$B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$ in ^{18}Ne and isospin purity in $A=18$ nuclei

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The $0^+_{\mathrm{g.s.}}\rightarrow 2^+_1$ excitation in the proton-rich nucleus ^{18}Ne has been studied via intermediate energy heavy-ion scattering with a beam of this radioactive isotope. The observed γ-ray yields have been combined with coupled channels calculations of the inelastic scattering reactions to obtain the electromagnetic matrix element $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$. This result is combined with the corresponding results in the mirror nucleus ^{18}O and the $T=1$ states in the $N=Z$ nucleus ^{18}F as a test of isospin purity.

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The degree to which the isospin symmetry is violated in nuclei in the vicinity of $A=18$ has been shown to play an important role in the understanding of Coulomb energies [1], β-decay matrix elements [2], and nuclear interaction symmetries [3]. Bernstein, Brown, and Madsen [4] pointed out that isospin purity in a $T=1$ multiplet can be tested by comparing corresponding electromagnetic transitions in three members of the multiplet. A systematic study of $0^+\rightarrow 2^+$ transitions in the $T=1$ multiplet of the $A=18$ system provides one example: The isoscalar multipole matrix element M_0 for this transition can be obtained from a comparison of the proton multipole matrix elements M_p in the $|T_z|=1$ mirror nuclei ^{18}O and ^{18}Ne. The relationship between M_p and the reduced electromagnetic matrix element $B(E2;0^+\rightarrow 2^+)$ is given by the equation

$$M_p=[B(E2;0^+\rightarrow 2^+)/e^2]^{1/2}. \qquad (1)$$

If isospin symmetry is satisfied, then the value of M_0 obtained via the comparison of ^{18}O and ^{18}Ne should be equal to that extracted from the $0^+\rightarrow 2^+$ transition between $T=1$ states in the $T_z=0$ nucleus ^{18}F. An analysis of $T=1$ isospin multiplets for $A=22-42$ recently reported by Cottle *et al.* [5] found suggestions of strong isospin symmetry breaking in the $A=34,38,42$ systems.

While the $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$ value in ^{18}O is known with considerable precision, the situation is quite different in the mirror nucleus ^{18}Ne. A measurement of the $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$ electromagnetic matrix element in ^{18}Ne was performed by McDonald *et al.* [6] using the Doppler shift attenuation method (DSAM) with the ^{3}He(^{16}O,n) reaction and the ^{3}He implanted in a nickel foil. They arrived at a result of $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)=260\pm 25e^2$ fm^4 ($M_p=16.1\pm 0.8$ fm^2). However, results from pion scattering measurements on ^{18}O [7] appear to disagree with the conclusion of McDonald *et al.* Under the assumption of isospin symmetry, M_p for a transition in one nucleus should be equal to M_n for the corresponding transition in the mirror nucleus. A comparison of ^{18}O($\pi^+,\pi^{+\prime}$) and ^{18}O($\pi^-,\pi^{-\prime}$) reactions yielded $M_n=12.4\pm 0.7$ fm^2 for ^{18}O (assuming the ''modified collective model'' analysis in Ref. [7]). The authors of Ref. [4] warn that a comparison of M_n in ^{18}O and M_p in ^{18}Ne must take into account that the valence protons in ^{18}Ne are less bound than the valence neutrons in ^{18}O. They prescribe that for the $0^+_{\mathrm{g.s.}}\rightarrow 2^+_1$ transition in ^{18}Ne the M_n value should be adjusted upward by 10% before comparison. Nevertheless, the pion scattering measurement yields a value of $M_p=13.6\pm 0.8$ fm^2 [corresponding to $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)=186\pm 23e^2$ fm^4] for ^{18}Ne.

To study the isospin purity of the $A=18$ system and resolve the apparent conflict in the experimental results for the electromagnetic matrix element $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$ in ^{18}Ne, we measured this value using a beam of radioactive ^{18}Ne ions in an intermediate energy heavy-ion scattering reaction. We also measured $B(E2;0^+_{\mathrm{g.s.}}\rightarrow 2^+_1)$ in the mirror nucleus ^{18}O using the same experimental arrangement so that this result could be compared with the well-known experimental value. A review of the experimental technique used in the present study is given in Ref. [8].

