Experimental Studies of Nonperturbative Dynamics in Heavy-Ion-Atom Collisions

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Experimental data for atomic collisions of highly-charged ions are essential for benchmarking the theoretical description of dynamical processes in atomic physics. Of particular challenge is the accurate description of those processes that exceed the applicability of relativistic first-order perturbation theories. Recently, we have investigated two characteristic cases of such collision systems at the Experimental Storage Ring ESR of the GSI heavy-ion accelerator facility in Darmstadt, Germany:

(1) For fast collisions of U^{89+} projectiles with N_2 and Xe targets at 76 MeV/u, we studied the electron-loss-to-continuum cusp both experimentally and theoretically. We compared the continuum electron spectra of the two collision systems, which originate from the ionization of the projectile, and we were able to identify a clear signature for the nonperturbative character of the collision systems [1].

(2) For slow collisions of Xe^{54+} and Xe^{53+} with a Xe target at 30 and 15 MeV/u, we performed an x-ray spectroscopy experiment focusing on the target $K\alpha$ radiation. Experimental data for such slow symmetric collision systems are important for testing relativistic two-center calculations and provide an intermediate step towards understanding heavy-ion collisions in super-critical fields. We used the target $K\alpha$ satellite and hyper-satellite lines to derive cross-section ratios for double-to-single target K-shell vacancy production and compared our experimental results to theory applying a fully relativistic time-dependent two-center approach [2].

References

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