

Study of Nuclear Structure by Electromagnetic Excitation with Accelerated Ions

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Reorientation measurements in ^{116}Sn and ^{124}Sn

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Abstract

The first 2^+ states of ^{116}Sn and ^{124}Sn have been studied by observing the γ -ray decay to the ground states, following Coulomb excitation with backscattered ^4He , ^{16}O and ^{32}S ions. The static electric quadrupole moment Q_{2+} of the 2^+ states and the reduced electric transition probability $B(E2, 0^+ \rightarrow 2^+)$ were obtained by interpreting the results in terms of the reorientation effect. The values of Q_{2+} found are $+0.09 \pm 0.13$ b for ^{116}Sn and -0.24 ± 0.15 b for ^{124}Sn . The measured $B(E2, 0^+ \rightarrow 2^+)$ values are $0.22 \pm 0.01 e^2 \cdot b^2$ for ^{116}Sn and $0.19 \pm 0.01 e^2 \cdot b^2$ for ^{124}Sn .

Quadrupole moments of 2^+ states of even tin isotopes*

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In high precision Coulomb excitation experiments α particles of 10.0, 10.5, and 10.6 MeV and ^{16}O ions of 42.0 and 46.0 MeV were used to excite the first 2^+ states in $^{112,116,118,120,122,124}\text{Sn}$. Static quadrupole moments $Q(2^+)$ and reduced quadrupole transition probabilities $B(E2; 0^+ \rightarrow 2^+)$ were extracted from intensities of particles elastically and inelastically scattered at angles near 173° into an annular detector. The values of $Q(2^+)$ are very small and consistent with 0.0 b. These results are in agreement with theoretical predictions based on pairing plus quadrupole forces.

[NUCLEAR REACTIONS $^{112,116,118,120,122,124}\text{Sn}(\alpha, \alpha')$, $E=10.0, 10.5, 10.6$ MeV, $^{112,116,118,120,122,124}\text{Sn}(^{16}\text{O}, ^{16}\text{O}')$, $E=42.0, 46.0$ MeV, measured $d\sigma/d\Omega$ for θ near 173° , deduced $Q(2^+)$, $B(E2; 0^+ \rightarrow 2^+)$. Enriched targets.]

I. INTRODUCTION

The discovery by de Boer *et al.*¹ of an unexpectedly large static quadrupole moment $Q(2^+)$ of the first $J^\pi = 2^+$ level in ^{114}Cd stimulated extensive experimental efforts to measure quadrupole moments of excited states in other nuclei. Measurement of

then normalized the relative values to their absolute determination of $Q(2^+)$ for ^{120}Sn from inelastic scattering and particle- γ coincidence measurements. A fundamental difficulty in these measurements was the determination of the relative efficiency of the γ ray detector as a function of γ ray energy. Therefore, measurement of $Q(2^+)$ for the

Coulomb Excitation of ^8Li

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We have observed the excitation of the first excited state ($E_x = 0.98$ MeV, $J^\pi = 1^+$) of the radioactive, neutron-rich nucleus ^8Li ($J_{\text{g.s.}}^\pi = 2^+$) from its inelastic scattering on $^{\text{nat}}\text{Ni}$ at $E(^8\text{Li}) \approx 14.6$ MeV. Cross sections measured out to large $\theta_{\text{c.m.}}$ agree well with Coulomb-excitation probabilities and have been used to deduce an $E2\uparrow$ transition rate for the $2_{\text{g.s.}}^+ \rightarrow 1^+$ excitation in $^8\text{Li}^*$. The latter [$B(E2\uparrow) = 55 \pm 15 e^2\text{fm}^4$] is large relative to nearby stable nuclei, but comparable to the neighboring neutron-rich nucleus ^{10}Be . The relevance of the data to predicted “neutron-halo” giant dipole resonances in unstable nuclear projectiles is considered.

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Coulomb Excitation of Radioactive $^{132,134,136}\text{Te}$ Beams and the Low $B(E2)$ of ^{136}Te

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The $B(E2; 0^+ \rightarrow 2^+)$ values for the first 2^+ excited states of neutron-rich $^{132,134,136}\text{Te}$ have been measured using Coulomb excitation of radioactive ion beams. The $B(E2)$ values obtained for $^{132,134}\text{Te}$ are in excellent agreement with expectations based on the systematics of heavy stable Te isotopes, while that for ^{136}Te is unexpectedly small. These results are discussed in terms of proton-neutron configuration mixing and shell-model calculations using realistic effective interactions.

PHYSICAL REVIEW C **84**, 061306(R) (2011)**One-phonon isovector $2_{1,MS}^+$ state in the neutron-rich nucleus ^{132}Te**

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The 2_2^+ state in ^{132}Te is identified as the one-phonon mixed-symmetry state in a projectile Coulomb excitation experiment presenting a firm example of a mixed-symmetry state in unstable, neutron-rich nuclei. The results of shell-model calculations based on the low-momentum interaction $V_{\text{low}-k}$ are in good agreement with experiment demonstrating the ability of the effective shell-model interaction to produce states of mixed-symmetry character.

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Some predictions for ^{134}Sn & ^{136}Sn

	^{134}Sn		^{136}Sn
	Expt	Calc	Calc
$B(E2:2_1^+ \rightarrow 0^+)$ [in W.u.]	1.4(2)	1.6	2.8
$B(E2:4^+ \rightarrow 2^+)$		1.7	0.83
$B(E2:6^+ \rightarrow 4^+)$	0.89(17)	0.82	0.12
$B(E2:2_2^+ \rightarrow 0^+)$		0.35	0.06
$B(E2:2_2^+ \rightarrow 2_1^+)$		2.93	1.8
$B(E2:2_2^+ \rightarrow 4^+)$		0.23	1.0
$B(M1:2_2^+ \rightarrow 2_1^+)$		0.02	0.09×10^{-2}
$Q(2_1^+)$ [in eb]		-0.02	-0.13
$Q(2_2^+)$		-0.03	+0.06
$\mu(2_1^+)$ [in nm]		-0.57	+0.46
$\mu(2_2^+)$		-0.25	+0.54



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Coulomb excitation with RIBs
Firenze, September 27-28, 2012



" It does not make any difference how beautiful your guess is - if it disagrees with experiment it is wrong. In that simple statement is the key to science."

(Richard Feynman)

...although there's always the option of playing with parameters.

From: J. N. Orce, Measurement of the sign of the quadrupole moment for the 2^+ in ^{10}Be , ECT* – Trento – October 29, 2010