The experiments were performed at the National Superconducting Cyclotron Laboratory. The primary beam of 80 MeV/nucleon ^{20}Ne was produced with the laboratory's K1200 cyclotron. The secondary beams were made via fragmentation of the primary beam in a 202 mg/cm^2 ^{9}Be production target located at the mid-acceptance target position of the A1200 fragment separator [9]. The ^{18}Ne and ^{18}O secondary beams had energies of 65 and 50 MeV/nucleon, respectively. Separation of beam isotopes was enhanced with a 130 mg/cm^2 ^{27}Al achromatic wedge placed at the second dispersive image of the A1200. The momentum acceptance of the A1200 was limited to 0.5% by slits located at the first dispersive image.

A 350 mg/cm^2 ^{197}Au foil was used as the secondary target. The secondary beams slowed significantly in this target, and the mid-target beam energies for ^{18}Ne and ^{18}O were 60 and 46 MeV/nucleon, respectively. The secondary beams

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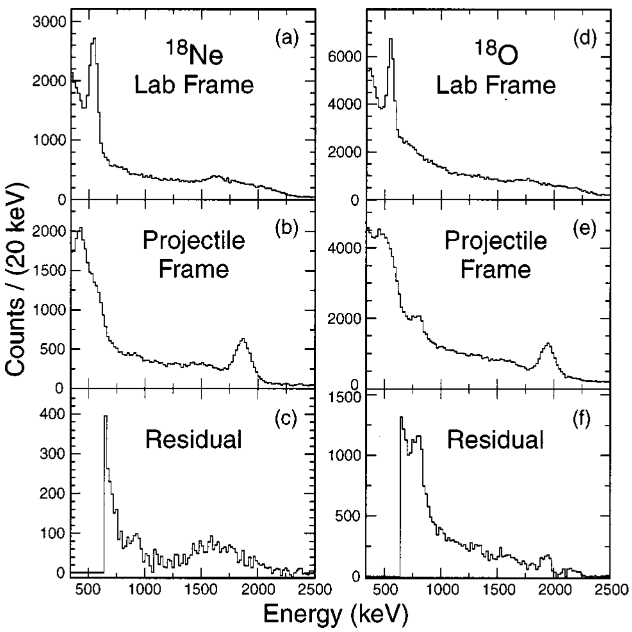

FIG. 1. In-beam photon spectrum gated on ^{18}Ne (left) and ^{18}O (right). The top panels show the spectra without Doppler correction as measured in the laboratory with the $7/2^+ \rightarrow 3/2^+$ transition in the gold target visible as a peak. The center panels show the spectra after event-by-event Doppler correction in the projectile frame. The bottom panels show the Doppler corrected spectra after subtraction of GEANT simulations described in the text.

were stopped in a cylindrical fast/slow plastic phoswich detector located at zero degrees. Both energy loss in the phoswich detector and time of flight relative to the cyclotron RF signal were used for particle identification. The zero degree detector subtended the scattering angles of 0° to 4° in the laboratory. The beam rates recorded in the zero degree detector for both ^{18}Ne and ^{18}O beams were 20 000 particles per second.

The γ rays were detected in an angular range of $56.5° - 123.5°$ in the laboratory by an array of ten position sensitive NaI(Tl) detectors. A description of the array and details of the analysis of γ-ray spectra can be found in Ref. [10]. The γ-ray spectrum measured in coincidence with beam particles identified as ^{18}Ne in the zero degree detector appear in Fig. 1. In Fig. 1(a), the laboratory frame spectrum (uncorrected for the Doppler shift of the projectile, which has $v/c = 0.34$) is shown. The 547 keV $7/2^+ \rightarrow 3/2^+_{\text{g.s.}}$ γ-ray in the ^{197}Au target nucleus appears strongly in this spectrum. The Doppler-corrected (projectile-frame) spectrum is shown in Fig. 1(b). The 1887 keV $2^+_1 \rightarrow 0^+_{\text{g.s.}}$ transition in ^{18}Ne is clearly evident. No other discernible peaks appear in this spectrum.

