PROTON RADIOACTIVITY STUDIES AT THE FMA *

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A double sided silicon strip (DSSD) setup is installed at the Argonne National Laboratory recoil separator FMA. Ground state proton emitters ^{146,147}Tm, ^{160}Re, ^{156}Ta, ^{150,151}Lu were produced in a series of test experiments. Improved $T_{1/2}$ values were obtained for ^{147}Tm, ^{160}Re, and ^{156}Ta. Improved alpha $T_{1/2}$ value of (13.2 ± 1.1) ms was obtained for ^{161}Re. In a search of new proton radioactivities a (5 ± 2) % proton decay branch with $E_p = (1345 \pm 13)$ keV for ^{161}Re was found.

A direct proton decay is a decay mode where a non-excited nucleus emits a proton [1]. The first proton emitter ^{151}Lu was found in 1981 [1], but only 12 proton radioactive nuclei were known prior to the present experiments. A DSSD [2] setup was installed at the the Fragment Mass Analyzer (FMA) [3] to provide an efficient detection system of proton activities. The operation of both the FMA and the DSSD are described more in detail in the references [2,3] and in the contribution of C. N. Davids elsewhere in these Proceedings.

The aim of the experiments was to reinvestigate the proton emitters ^{146,147}Tm [4], ^{160}Re and ^{156}Ta [5], and to search for a proton decay branch in ^{161}Re. The studied decays provided a test case for experimental setup before advancing to searches for new proton emitters like ^{166}Ir and ^{170}Au. The reactions that were used, the observed decay energies and the half lives are given in Table I. In general, the present experiment resulted improved statistics compared with the previous experiments. A previously unknown 50 % β–decay branch was found for ^{156}Ta. To search for the proton decay branch of ^{161}Re, the decays following the implantation of recoils with mass A = 161 were gated by the ^{161}Re proton decay daughter ^{160}W and the granddaughter ^{156}Hf α–decays in subsequent generations. In the resulting energy spectrum a peak appears at 1345 ± 13 keV. The proton decay half-life $T_{1/2} = 15^{+8}_{-4}$ ms agrees with the α–decay half-life of ^{161}Re. The proton decay branch 5 ± 2 % results in a partial proton decay half-life of 260^{+180}_{-80} ms. This corresponds to emission of a proton from $h_{11/2}$ orbital.

Table I

Nuclide	Ep [keV]	Eα [keV]	$T_{1/2}$	Production/Comments
^{147}Tm	1051 *)		559±26 ms	^{58}Ni (261MeV) + ^{92}Mo ,p2n
^{147m}Tm	1115±8 *)		390^{+93}_{-71} μs	^{58}Ni (261MeV) + ^{92}Mo ,p2n
^{146m}Tm	1118±7 *) 1120±4 †)		206±25 ms	^{58}Ni (290MeV) + ^{92}Mo ,p3n ^{58}Ni (279MeV) + ^{92}Mo ,p3n
^{146}Tm	1189±10 *)		62^{+19}_{-14} ms	^{58}Ni (290MeV) + ^{92}Mo ,p3n
^{160}Re	1258±4 †)	6545±14	637^{+90}_{-70} μs 739^{+220}_{-138} μs	^{58}Ni (300MeV) + ^{106}Cd ,p3n
^{156}Ta	1011±7 †)		105^{+58}_{-28} ms	^{160}Re α decay
^{161}Re	1345±13 †)	6244±5	15^{+8}_{-4} ms 13.2 ± 1.1 ms	^{58}Ni (300MeV) + ^{106}Cd ,p2n

†) Calibrated with respect to ^{147}Tm (1051.1±2.6) keV and ^{151}Lu (1232.9±2.0) keV [1]

*) Calibrated with respect to ^{147}Tm (1051.1±2.6) keV [1]

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