

Coulomb excitation [1980La01,2006Wi15,2012Ra03](#)

Type	Author	History	Citation	Literature Cutoff Date
Full Evaluation	Jun Chen, Balraj Singh		NDS 164, 1 (2020)	15-Feb-2020

- 1980La01:** this experiment consists of two parts. Part 1 (gamma spectroscopy): ($^{16}\text{O}, ^{16}\text{O}'\gamma$), $E=44.8$ MeV. Measured $E\gamma$, $I\gamma$, γ -ray yields, Q by reorientation effect. Part 2: (particle spectroscopy): ($^{16}\text{O}, ^{16}\text{O}'$): $E=36-37.2$ MeV. FWHM=100-130 keV. Data at $\theta=157.5^\circ$ and 172.5° . (α, α'), ($\alpha, \alpha'\gamma$): $E=8-9.5$ MeV. FWHM=30 keV. Measured γ and $\sigma(\text{inelastic})/\sigma(\text{elastic})$.
- 2006Wi15:** beam=289 MeV ^{98}Ru . Target= ^{27}Al . Measured $E\gamma$, $I\gamma$, $\gamma\gamma$ -coin using YRAST Ball array of seven Compton-suppressed EURISYS Clover Ge detectors at 90° to the beam axis. Deduced $B(E2)$ values. The cross sections were deduced using Winther-de Boer code for a thick target.
- 2012Ra03:** beam= ^{98}Ru at 300 MeV. Target= 0.7 mg/cm 2 ^{24}Mg . Gamma rays detected using the detector array SPEEDY with ten HPGe Clover detectors of the YRAST ball array. Measured $E\gamma$, $I\gamma$, $\gamma\gamma(\theta)$, lifetimes by RDM using Yale plunger device, deorientation. Deduced transition strengths.
- 2011Ch23:** measurement of g factor by transient-field technique in Coulomb excitation in inverse kinematics. Beam= 240 MeV ^{98}Ru produced by the Australian National University (ANU) 14UD Pelletron accelerator. Target= 0.4 mg/cm 2 thick carbon layer adhered to a 0.04 mg/cm 2 layer of copper on a 6.1 mg/cm 2 thick gadolinium foil with a 5.5 mg/cm 2 layer of copper evaporated on the back and an additional 4.5 mg/cm 2 copper foil behind to stop the beam. Cooled below 5 K to minimize the effect of beam heating and to maximize the magnetization of the gadolinium layer for the purposes of the transient field measurements. Used ANU Hyperfine Spectrometer, silicon photodiode, two HPGe and two NaI detectors.
- 2011Ta06:** beam= ^{98}Ru at 230 and 280 MeV. Targets: ^{26}Mg and ^{12}C layered with Gd and Cu, layers of Ta or Ni were used in between Gd and Cu for better adhesion. Measured g factor using transient-field perturbed angular correlation technique in Coulomb excitation in inverse kinematics. Absolute scale was determined relative to the g factor= $+0.39$ of the first 2^+ state in ^{106}Pd . External magnetic field of 0.073 T was applied to the Gd layer in which the spins of the excited Ru nuclei precessed due to the interacting magnetic moment and the transient hyperfine field. The γ rays emitted from the first 2^+ state were detected with four segmented Clover HPGe detectors placed at $\pm 67^\circ$ and $\pm 113^\circ$. The (particle) γ correlations were measured using Si detectors for particles. Measured spin precession angles. Deduced transient field strength.
- Others:
1977Ma41: ($\alpha, \alpha'\gamma$), $E=8.5$ MeV; ($^{16}\text{O}, ^{16}\text{O}'\gamma$) $E=33$ MeV; ($^{32}\text{S}, ^{32}\text{S}'\gamma$) $E=48$ MeV. Measured Q .
1969He11: ($^{16}\text{O}, ^{16}\text{O}'\gamma$) $E=33-38$ MeV. Measured g factor by IMPAC. See [1974Hu01](#) for reanalysis of these results.
1968Mc08: ($\alpha, \alpha'\gamma$) $E=10$ MeV and ($^{16}\text{O}, ^{16}\text{O}'\gamma$) $E=42-49$ MeV. Measured γ , $\gamma\gamma$, $\gamma(\theta)$.
1961St02: ($\alpha, \alpha'\gamma$) $E=10$ MeV.
1958St32: ($p, p'\gamma$) $E=1.5-3.3$ MeV and ($\alpha, \alpha'\gamma$) $E=8-10$ MeV.

