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X-ray Spectroscopy of Charge Exchange at Ultra-Low Collision Energies

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Charge exchange (CX), the atomic process in which a bound electron from a neutral atom or molecule is tranferred into a highly excited state of a highly charged ion (HCI), results in the emission of a complex characteristic x-ray spectrum. Relative line intensities in this spectrum depend on the donor and acceptor species, as well as their relative velocity.

CX contributes to spectra of astrophysical plasmas observed with x-ray observatories and can provide information about their compositions, temperatures and densities. However, how much of this information can be reliably deduced from spectra is currently limited by our incomplete understanding of the capture process and the subsequent radiative cascade. With the high-resolution microcalorimeter instruments onboard the next generation of x-ray observatories, better models are urgently needed. Such models have to be benchmarked by laboratory experiments.

HITRAP provides an excellent environment to study CX with ultra-slow HCI in a wide range of elements and charge states, for many of which very little or no experimental data is available. Experiments could explore the regime of high-Z ions undergoing CX at collision energies well below 10 keV/u, in which many commonly used approximations are expected to not be applicable anymore.
X-ray and UV spectroscopy combined with ion time-of-flight measurements at the HITRAP pulsed gas target would make unique systematic studies possible, which will directly impact the interpretation of astrophysical x-ray spectra and give insights into fundamental aspects of ion-atom interactions.

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