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Discovery of new superheavy element isotopes[1]

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The first confirmation of element 114 production and decay was performed in 2009 with the Berkeley Gas-filled Separator at the Lawrence Berkeley National Laboratory 88-Inch Cyclotron. The ^{48}Ca + ^{242}Pu reaction was used. Compound nucleus evaporation residues were separated from beam and other reaction products with the Berkeley Gas-filled separator and implanted in the focal plane detector system. Production and decay of one atom each of ^{287}114 (via the ^{242}Pu(^{48}Ca, $3n$)^{287}114 reaction) and ^{286}114(via the ^{242}Pu(^{48}Ca, $4n$)^{286}114 reaction) were observed. Production cross sections, decay modes, decay energies, and half-lives and for these element 114 isotopes and their daughters were consistent with those reported by the Dubna Gas Filled Recoil Separator Group (Yuri Oganessian, J. Phys. G: Nucl. Part. Phys. **34** (2007) R165–R242). In 2010, the ^{48}Ca + ^{242}Pu reaction was used again, at an increased beam energy to optimize the production of new isotope, ^{285}114, by the ^{242}Pu(^{48}Ca, $5n$)^{285}114 reaction. The production and decay of one atom of ^{286}114 (via the ^{242}Pu(^{48}Ca, $4n$)^{286}114 reaction) was observed, re-confirming the properties of this isotope. In addition, a single event corresponding to the production and decay of ^{285}114 (via the ^{242}Pu(^{48}Ca, $5n$)^{285}114 reaction) was observed. The implantation of ^{285}114 in the detector was followed by five α-decays and a spontaneous fission event, indicating the α-decays of new isotopes, ^{285}114, ^{281}Cp, ^{277}Ds, ^{273}Hs, ^{269}Sg, and the spontaneous fission of new isotope, ^{265}Rf. The decay properties of all these new isotopes match expectations based on microscopic-macroscopic mass models supplemented with extrapolations of previously reported superheavy element isotope decay properties. However, some systematic differences between observed and predicted α-decay Q-values may be used to refine models of nuclear shell effects in heavy element isotopes.

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