Beitrag ID: **3** Typ: **Poster**

Signature of Charge Equilibrium Process in L-Shell Auger-Meitner Electron Emission Spectra of Ar^{+q}-Ar Collisions

Montag, 15. September 2025 16:30 (1 h 30m)

The well-known Auger-Meitner (AM) effect has been used extensively to study electron correlations. In ion-atom collisions, the AM process occurs during hard collisions (small impact parameter). It is known that for ions, the energy of AM e^- shifts to the low-energy side, in contrast to X-ray energy, which shifts toward the high-energy side. For ion-atom collisions, understanding this process can be categorized into two regimes: (1) Coulomb ionization (for proton and bare-ion projectiles), and (2) excitation or ionization of a quasi-molecule. When the projectile moves very fast relative to the orbital electron or is lighter than the target, the process can be understood through Coulomb ionization. Excitation or ionization of a quasi-molecule has been studied for X^+–X collision systems. However, very few studies are available in the literature where the projectile undergoes inner-shell excitation.

In this talk, I shall discuss the double differential cross section (DDCS) for electron emission in Ar^{3+}–Ar and Ar^{6+}–Ar collisions. A significant shift exceeding 40 eV is observed in the characteristic Auger-Meitner (AM) electron energy peak for LMM transitions. For a neutral Ar target, this peak is expected near 197 eV; the shift occurs for both projectile and target after Doppler-shift correction. Although existing literature attributes this shift to binding-energy changes in ions versus neutral atoms, experimental peaks typically result from convolutions of multiple peaks. Here, simply knowing binding-energy changes is insufficient to quantify ionization. We adopt an approach where the probability of AM transitions is calculated using ground-state wave functions of ions. Using these probabilities as weight factors for the energy-peak function, the shift in convoluted peaks may quantify ionization. Comparing calculations with experiments, both target and projectile exhibit equilibrium charge states between 3+ and 4+ before AM emission. I shall also discuss experimental results for C^{q+} ($q = 1, 2$)–CH4 and N^{q+} ($q = 2, 3$)–CH4 collision systems.

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Sitzung Einordnung: Poster Session