

Using for a bound dineutron in REACTION SF3=n2

(O. Gritzay, 2021-04-27)

The dineutron was predicted by A. B. Migdal ["Two interacting particles in the potential hole", Sov. J. Nucl. Phys., v. 16, p.238, 1973) to be formed as a bound particle under certain circumstances when an additional bound state appears, not existing in the perturbation theory. This bound state is interpreted as a single particle state for the two neutrons, or bound dineutron, located near the surface of some nucleus, beyond its volume but within its potential well.

At first this reaction channel was attempted to observe by I. M. Kadenko in 2016 ("Possible observation of the neutron in the $^{159}\text{Tb}(n, ^2n)^{158}\text{gTb}$ nuclear reaction", EPL, v. 114, p. 42001, 2016), but the cross section value was not determined through low statistic.

A new nuclear reaction channel on ^{197}Au with the neutron as a projectile and a bound dineutron (2n) as an ejectile in the output channel was experimentally observed. These results were published in the article "Statistically significant observation of and cross-sections for a new nuclear reaction channel on ^{197}Au with bound dineutron escape" by I. M. Kadenko, B. Biro and A. Fenyvesi, EPL, v. 131 p. 52001, 2020.

It is very difficult to find another experimental works (I could not do it), as this reaction channel has no special code, so I propose to use in REACTION SF3=n2 for a bound dineutron.

REACTION (79-AU-197(N,N2)79-AU-196-G,,SIG,,SPA)

ENTRY 32251
 SUBENT 32251001
 BIB
 TITLE Statistically significant observation of and cross-sections for a new nuclear reaction channel on ^{197}Au with bound dineutron escape
 AUTHOR (I.M.Kadenko,B.Biro,A.Fenyvesi)
 INSTITUTE (4UKRKGU,3HUNDEB)
 REFERENCE (J,EUL,131,52001,2020)
 #doi:10.1209/0295-5075/131/52001
 FACILITY (CYCLO,3HUNDEB) The MGC-20E cyclotron.
 INC-SOURCE (D-D) The energies of the deuterons were $E_d = 3.459$ MeV and $E_d = 3.523$ MeV. The energy spread of the analysed deuteron beam was $dE_d/E_d = 0.1\%$.
 DETECTOR (HPGE)
 METHOD (ACTIV)
 ANALYSIS It was estimated:
 The contribution of the $^{196}\text{Hg}(n, X)^{196}\text{Au}$ nuclear interference to the $^{196}\text{g Au}$ production was less than 1% (taking into account that the evaluated cross sections of the $^{196}\text{Hg}(n, X)^{196}\text{Au}$ reaction are 9.6 mb at $E_n = 6.0$ MeV and 24.5 mb at $E_n = 6.8$ MeV). The contribution of the $^{197}\text{Au}(n, 2n)^{196}\text{Au}$ reaction to the measured net areas of the gamma peaks observed at 332.983 and 355.983 keV energies is about $6 \cdot 10^{-4}\%$. The contribution of the $^{196}\text{Hg}(n, p)^{196}\text{g Au}$ nuclear reaction to $^{196}\text{g Au}$ production in the samples of gold via this nuclear reaction channel is about $1.4 \cdot 10^{-11}\%$.
 ERR-ANALYS (DATA-ERR) The main contributors for the total uncertainty were as follows.
 (ERR-1,,10.) Positioning of the stacks in front of the D2-gas target, $<10\%$.
 (ERR-2,,5.) Limited knowledge on the possible contribution of neutrons generated by the bombarding deuteron beam impinged on the Ta collimators, the Nb window foil and the W beam stop, $<5\%$.
 (ERR-S) Counting statistics.
 (ERR-3) Uncertainty of the detection efficiencies estimated for the counting geometry used at the HPGe detector at Atomki.
 The partial uncertainties were summed up in quadrature and then the square root of the sum was used for estimation of the total uncertainty.
 HISTORY (20210424C) UkrNDC
 ENDBIB
 NOCOMMON
 ENDSUBENT
 SUBENT 32251002
 BIB
 REACTION (79-AU-197(N,N2)79-AU-196-G,,SIG,,SPA)
 DECAY-DATA (79-AU-196-G,6.183D,DG,332.983,0.229,
 DG,355.684,0.87)
 SAMPLE Three Au foil samples (99.9 per cent by weight Au of chemical purity) 100 $\mu\text{-m}$ thick and 1.3 cm diameter putted in a closed cadmium cover of 0.51 mm wall thickness. The presence of Hg (0.1 wt%) with natural isotopic composition and minor Bi (<0.01 wt%) were detected as impurities.
 STATUS (TABLE) Tab.1 (p.52001-p5) in EPL,131,52001,2020.
 (SUPPL,32251004) Calculated neutron spectrum
 ENDBIB 9
 NOCOMMON 0 0

DATA		3	1
EN-MIN	EN-MAX	DATA	DATA-ERR
MEV	MEV	MB	MB
6.09	6.39	0.18	0.06

ENDDATA
ENDSUBENT
SUBENT 32251003
BIB 5 9
REACTION (79-AU-197(N,N2)79-AU-196-G,,SIG,,SPA)
DECAY-DATA (79-AU-196-G,6.7D, DG,355.684,0.87)
SAMPLE Three Au foils (99.9 per cent by weight Au of chemical purity)- two samples of 12.2 mm diameter and 150 mu-m thickness and one Au sample of the same diameter and 200 mu-m thickness stacked and covered by 1 mm thick cadmium shielding. The presence of Hg (0.1 wt%) with natural isotopic composition and minor Bi (<0.01 wt%) were detected as impurities.

STATUS (TABLE) Tab.1 (p.52001-p5) in EPL,131,52001,2020.
(SUPPL,32251005) Calculated neutron spectrum

ENDBIB 9
COMMON
ERR-S ERR-3
PER-CENT PER-CENT
22. 17.
ENDCOMMON

DATA		3	1
EN-MIN	EN-MAX	DATA	DATA-ERR
MEV	MEV	MB	MB
6.175	6.455	0.037	0.008

ENDDATA
ENDSUBENT
ENDENTRY