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Exploring the N=20 island of inversion through lifetime measurements

The region around ^{32}Mg has become a focus of nuclear structure studies due to the disappearance of the $N = 20$ shell closure, giving rise to a so-called island of inversion. As a result of multi-nucleon correlations, the isotopes in this region exhibit ground states dominated by $2p-2h$ excitations into the fp shell, deviating from the predictions of a harmonic oscillator potential combined with spin-orbit interaction. ^{34}Si is located only two protons above ^{32}Mg, yet it displays properties characteristic of a doubly magic nucleus and is considered the last even-even isotope at the edge of the island of inversion. Previous studies have revealed the presence of intruder states among the excited states of ^{34}Si and other isotopes along the $N = 20$ line. However, the intruder band remains unseen in ^{35}P.

The measurement of nuclear lifetimes, along with the determination of reduced transition probabilities, provides a sensitive method for probing the nature of nuclear states. Knowledge of the transition probabilities for low-lying excited states in isotopes located at the edge of the island of inversion is crucial for assessing the interplay of spherical and intruder configurations in this region, and the shell evolution towards the island of inversion.

An experiment was performed at the Legnaro National Laboratories (LNL) aiming to measure the lifetimes of excited states in ^{35}P, ^{34}Si, and other isotopes in the region. The measurement was performed using the Doppler Shift Attenuation Method (DSAM). The isotopes of interest were produced through multi-nucleon transfer reactions between a ^{36}S beam and a ^{208}Pb target. The set-up consisted of the AGATA high-purity germanium array and the PRISMA spectrometer, used to identify the recoiling nuclei. The precise Doppler correction allowed by this setup provided the sensitivity needed to measure lifetimes within the range of tens to hundreds of femtoseconds.

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