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Observation of coherence in radiative recombination

The process of radiative recombination (RR) was studied in the regime of hard x-rays. In the experiment the relativistic electrons recombined into the 2p3/2 excited state of hydrogenlike uranium ions and the RR x-rays and the subsequently emitted characteristic x-rays were detected in coincidence. In this new type of experiment the reaction plane is defined by the incoming (unpolarized) electron and the emitted RR x-ray propagation directions, and, most importantly, the formed excited state becomes a coherent superposition of the magnetic substates. Here the electron propagation direction in the ion rest-frame is taken as the quantization axis. As the result of the coherence the state attains a new alignment axis, which is confined to the reaction plane and forms a finite angle γ with respect to the collision axis. The alignment angle γ can be measured via the angular distribution of the characteristic Lyα1 x-rays.

The results show the dominance of the relativistic effects and indicate the generation of the strong magnetic fields during the recombination process. The technique of the photon-photon coincidences was extended, for the first time, to the domain of hard x-rays and heavy ions. This is a qualitative improvement from the previous experiments, and it has a high potential for studies of alignment and polarization phenomena in atomic collisions. Moreover, by this technique we are able to manipulate and monitor the alignment and coherence of the excited states in heavy highly charged ions.

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