Increased lifetime of hydrogen-like ^{192m}Os observed in the ESR*

A. Akber[1], M.W. Reed[1], P.M. Walker[2], I.J. Cullen[2], Yu.A. Litvinov[3,4,5], K. Blaum[3,5], F. Bosch[4], C. Brandau[4,6], J.J. Carroll[7], D.M. Cullen[8], A.Y. Deo[2], B. Detwiler[9], C. Dimopoulou[4], G.D. Dracoulis[1], F. Farinon[4], H. Geissel[4,10], E. Haettner[10], M. Heil[4], R.S. Kempley[2], T. Kibédi[1], R. Knöbel[4,10], C. Kozhuharov[4], J. Kurcewicz[4,11], N. Kuzminchuk[4,10], G.J Lane[1], S. Litvinov[4], Z. Liu[12,13], R. Mao[13], C. Nociforo[4], F. Nolden[4], W.R. Plass[4,10], A. Prochazka[4], C. Scheidenberger[4,10], D. Shubina[3,5], M. Steck[4], Th. Stöhlker[4,14,15], B. Sun[4], T.P.D. Swan[2], G. Trees[9], H. Weick[4], N. Winckler[3,4], M. Winkler[4], P.J. Woods[12], and T. Yamaguchi[16]

[1]Department of Nuclear Physics, R.S.P.E., Australian National University, Canberra ACT 0200, Australia; [2]Department of Physics, University of Surrey, Guildford, Surrey GU2 7XH, United Kingdom; [3]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany; [4]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany; [5]Physikalisches Institut, Universität Heidelberg, 69120 Heidelberg, Germany; [6]ExtreMe Matter Institute EMMI, 64291 Darmstadt, Germany; [7]US Army Research Laboratory, 2800 Powder Mill,Road, Adelphi MD, USA; [8]Schuster Laboratory, University of Manchester, Manchester M13 9PL, United Kingdom; [9]Youngstown State University, One University Plaza, Youngstown, Ohio 44555, USA; [10]II Physikalisches Institut, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany; [11]CERN, 1211 Geneva 23, Switzerland; [12]School of Physics and Astronomy, University of Edinburgh, Edinburgh EH9 3JZ, United Kingdom; [13]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, PR China; [14]Institute of Physics, Friedrich-Schiller-Universität Jena, 07743 Jena, Germany; [15]Helmholtz-Institut Jena, Fröbelstieg 3, 07743 Jena, Germany; [16]Graduate School of Science and Engineering, Saitama University, Saitama 338-8570, Japan

Using the Experimental Storage Ring (ESR) it is possible to distinguish between charge states of an isotope with sensitivity down to single ions [1]. Projectile fragmentation of a ^{197}Au beam (478-492 A·MeV) with a ^{9}Be target was performed and the resultant fragments were passed through the FRagment Separator [2] where isotopes of interest were separted before being injected into the ESR. The ions were cooled by electron and stochastic cooling enabling Schottky Mass Spectrometry to be used and nuclear decays within the ESR are inferred from changes in ion revolution frequency [3].

Prior studies of ^{192}Os revealed an isomer with a lifetime of $\tau_{\rm neut} = 8.5(14)$ s at 2015 keV. Three decay branches have been observed with transition energies of 47, 302, and 307 keV [4]. Neutral [5] and hydrogen-like internal conversion coefficients were calculated and indicate a decrease for all transitions (Table 1). For the 47 keV transition internal conversion in the hydrogen-like state is forbidden. An increased lifetime of $\tau_{\rm calc} = 13.0(24)$ s due to the reduction of internal conversion can be expected.

Table 1: Calculated total internal conversion coefficients for transitions from ^{192m}Os [4, 5].

$E_{\rm trans}$	I_γ	$\sigma\lambda$	$\alpha_{t\,(\rm neut)}$	$\alpha_{t\,(\rm H-like)}$
47.4	0.0031(6)	E3	7760	0
302.6	100(6)	E3	0.433	0.084
307.0	13.3(3)	M2	0.975	0.374

*Work supported in part by the Helmholtz-CAS Joint Research Group HCJRG-108, National Natural Science Foundation of China (No. 11105010), the Australian Research Council, UK STFC and AWE plc.

An increased lifetime for ^{192m}Os was measured from observations of 106 single hydrogen-like ions in the ESR (Figure 1). After Lorentz correction ($\gamma = 1.4$) the measured mean lifetime of ^{192m}Os^{75+} was $\tau_{\rm Lorentz} = 14.2(16)$ s. The observed increase in lifetime is attributed to the reduction of internal conversion because of the high charge state.

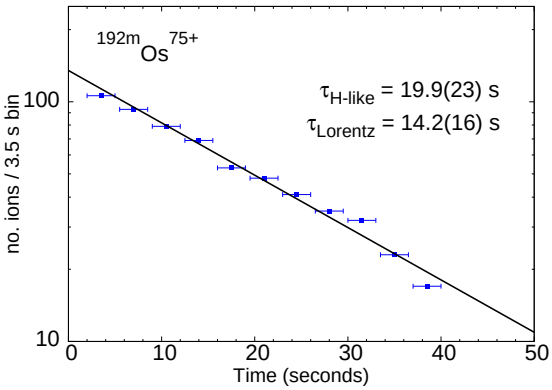

Figure 1: Lifetime curve for ^{192m}Os^{75+} produced by direct observation of highly charged single ions in the ESR.

References

[1] Yu. Litvinov, *et al.*, Nucl. Phys. A **756**, 3 (2005).

[2] H. Geissel *et al.*, Nucl. Inst. Meth. B **70**, 286 (1992).

[3] Yu. Litvinov & F. Bosch, Rep. Prog. Phys. **74**, 016301 (2011).

[4] G.D. Dracoulis *et al.*, Phys. Lett. B **720**, 330 (2013).

[5] T.Kibédi *et al.*, Nucl. Inst. and Meth. A **589**, 202 (2008).

 doi:10.15120/GR-2014-1-PNI-AP-07