Review

A RISING $g$-factor measurement of the $19/2^+$ isomer in $^{127}$Sn

L. Atanasova$^a$,∗, D.L. Balabanski$^b$, M. Hass$^d$, F. Becker$^e$, P. Bednarczyk$^e$, S.K. Chamoli$^d$, P. Doornenbal$^e$, G. Georgiev$^g$, J. Gerl$^e$, K.A. Gladnishki$^c$, M. Górska$^e$, J. Grebosz$^e$, F. Kmicik$^f$, S. Lakshmi$^d$, R. Lozeva$^a$, A. Maj$^f$, G. Neyens$^h$, M. Pfützner$^i$, G. Simpson$^j$, N. Vermeulen$^h$, H.J. Wollersheim$^e$ and the g-RISING Collaboration

$^a$Faculty of Physics, University of Sofia, BG-1164 Sofia, Bulgaria
$^b$INRNE, Bulgarian Academy of Sciences, BG-1784 Sofia, Bulgaria
$^c$Università di Camerino and INFN-Perugia, 62032 Camerino, Italy
$^d$Weizmann Institute of Science, Rehovot 76100, Israel
$^e$GSI, Planckstrasse 1, D-64291, Darmstadt, Germany
$^f$IFJ PAN, PL-31-342 Kraków, Poland
$^g$CSNSM, F-91405 Orsay Campus, France
$^h$IKS, K.U. Leuven, 3001 Leuven, Belgium
$^i$IEP, Warsaw University, PL-00-681 Warsaw, Poland
$^j$LPSC, 38026 Grenoble Cedex, France

Abstract

The $g$-factor of the $19/2^+ T_1/2 = 4.5(3)$ µs isomer in $^{127}$Sn, which was populated in relativistic projectile fragmentation, was measured within the g-RISING campaign at GSI, utilizing the time-differential perturbed angular distribution method. The deduced $g$-factor $|g| \approx 0.16$ is in agreement with theoretical estimates based on the empirical $g$-factors.

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* Corresponding address: Department of Atomic Physics, Faculty of Physics, University of Sofia, 5 James Bourchier Blvd, BG-1164 Sofia, Bulgaria. Tel.: +359 2 8161 834.

E-mail address: liliya@phys.uni-sofia.bg (L. Atanasova).

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The $g$-factor measurement of the 19/2$^+$, $T_{1/2} = 4.5(3)$ µs isomer in $^{127}$Sn [1,2] aims at a study of the structure of the neutron-rich nuclei in the vicinity of the doubly-magic $^{132}$Sn. The experiment was done in relativistic projectile fragmentation of a $^{136}$Xe beam at $E/A = 600$ MeV on a thin Be production target within the RISING (Rare ISotope INvestigations at GSI) project [3] at the GSI laboratory, Germany. The fully-stripped ions were separated, tracked and identified on an event-by-event basis. They were implanted in a high-purity Cooper plate, which provided a perturbation-free environment for the isomeric decay. Ion–γ coincidences were recorded and analyzed with the CRACOW software [4]. The experimental set-up is discussed in detail in [5].

The Time-Differential Perturbed Angular Distributions (TDPAD) method, based on the measurement of the Larmor precession of a spin-oriented nuclear ensemble in an external magnetic field $B$, was applied; the Larmor frequency $\omega_L = -\frac{g\mu_N B}{\hbar}$ is measured in the experiment. The magnitude and sign of alignment of the ensemble depend on the longitudinal momentum distribution [6] of the fragments. In order to preserve the orientation produced in the reaction, fully-stripped ions are separated at relativistic energies. Note that ions heavier than $A = 80$ produced and separated as fully-stripped fragments are available only at GSI.

To extract the $g$-factor, the $\gamma$-decay time spectra, measured at ±45° and ±135° with respect to the beam axis in a horizontal plane, were combined and compared with the theoretical $R(t)$ function, $R(t, \omega_L) = \frac{3a_2}{4+a_2} \sin(2\omega_L t)$, where $a_2$ depends on details of the $\gamma$ decay and the amount of orientation. The $R(t)$ functions of the 1095 and 715 keV $\gamma$-rays for the outmost wing of the momentum distribution are presented in Fig. 1. They are out of phase, which is in disagreement with the published level scheme [1]. For the $R(t)$ function of the 715 keV transition $\sim 10^4$ photopeak events were used in the data analysis, which sets a limit for such experiments.

Fig. 1. Left: $R(t)$ functions for the 1095 keV transition (up) and for the 715 keV transition (down) at the wing of the momentum distribution. Right: partial level scheme of $^{127}$Sn, revealing the decay of the 19/2$^+$ isomer [1].
The deduced value of the $g$-factor, $|g| \approx 0.16$, is in agreement with theoretical expectations based on the empirical $g$-factors, which yield a value $g(s_{1/2}^{-1/2}h_{11/2}^{-2}) \approx -0.156$ for the main component of the wave function, and with large-scale shell model calculations. These results will be discussed in detail elsewhere [7].

First results from the $g$-RISING campaign for the $g$-factor of the $19/2^+$ isomer in $^{127}$Sn from relativistic fragmentation demonstrate that significant alignment ($\sim 10\%$) is observed in the outmost wing of the momentum distribution. The present experiment provides a benchmark (in terms of intensity of the isomer beam and number of detected $\gamma$-rays) for further studies of electromagnetic moments of isomers in nuclei yet farther away from stability.

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