A cross section (integrated over the scattering angles 0° to 4°) of 45 ± 6 mb is obtained for producing the 1887 keV γ ray in ^{18}Ne, assuming a γ-ray angular distribution corresponding to a pure $E2$ transition. It is important to note that this γ-ray production cross section may not be identical to the cross section for directly exciting the 2^+_1 state in the scattering reaction, since this state can be fed by γ decays from higher-lying states. In particular, it is possible that the 2^+_2 state at 3613 keV is significantly populated in the present scattering reaction since the corresponding 2^+_2 state in the mirror nucleus ^{18}O is strongly populated in proton and neutron scattering reactions [11], in electron scattering [12], and in pion scattering [7]. In addition, $91 \pm 2\%$ of the γ decays from the 3613 keV state in ^{18}Ne deexcite to the 2^+_1 state via a 1726 keV transition [13]. However, the 1726 keV γ-ray cannot be seen in the projectile frame spectrum in Fig. 1. We studied the projectile frame spectrum using the computer simulation code GEANT [14] to determine an upper limit on the production cross section for the 1726 keV γ ray. The GEANT simulation of the response of the NaI(Tl) array took into account the observed cross section for the 1887 keV transition and an exponential background extrapolated from the background observed at energies above the 1887 keV peak. We obtained an upper limit of 10 mb for the cross section for producing the 1726 keV peak. When this is combined with the observed cross section of 45 ± 6 mb for producing the 1887 keV γ ray, we arrive at a cross section of 40 ± 11 mb for directly populating the 2^+_1 state.

To analyze the scattering cross sections while accounting for both the Coulomb and nuclear contributions to the reactions, we used the coupled channels code ECIS88 [15]. The analyses were performed assuming the midtarget beam energies. We do not have elastic scattering data for the present reaction, so we adopted optical model parameters determined in other studies of intermediate energy heavy-ion scattering. In particular, we analyzed our data using the optical model parameters of Mermaz *et al.* [16] from their study of the scattering of ^{16}O from ^{208}Pb at a laboratory energy of 49.5 MeV/nucleon, and the parameters of Barrette *et al.* [17] obtained for the scattering of ^{17}O from ^{208}Pb at a laboratory energy of 84 MeV/nucleon. A comparison of the results we obtained using these two parameters sets provides some understanding of their model dependence. The standard vibrational form factor was used. Cross sections for multiple excitations in intermediate energy heavy-ion scattering are generally negligible [8], so we only considered single-step excitations here.

There are two coupling strengths (dynamic deformation parameters) involved in the ECIS calculations. The first, the "Coulomb deformation" β_C, reflects the deformation of the proton fluid in the nucleus and corresponds to the electromagnetic matrix element $B(E2;0^+_{\text{g.s.}} \rightarrow 2^+_1)$. The quantities $B(E2;0^+_{\text{g.s.}} \rightarrow 2^+_1)$ and β_C are related via the equation [18]

$$\beta_C = \frac{4\pi}{3ZR_0^2}[B(E2;0^+_{\text{g.s.}} \rightarrow 2^+_1)/e^2]^{1/2}, \qquad (2)$$

where the radius R_0 is given by $R_0 = r_0 A^{1/3}$ and we take $r_0 = 1.20$ fm.

The second deformation parameter in the calculation is the "nuclear deformation parameter" β_N. While the Coulomb deformation parameter is used to calculate the electromagnetic interaction between target and projectile, the nuclear deformation parameter is used in the nuclear potential to determine the matter interaction. To set β_N for the ECIS calculation, we adopt the prescription of Ref. [19]

which takes into account not only the difference between the charge and matter deformations but also the sensitivity of the particular probe used in the measurement. In this prescription, the deformation length $\delta_F=\beta_F R$ for an experimental probe F (where R is the nuclear radius $R=r_0A^{1/3}$) is given by

$$\frac{\delta_F}{\delta_p}=\frac{1+(b_n^F/b_p^F)(M_n/M_p)}{1+(b_n^F/b_p^F)(N/Z)}, \qquad (3)$$

where $b^F_{n(p)}$ is the external field interaction strength of the probe F with neutrons (protons) in the nucleus to be studied. When F is an electromagnetic probe, the ratio $b_n^F/b_p^F=0$, since the probe is sensitive only to the charge density and not to the neutron density. For low-energy proton scattering (<50 MeV), $b_n^F/b_p^F=3$ and for low-energy neutron scattering $b_n^F/b_p^F=1/3$ [19]. In the present case, the probe F is ^{197}Au, which contains both protons and neutrons. To extract b_n^F/b_p^F for ^{197}Au, we start from the assumption that

$$b^F_{n(p)}=Z_F b^p_{n(p)}+N_F b^n_{n(p)}, \qquad (4)$$

where Z_F and N_F are the proton and neutron numbers of the probe F, respectively. This assumption gives

$$\frac{b_n^F}{b_p^F}=\frac{Z_F b_n^p+N_F b_n^n}{Z_F b_p^p+N_F b_p^n}, \qquad (5)$$

which yields $b_n^F/b_p^F=0.820$ for ^{197}Au.

