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Study of two-body beta decays of highly-charged ions

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Periodic time modulations were found recently in the measurements of the two-body orbital electron capture (EC) decay of hydrogen-like 140Pr58+ and 142Pm60+ ions stored and cooled in the Experimental Storage Ring (ESR). The modulations in both investigated systems can be characterized by periods TP near to 7 s and amplitudes a of about 20% [1]. The observed phenomenon caused intensive discussions in the physics community on its possible explanation. Numerous suggestions were proposed. However, no consensus is presently reached and the effect remains still unexplained.

In the last years, a new Schottky detector has been developed [2], which allowed for an unambiguous determination of the EC decay-time of each individual stored and cooled parent ion, with a very high time accuracy of merely a few tens of milliseconds. The EC decay of H-like 142Pm60+ ions was re-investigated in the ESR by employing the previously used Schottky pick-up as well as this new detector [3]. The data recorded by both detectors confirmed that the exponential EC decay is modulated with a period TP =7.11(8) s (mean of both detectors), in full accordance with the modulation period TP = 7.10(25) s obtained for 142Pm60+ in the previous experiment. However, the mean modulation amplitude of both detectors of a = 12(2)%, although being statistically significant, is almost two times smaller than the one seen previously. Also the three-body β + decays of H-like 142Pm60+ ions has been analyzed in the new experiment. No significant modulation period could be observed.

The nature of the modulated EC decays, if undoubtedly confirmed in future experiments, is still unclear and, since it might be related to physics beyond the Standard Model, it requires urgently additional experimental investigations and theoretical interpretation. In this presentation the present status of the experiment and future perspectives will be discussed in detail.

[1] Yu. A. Litvinov et al., Phys. Lett. B664 (2008) 162
[2] F. Nolden et al., Nucl. Instr. Meth. A6 5 9 (2011) 69
[3] P. Kienle et al., Phys. Lett. B726 (2013) 638

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