 ^{98}Ru Levels

E(level) [†]	J^π [‡]	$T_{1/2}$	Comments
0.0	0^+		
652.40 10	2^+	5.79 ps 20	$B(E2)\uparrow=0.373$ 7 (1980La01); $Q=-0.20$ 9 (1980La01) $g=+0.44$ 3 $T_{1/2}$: measured by 2012Ra03 , using recoil-distance method. Others: 6.42 ps 13 from $B(E2)=0.373$ 7 and 6.2 ps 5 from $B(E2)=0.389$ 31 (1980La01), 5.8 ps +8-7 from $B(E2)=0.41$ 5 (1968Mc08), 5.0 ps +5-4 from $B(E2)=0.475$ 38 (1958St32). $B(E2)\uparrow$: from particle yield analyzed using $B(E2)$ for 4^+ and 2^+ levels as determined from γ -yield (1980La01). Others: 0.389 31 (1980La01), 0.41 5 (1968Mc08), average of 0.40 5 and 0.42 5), 0.475 38 (1958St32), all from thick-target γ -ray yield. Q : for constructive interference, $Q=-0.01$ 9 for destructive interference (1980La01). Other: -0.03 14 (constructive interference) (1977Ma41). g : weighted average of +0.408 32 (2011Ch23) and +0.47 3 (2011Ta06 , average of +0.48 3 and +0.47 2 with statistical uncertainty only, whereas the uncertainty including that in the absolute value is 0.03, arising mainly from the calibration value. Others: $g=0.30$ 17 (1969He11), 0.39 30 (1974Hu01 , reanalysis of data from 1969He11).
1322.1 10	0^+	3.7 ps +13-8	$T_{1/2}$: deduced by evaluators from weighted averaged $B(E2)(W.u.)=43$ 11. $B(E2)$ for this level studied by 2006Wi15 .
1397.8 5	4^+	1.60 ps 11	$B(E2)\uparrow=0.194$ 22

Continued on next page (footnotes at end of table)

Coulomb excitation 1980La01,2006Wi15,2012Ra03 (continued) ^{98}Ru Levels (continued)

<u>E(level)[†]</u>	<u>J^π[‡]</u>	<u>T_{1/2}</u>	<u>Comments</u>
1414.9 4	2 ⁺	1.18 ps 14	T _{1/2} : measured by 2012Ra03, using recoil-distance method. Others: 2.3 ps 3 from B(E2)=0.194 22 (1980La01), 1.7 ps +5-3 from B(E2)(W.u.)=53 10 (2006Wi15). B(E2)†: from 1980La01. T _{1/2} : measured by 2012Ra03, recoil-distance method using a plunger device. Others: 1.2 ps 4 from B(E2) values in 1980La01. B(E2)(from g.s.)=0.0067 11; B(E2)(from 652)=0.147 25 (1980La01). Other: B(E2)=0.0074 11 (1968Mc08).

[†] From a least-squares fit to γ -ray energies.

[‡] From Adopted Levels.

 $\gamma(^{98}\text{Ru})$

<u>E_i(level)</u>	<u>J_i^π</u>	<u>E_γ[†]</u>	<u>I_γ[†]</u>	<u>E_f</u>	<u>J_f^π</u>	<u>Comments</u>
652.40	2 ⁺	652.4 1	100	0.0	0 ⁺	Additional information 1. E _γ : rounded value from Adopted Gammas. B(E2)(W.u.)=36 18, 52 26, 42 21, and 49 25, for four different combinations of B(E2)(W.u.)(1414,2 ⁺ to 1320,0 ⁺)=1 or 0 (1 for first two B(E2) values and 0 for others) and the relative sign=same or opposite for interfering matrix elements for the excitation of the second 2 ⁺ state, respectively (2006Wi15). The weighted average is 43 11.
1322.1	0 ⁺	669.7		652.40	2 ⁺	
1397.8	4 ⁺	745.4 5	100	652.40	2 ⁺	Additional information 2. B(E2)(W.u.)=50 18, 59 21, 50 18, and 57 21, for four different combinations of B(E2)(W.u.)(1414,2 ⁺ to 1320,0 ⁺)=1 or 0 (1 for first two B(E2) values and 0 for others) and the relative sign=same or opposite for interfering matrix elements for the excitation of the second 2 ⁺ state, respectively (2006Wi15). The weighted average is 53 10.
1414.9	2 ⁺	762.5 5 1414.9 5	100 20 5	652.40 0.0	2 ⁺ 0 ⁺	I _γ : I _γ (1415γ)/I _γ (762γ)=50/100 in Adopted dataset.

[†] From figure 1 in 1980La01 (corresponding energy values given in the table 2 are slightly different), unless otherwise noted.

Coulomb excitation 1980La01,2006Wi15,2012Ra03Level Scheme

Intensities: Relative photon branching from each level

