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Spins and g-factors of Mn isotopes near N = 40: Significance of proton and neutron excitations in ground and isomeric states

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The neutron-rich Mn isotopes (Z = 25) were studied using bunched-beam collinear laser spectroscopy at ISOLDE, CERN. In this experiment, the hyperfine spectra of the 57-64Mn ground states and the isomeric states in 58,60,62Mn were measured for the first time. From these spectra the spins and g-factors could be model-independently extracted, providing valuable nuclear structure information up to N = 39.

Previously all spins beyond N = 33 were only tentatively assigned. By our direct measurement we firmly establish a I = 5/2 ground state spin for 59,61,63Mn and a I = 1 low-spin state and I = 4 high-spin state in 58,60,62,64Mn. The high-spin state in 64Mn could not be measured due to its short half-life.

As a result of their sensitivity to the nuclear configuration, g-factors offer an important tool for understanding the rapid shell structure evolution in the region south of 68Ni (Z < 28, N ≈ 40).
A comparison of our experimental results with shell model calculations performed with the GXPF1A [1] and LNPS [2] effective interactions illustrates that an adequate description of neutron-rich Mn requires neutron excitations across N = 40. In addition, proton excitations across Z = 28 become increasingly important towards N = 40.

[1] M. Honma et al., Eur. Phys. J A 25, 499 (2005)
[2] S. Lenzi et al., Phys. Rev. C. 82, 054301 (2010)

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