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Neutron-Proton Coupling and the Lifetime of the First Excited State in ^{16}C[1]

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Nuclei near the valley of β-stability have strongly correlated proton and neutron spatial distributions. This need not be the case for nuclei with a large excess of one nucleon type and the search for new phenomena and structure effects due to the "decoupling" of neutrons and protons is of great interest in nuclear structure physics. Cited examples of decoupled behavior include neutron-halo nuclei with measurably different proton and neutron radial distributions, and low-energy dipole modes such as "pygmy" resonances where, simplistically, a core of equal numbers of protons and neutrons oscillates against the excess neutron "skin"'. Recently, another example was suggested to occur in ^{16}C where the measurement of an anomalously quenched B(E2;$2^+ \rightarrow 0^+$) value of 0.63 e^{2}fm^4 combined with a large nuclear deformation led to the suggestion that the ^{16}C valence neutrons were decoupled from its near-spherical proton core (N.Imai et al., PRL 92 (2004) 062501; Z.Elekes et al., PLB 586 (2004) 34; H.J.Ong et al., PRC 73 (2006) 024610). In this talk I will discuss a new lifetime measurement for the first-excited 2^+ state in ^{16}C carried out at the LBNL 88-Inch Cyclotron using the Recoil Distance Method and ^{9}Be(^{9}Be,2p) fusion-evaporation reaction. The mean lifetime was found to be 11.7(20) ps corresponding to a B(E2) of 4.15(73) e^{2}fm^4, consistent with other even-even closed shell nuclei and neighboring systematics. Our result does not support the interpretation of decoupled protons and neutrons in ^{16}C. The revised value provides an important benchmark for theory. Time permitting I will present results on the neutron-rich nucleus ^{30}Ne produced in a 2p knockout reaction performed at the NSCL using the S800 spectrometer and SeGA gamma-ray detector. The measured (quenched) 2p knockout cross-section, when compared to theory, suggests a significant difference in the neutron intruder content between ^{32}Mg and ^{30}Ne, contrary to current shell models.

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