The ECIS analysis of the $0^+_{\rm g.s.}\to 2^+_1$ excitation in ^{18}Ne includes two parameters, β_C and β_N. However, we can use the results of a recent measurement of low energy proton scattering on ^{18}Ne in inverse kinematics [20,21] to constrain the value of β_N for the present experiment so that there is only one free parameter to fit, β_C. The coupled channels analysis of the ^{18}Ne(p,p') data using the standard vibrational form factor [20] yielded $\beta_{(p,p')}=0.46\pm0.04$ and $\delta_{(p,p')}=1.33\pm0.12$ fm. If the ratio $b_n^F/b_p^F=3$ for low-energy proton scattering is used in Eq. (3), then the value of β_N for the present heavy ion reaction can be calculated from $\beta_{(p,p')}$ and an assumed value of β_C. This technique then gives us a way to perform a fit to the present cross section data that has only one parameter, β_C. With the optical model parameters of Mermaz *et al.*, we obtain $\beta_C=0.450\pm0.036$ (and $\beta_N=0.481\pm0.039$). With this result for β_C and equation 1, we obtain $B(E2;0^+_{\rm g.s.}\to 2^+_1)=113\pm18e^2$ fm^4, corresponding to $M_p=10.6\pm0.9$ fm^2. [The uncertainty in the $\beta_{(p,p')}$ value gives an uncertainty in the $B(E2;0^+_{\rm g.s.}\to 2^+_1)$ result of only 2.4%. Hence, the $B(E2;0^+_{\rm g.s.}\to 2^+_1)$ uncertainty is dominated by the other sources of error]. Using the optical model parameters of Barrette *et al.* instead, we obtain $\beta_C=0.496\pm0.040$ ($\beta_N=0.503\pm0.040$), giving $B(E2;0^+_{\rm g.s.}\to 2^+_1)=137\pm22e^2$ fm^4, corresponding to $M_p=11.7\pm0.9$ fm^2.

While we have set the value of b_n^F/b_p^F for ^{197}Au using a simple algorithm, uncertainties in this parameter introduce only small uncertainties in the final result for $B(E2{:}0^+_{\rm g.s.}\to 2^+_1)$ in ^{18}Ne. If we repeat the analysis assuming that ^{197}Au is an isoscalar probe ($b_n^F/b_p^F=1$), then the result for $B(E2{:}0^+_{\rm g.s.}\to 2^+_1)$ in ^{18}Ne increases by 0.4%.

We now examine our measurement of ^{18}O to assess the reliability of the present study of ^{18}Ne. The energy of the $2^+_1\to 0^+_{\rm g.s.}$ transition in ^{18}O is 1982.1 keV, and the peak in the ^{18}O γ-ray spectrum at that energy [Fig. 1(e)] yields a cross section of 29 ± 5 mb. However, as in the case of ^{18}Ne the 2^+_1 state in ^{18}O is fed by higher lying 2^+ states that are populated strongly in other scattering reactions. A careful study of the ^{18}O γ-ray spectrum using GEANT reveals peaks corresponding to transitions deexciting the 2^+_2 and 2^+_3 states. Both these states deexcite to the 2^+_1 state, so the cross section for producing the $2^+_1\to 0^+_{\rm g.s.}$ γ ray must be adjusted for feeding to obtain the cross section for direct excitation of the 2^+_1 state. In particular, the cross sections for producing γ rays corresponding to the $2^+_2\to 2^+_1$ and $2^+_3\to 2^+_1$ transitions must be subtracted from the $2^+_1\to 0^+_{\rm g.s.}$ cross section.

When an exponential background and a simulated 1982 keV peak are subtracted from the projectile-frame γ-ray spectrum for ^{18}O [Fig. 1(f)], two peaks become apparent. The first is the 1938.4 keV $2^+_2\to 2^+_1$ γ-ray. The analysis of this peak leads to a cross section of 4.0 ± 0.6 mb for producing it. The second peak is the 1334.4 keV $2^+_3\to 2^+_2$ γ ray, for which the production cross section is 1.4 ± 0.3 mb. We need the cross section for the 3272.7 keV $2^+_3\to 2^+_1$ γ ray, which is not observed because of the low efficiency of the detector system at that energy, to complete the feeding analysis for the 2^+_1 state. We can obtain that cross section with previously measured branch ratios [13] for the 2^+_3 state and the $2^+_3\to 2^+_2$ γ-ray cross section reported here. With the $55.9\pm1.0\%$ branch for the $2^+_3\to 2^+_1$ transition and the $8.7\pm0.4\%$ branch for the $2^+_3\to 2^+_2$ transition, we obtain a cross section of 9.0 ± 2.2 mb for the $2^+_3\to 2^+_1$ γ-ray. Adjusting the $2^+_1\to 0^+_{\rm g.s.}$ γ ray cross section for feeding, we arrive at a result of 16 ± 5 mb for direct population of the 2^+_1 state.

