accelerator Facility (HIAF).

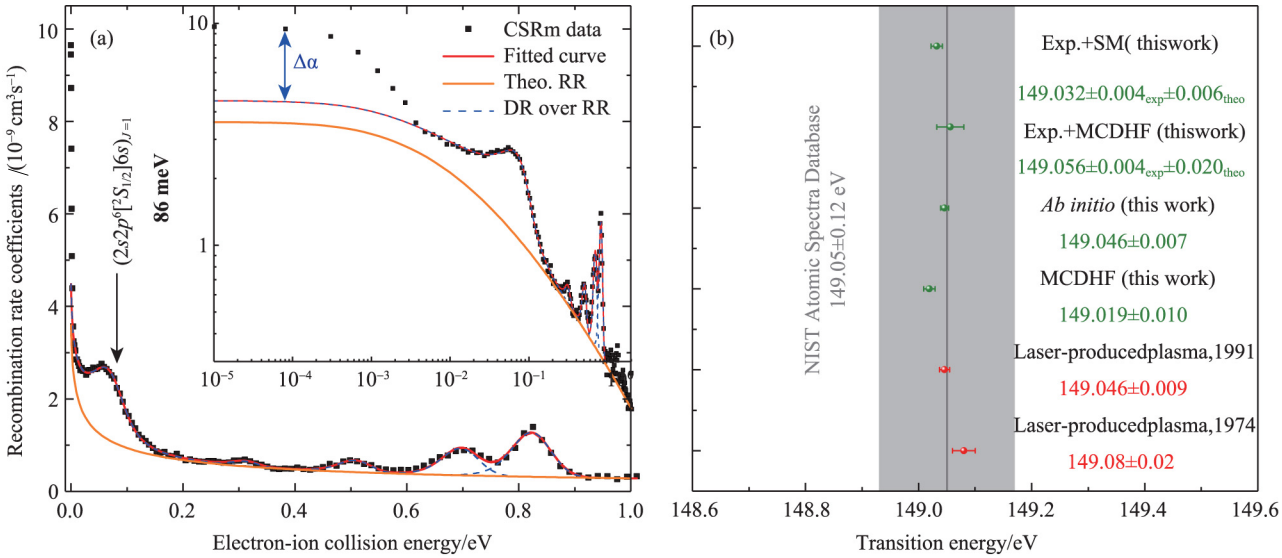

Fig. 1 (color online) (a) Fit of the experimental low-energy recombination spectrum, (b) Comparison of the present experimental and theoretical transition energies with previous plasma observations and the NIST recommended data.

References

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