Measurement of the radiative width of the 12.71-MeV level in ^{12}C

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The ground-state magnetic dipole transition width of the 1^+ level at 12.71 MeV in ^{12}C has been measured to be 0.35 ± 0.05 eV. This value is used to calculate the total width of the level based on a previous measurement of the relative ground-state γ width. A total width of 14.6 ± 2.6 eV is thus calculated. A model-dependent measurement of the isospin mixing between this level and the 15.11-MeV level yields the values $\beta = 0.19 \pm 0.01$ or 0.05 ± 0.01.

[NUCLEAR REACTION $^{12}C(e,e')$ $p = 50.5$ MeV/c; levels measured $\Gamma(\Lambda)$; deduced isospin mixing.]

Recent experiments[1-4] attempting to measure the isospin mixing between the 1^+ doublet at 12.71 and 15.11 MeV in ^{12}C are in significant disagreement as to the extent of this mixing. Theoretical considerations[5] have been offered in an effort to resolve this disagreement. A measurement of the radiative width of the predominantly $T = 0$ level at 12.71 MeV will further contribute to this effort by furnishing an additional, albeit model-dependent, measurement of the isospin mixing between these levels. Accordingly we have measured the spectrum of electrons inelastically scattered at 180° from ^{12}C using the electron beam from the Naval Research Laboratory at 50.5-MeV/c incident momentum. The spectrum is shown in Fig. 1. In addition to the strongly excited 1^+ $T = 1$ level at 15.11 MeV, the level at 12.71 MeV is seen to be excited.

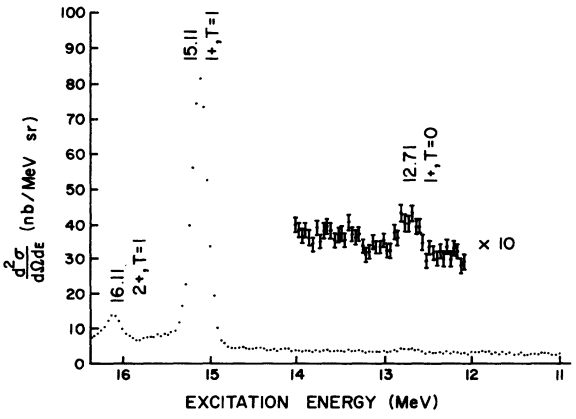

FIG. 1. Spectrum of electrons inelastically scattered at 180° from ^{12}C.

The relative cross sections of these levels are found to be $(1.72 \pm 0.25) \times 10^{-2}$. The radiative width of the 12.71-MeV level relative to that of the 15.11-MeV level is determined by the relative cross sections with corrections for the differences in excitation energy and momentum transfer made in the plane-wave approximation.[6] From the recently measured value of the radiative width of the 15.11-MeV level of 37.0 ± 1.1 eV,[7] we thus determine the ground-state width of the 12.71-MeV level to be 0.35 ± 0.05 eV. The relative ground-state widths of these levels as measured in the present experiment agree with the rough estimate of 1% of Spamer.[8]

From the relative ground-state γ-ray width of the 12.71-MeV level measured by Reisman, Connors, and Marion,[2]

$$\frac{\Gamma_{\gamma 0}}{\Gamma} = 0.024 \pm 0.003 ,$$

the total width of the 12.71-MeV level is then determined as 14.6 ± 2.8 eV.

The value of $\Gamma(M1)$ for the level at 12.71 MeV of 0.35 ± 0.05 eV measured in the present experiment is significantly in excess of realistic predictions[9,10] of the isoscalar $M1$ width of this level, the latter being typically 0.1 eV. This excess is suggestive of an isovector admixture in the 12.71-MeV level. Assuming

$$|\psi\rangle_{12.71} = (1-\beta^2)^{1/2} |\psi\rangle_{T=0} + \beta |\psi\rangle_{T=1} ,$$

then

$$\Gamma(M1)_{12.71} \propto (E_{12.71})^3 |(1-\beta^2)^{1/2} M_{T=0} + \beta M_{T=1}|^2 ,$$

where $M_{T=0}$ and $M_{T=1}$ are the isoscalar and isovec-

tor magnetic dipole reduced matrix elements. Assuming the theoretical estimate of $\Gamma(1) = 0.113$ eV of Cohen and Kurath[9] (as quoted in Ref. 2) for the isoscalar $M1$ width, and using the measured value of 37.0 eV of the 15.11-MeV level, values of $M_{T=0}$ and $M_{T=1}$ were deduced. Taking the measured value of $\Gamma(M1)_{12.71} = 0.35 \pm 0.05$ eV measured in the present experiment, we solve for β.

Accordingly $\beta = 0.194 \pm 0.011$ or 0.054 ± 0.011, depending upon the relative signs of $M_{T=0}$ and $\beta M_{T=1}$. The value of $\beta = 0.054$, while roughly consistent with the upper limits given by van der Woude *et al.*[3] and by Artemov *et al.*,[4] is significantly smaller than the value of $\beta = 0.11$ measured by Braithwaite *et al.*[1] It should be emphasized, however, that the value of β here derived is dependent upon the assumed value of the isoscalar magnetic dipole matrix elements.

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