We can compare our measured cross section for directly populating the 2^+_1 state in ^{18}O to values calculated using the results of a pion scattering study of ^{18}O [7] and the two optical model parameter sets adopted here. In the pion scattering study, comparisons of the cross sections for exciting the 2^+_1 state in the ^{18}O$(\pi^+,\pi^{+\prime})$ and ^{18}O$(\pi^-,\pi^{-\prime})$ reactions at 164 MeV yielded values of M_p and M_n for the $0^+_{\rm g.s.}\to 2^+_1$ excitation; here we adopt the M_p and M_n results obtained in Ref. [7] using the ''modified collective model'' analysis. With the optical model parameter set of Mermaz *et al.*, we obtain $\sigma=22\pm3$ mb; for the Barrette *et al.* parameter set, we calculate 16 ± 2 mb. Our measured result, 16 ± 5 mb, is consistent with both calculated values. Hence, the measurement of ^{18}O supports the reliability of our ^{18}Ne result.

It is important to assess the relative roles of the nuclear and Coulomb forces in the present reaction. The magnitudes of the nuclear and Coulomb contributions to the scattering process depend on both the energy of the beam and the mass of the scattered particle. For masses of $A=40$ and above, the

Coulomb interaction is so dominant at energies near 50 MeV/nucleon that the nuclear interaction can be neglected in analyses such as the one performed here. However, at lower masses the nuclear force must be included in the analysis (for example, see Ref. [22]). The relative roles of Coulomb and nuclear interactions in the present experiment with ^{18}Ne were investigated by performing ECIS calculations in which only the nuclear interaction was used. A calculation using the optical model parameters of Mermaz *et al.* in which the Coulomb interaction is turned off ($\beta_C=0$) yields a cross section of 17 mb, which is 42% of the cross section with the Coulomb interaction included (40 mb). The corresponding nuclear interaction-only calculation with the optical model parameters of Barrette *et al.* yields a cross section of 11 mb, which is 27% of the cross section including the nuclear interaction. It seems clear that the nuclear interaction plays an important role in the present reaction, unlike the situation at higher masses. In addition, calculations of the size of the role of the nuclear interaction depend significantly on the optical model parameters adopted.

The present results for ^{18}Ne are significantly different from the previous experimental result of McDonald *et al.* [6] ($M_p=16.1\pm0.8$ fm^2). It should be noted that their experiment was quite difficult, having a large background in the γ-ray spectrum generated by neutrons since their γ-ray detector was positioned at 0 ° with respect to the beam direction. In addition, the detector they used, a 19% efficient Ge(Li), was much less efficient for detection of 2 MeV γ rays than the large volume intrinsic Ge detectors available for similar experiments today. For this reason, it would seem prudent to repeat the DSAM experiment in a way which would decrease the neutron background in the γ-ray spectrum and take advantage of the high efficiencies of modern Ge detectors. The present result is also significantly below the value for M_p in ^{18}Ne extracted from pion scattering (13.6 ± 0.8 fm^2), although the pion scattering value also disagrees with the DSAM result.

The present result for the 2_1^+ state in ^{18}Ne provides the opportunity to examine isospin symmetry in the $A=18$ multiplet. If isospin symmetry is satisfied within a mass multiplet, then the matrix elements of the corresponding electromagnetic transitions in each isobar are related in a straightforward way. The relationship between multipole matrix elements in the neutron/proton and isospin representations yields [4]

$$M_p(T_z)=(1/2)[M_0(T_z)-M_1(T_z)], \tag{6}$$

where $M_0(T_z)$ and $M_1(T_z)$ are the isoscalar and isovector multipole matrix elements, respectively. With the assumption of isospin conservation, the matrix elements in different isobars are related by

