Why the beam-foil interaction is not charge exchange

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In beam-foil spectroscopy, the interaction of the swift ions with the exciter foil has been studied for decades. Ions of practically all elements and charge states have interacted with many foil materials in many geometrical arrangements. There have been investigations into atomic effects of the target material, level population influenced by the band structure of the foil material, core excitation vs. valence electron excitation and capture, surface field effects and whatever else. The contradictory results obtained by various groups have led to the sprouting of a wide variety of models and of specific explanations that, however, often failed to help understand most other results.

At the risk of underappreciating the many effects claimed earlier, I intend to discuss the basics of the beam-foil interaction and its (somehow inverse) relation to the excitation by an electron beam in an electron beam ion trap in very simple pictures. There are a number of gross scaling rules, some of which work, although they can't be fully correct. Their generality, however, implies that they are not material-specific and do not very notably depend on atomic properties. Moreover, the typical collision energies used in beam-foil spectroscopy as well as the (solid-state) target electron density and many-atomic layer target thickness are not favourable for insight into individual atomic processes. Nevertheless, beam-foil spectra have over and over again incited speculation whether there might not be something special or fundamental that one might extract for diagnostics.