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Precise Nuclear Moments of Extremely Proton-Rich Nuclei 23Al

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Nuclear magnetic moment μ and the electric quadrupole moment Q of the ground state of 23Al have been measured precisely by the β-NMR/NQR technique.

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Summary

The one-proton-separation energy of 23Al is very small (125 keV) and so 23Al is expected to have an exotic structure. Recently, a large reaction cross section of 23Al at the intermediate energy (~36A MeV) was reported [1,2] and that indicated the possibility of the proton-halo structure of 23Al. In previous work, we successfully obtained NMR signal of 23Al in a Si single crystal which had enough precision to determine the spin and parity of the ground state as Iπ = 5/2+ [3]. In present work, we have remarkably improved the precision of μ(23Al) and have obtained the quadrupole coupling constant eqQ of 23Al in Al2O3 for the first time to discuss details of the nuclear structure.
Experiment was performed at RIKEN Nishina Center. Unstable 23Al beam were produced through high-energy nuclear collisions of 100A MeV 24Mg12+ ions and 9Be. The nuclear spin polarization of 23Al were produced by restriction of the outgoing momentum and the emission angle relative to the primary beam by utilizing the projectile-fragment separator RIPS at RIKEN. After the separation, the polarized 23Al ions (~ 90% purity) were implanted into single crystals of Si and α-Al2O3 for the μ and Q measurements, respectively. By use of the β-NMR/NQR method at the room temperature, we have precisely determined the μ moment as |μ| = 3.8881(14) μN, and Q moment as |Q| = 168(10) mb as shown in Fig. 1 together with the best-fit-shape function. From the results, we will discuss the possible nuclear structure of 23Al by comparison with the mirror nuclei 23Ne and the other nuclei which locates around 23Al such as 22Mg that is known to have well-deformed structure.

References
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