^{9}Be(^{70}Zn,^{69}Cuγ)   **2016Ku11**

2016Ku11: ^{69}Cu was produced via the single-proton removal from the primary beam ^{70}Zn. At RIKEN, the reaction was studied by impinging the ^{70}Zn beam at E=63.13 MeV/nucleon on a 101.46 mg/cm^2 ^{9}Be target at the entrance of RIPS spectrometer. Beam identification was done using a Si detector via the ΔE -time-of flight technique. The detector was later replaced by a plastic scintillator during the data taking to increase the implantation rate. The plastic scintillator provided start signal for the isomeric lifetime measurement. Four coaxial HPGe detectors were used to detect the γ-rays at θ=±135≈ and θ=±45≈ with respect to the beam axis. The ^{69}Cu nuclei were implanted on a 1 mm Cu foil positioned between the poles of an electromagnet that provided an external magnetic field of 0.50 T 1. Eγ, Iγ, mult, E(particle), particle-γ coin. were measured. Deduced $T_{1/2}$ using the time difference between the implantation and correlated γ-transitions, experimental time dependent perturbation function R(t), constructed by energy-gated time spectra, spin alignment α, and g-factor using Time-dependent Perturbed Angular Distribution (TDPAD) method.

The spin alignment α =−3.3 % 9 was measured for ^{69}Cu populated in single-nucleon removal reaction using the amplitude of the oscillating R(t) function and assuming E2 character for 189.7γ.

^{69}Cu Levels

E(level)[†]	J$^\pi$[‡]	T$_{1/2}$	Comments
0.0	3/2$^-$		
1212.80 25	(5/2)$^-$		
1710.62 20	7/2$^-$		
1870.73 17	7/2$^-$		
2180.84 22	9/2$^-$		
2550.95 19	(9/2$^+$)		
2666.56 24	11/2$^-$		
2740.6 10	(13/2$^+$)	351 ns 14	g=+0.248 9

T$_{1/2}$: From the time difference between the implantation and correlated γ-transitions in 2016Ku11. All the observed γ-ray transitions below the isomer were summed to produce the decay curve. The quoted uncertainty is statistical only.

g: From TDPAD method in 2016Ku11. Experimental R(t) function was fitted by the theoretical curve and χ^2-minimization was applied. The uncertainty quoted includes the statistical uncertainty 8 and the systematic uncertainty 5 due to the variation of the magnetic field at the target position. The authors of 2016Ku11 stated that the sign of the g-factor was determined from the sign dependence of the nuclear spin alignment as a function of the momentum distribution and the E2 character of 189.7γ. The + sign is also in agreement with the Shell Model calculations. Note that the g-factor of this state was measured using the same technique in the projectile fragmentation experiment, ^{9}Be(^{76}Ge,Xg) in 2002Ge16 .

Shell model calculations give g^{free}=+0.261 and g^{eff}=+0.226 using JUN45 interaction and g^{free}=+0.274 and g^{eff}=+0.236 using jj44b interaction. The wave function of the state is dominated by πp$^1_{3/2}$⊗νp$^1_{1/2}$g$^1_{9/2}$ and πp$^1_{3/2}$⊗νf$^4_{5/2}$p$^1_{1/2}$g$^3_{9/2}$.

† From least-squares fit to Eγ data by the evaluator.
‡ From 2014Ne01 as given by 2016Ku11.

γ(^{69}Cu)

E$_\gamma$[†]	I$_\gamma$[†]	E$_i$(level)	J$^\pi_i$	E$_f$	J$^\pi_f$	Comments
189.7	1000 1	2740.6	(13/2$^+$)	2550.95	(9/2$^+$)	Mult.: E2 from the R(t) function measured at θ = ±135°.
470.2 1	34.1 1	2180.84	9/2$^-$	1710.62	7/2$^-$	Mult.: M1 (2016Ku11).
485.7 1	59.0 1	2666.56	11/2$^-$	2180.84	9/2$^-$	Mult.: M1 (2016Ku11).

^{9}**Be(^{70}Zn,^{69}Cuγ)**　　**2016Ku11 (continued)**

γ(^{69}Cu) (continued)

E_γ[†]	I_γ[†]	E_i(level)	J_i^π	E_f	J_f^π	Comments
						I_γ: 2016Ku11 states that this transition is contaminated due to β-decay of ^{71}Zn.
657.6 4	5.3 1	1870.73	7/2$^-$	1212.80	(5/2)$^-$	Mult.: (M1) (2016Ku11).
680.2 1	128.7 2	2550.95	(9/2$^+$)	1870.73	7/2$^-$	Mult.: (E1) (2016Ku11).
956.2 4	12.0 2	2666.56	11/2$^-$	1710.62	7/2$^-$	Mult.: E2 (2016Ku11).
1212.6 3	9.1 1	1212.80	(5/2)$^-$	0.0	3/2$^-$	Mult.: (M1) (2016Ku11).
1710.6 2	33.2 2	1710.62	7/2$^-$	0.0	3/2$^-$	Mult.: E2 from the R(t) function measured at $\theta = \pm135^\circ$ (2016Ku11).
1870.7 2	132.8 2	1870.73	7/2$^-$	0.0	3/2$^-$	Mult.: E2 (2016Ku11).
2551.4 5	3.8 3	2550.95	(9/2$^+$)	0.0	3/2$^-$	Mult.: (E3) (2016Ku11).

[†] From 2016Ku11, with intensities normalized to Iγ(189.7)=100 by the evaluator.

^{9}Be(^{70}Zn,^{69}Cuγ)   2016Ku11

Level Scheme

Intensities: Relative I$_γ$

Legend

→	I$_γ$ < 2%×I$_γ^{max}$
→	I$_γ$ < 10%×I$_γ^{max}$
→	I$_γ$ > 10%×I$_γ^{max}$

${}^{69}_{29}$Cu$_{40}$