Complete measurements of anisotropic x-ray emission following recombination of highly charged ions

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X-ray emission asymmetries following the resonant recombination into highly charged ions were studied using an electron beam ion trap (EBIT) of Max Planck Institute for Nuclear Physics in Heidelberg. Iron and krypton ions in the He-like through O-like charge states were populated in an EBIT and the K-shell dielectronic recombination (DR), trielectronic recombination (TR) and quadroelectronic recombination (QR) resonances were systematically investigated. The x rays emitted in the decays of resonantly excited states were observed by two germanium detectors aligned along and perpendicular to the electron beam propagation direction and the corresponding intensities of the K-shell x-ray transition were recorded as a function of the electron collision energy. The x-ray emission asymmetries reveal the alignment of the intermediate excited states and, therefore, the polarization of the emitted x rays. Except for a few transitions, the experimental results are in excellent agreement with the theoretical calculations done with FAC and RATIP computer codes.

This measurement allows for a systematic modeling of the polarization of the prominent $K\alpha$ radiation emitted by hot anisotropic plasmas. Using the experimental data, we calculated the maximum polarization of the $K\alpha$ x rays emitted by an anisotropic plasma as a function of the plasma temperature, see Figure 1. Unexpectedly, we found that the degree of x-ray polarization is dominated by previously neglected trielectronic and quadroelectronic recombination transitions. This information can be used for diagnostics of anisotropies in hot plasmas, in particular the experimental results should play an important role in diagnostics of hot astrophysical plasmas of solar flares and active galactic nuclei and laboratory fusion plasmas of tokamaks and stellarators.

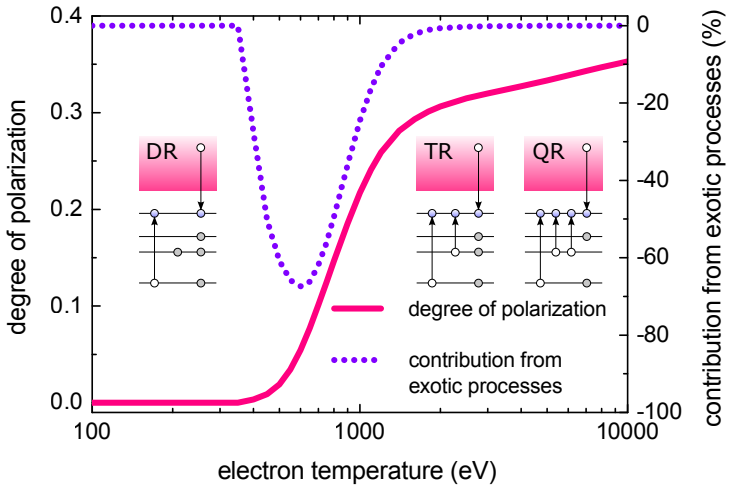

Figure 1: *Maximum polarization of iron $K\alpha$ x rays due to resonant recombination as a function of the plasma temperature. Exotic trielectronic and quadroelectronic recombination transitions dominate polarization in an intermediate range of plasma temperature.*