$$M_0(T_z')=M_0(T_z), \tag{7}$$

$$M_1(T_z')=M_1(T_z)T_z'/T_z. \tag{8}$$

If two nuclei are mirrors, then $T_z'=-T_z$ and

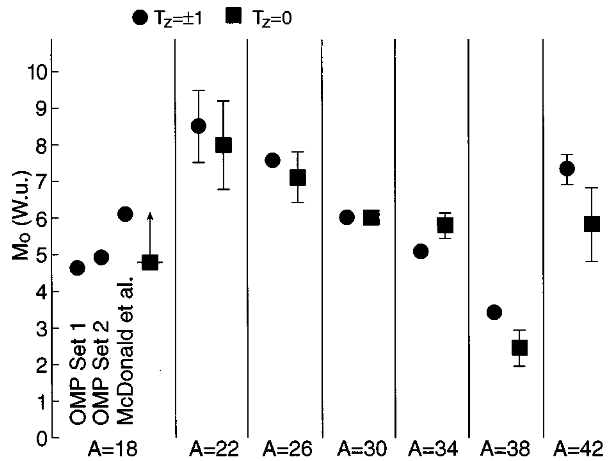

FIG. 2. A comparison of isoscalar multipole matrix elements M_0 extracted from the comparison of M_p values for $0^+_{\rm g.s.}\rightarrow 2^+_1$ transitions in $T=1$ nuclei to the M_0 values taken from transitions between $T=1$ states in $T_z=0$ nuclei. This comparison allows a test of isospin purity in $A=4n+2$ systems. Three $A=18T_z=\pm1$ values are shown, corresponding to the results obtained in the present work with the two optical model parameter sets and the result of McDonald *et al.* [6].

$$M_0(T_z)=M_p(T_z)+M_p(-T_z). \tag{9}$$

According to Eq. (9), the corresponding transition between $T=1$ states in a $T_z=0$ nucleus satisfies

$$M_p(T_z=0)=M_0(T=1)/2. \tag{10}$$

That is, the hypothesis of isospin purity implies that the value of M_0 extracted from the M_p values in two mirror $T_z=\pm1$ nuclei should be equal to the value $M_0=2M_p$ obtained for the $0^+_{T=1}\rightarrow 2^+_{T=1}$ transition in the $T_z=0$ nucleus. According to Ref. [4], this comparison provides an experimental test of isospin purity for $A=4n+2$ multiplets.

For $A=18$, the results obtained with the parameter sets of Mermaz *et al.* (2.84 ± 0.23 single particle units, or SPU) and Barrette *et al.* (3.13 ± 0.20 SPU) for ^{18}Ne, when taken with the corresponding value for ^{18}O from the compilation of Ref. [23], $M_p=1.82\pm0.02$ SPU, yield $M_0=4.66\pm0.23$ SPU and 4.95 ± 0.25 SPU, respectively. In the $T_z=0$ nucleus ^{18}F, the $T=10^+$ and 2^+ states are located at 1042 and 3062 keV, respectively. The 3062 keV state decays predominantly to the $T=0$ states at 0 keV ($J^\pi=1^+$) and 937 keV ($J^\pi=3^+$) via $M1$ transitions. Only $0.11\pm0.03\%$ of the decays of the 3062 keV state populate the 1042 keV state. The $M1$ decays cause the lifetime of the 3062 keV to be quite short, and only an upper limit (the mean life $\tau<1.2$ fs) has been determined [13]. The measurement of the branch ratio and the upper limit of the lifetime allow a lower limit on the reduced matrix element $B(E2;0^+\rightarrow 2^+)>5.8$ SPU to be obtained (this value is calculated with the lower 1σ limit, 0.08%, of the measured branch ratio). This, in turn, gives $M_p>2.40$ SPU and $M_0>4.80$ SPU. Hence, the values of M_0 obtained from ^{18}O and the present results for ^{18}Ne are consistent with the lower limit extracted from the available data on ^{18}F. Therefore, the data on these $0^+_{T=1}\rightarrow 2^+_{T=1}$ transitions are consistent with the assumption of isospin purity. This conclusion is valid for both sets of optical model parameters adopted here. It is worth noting that the ^{18}Ne result of McDonald *et al.* [6] gives $M_p = 4.30 \pm 0.20$ SPU yielding a ^{18}O/^{18}Ne M_0 result of 6.12 ± 0.20 SPU.

To refine this test of isospin purity in the $A=18$ system, at least two experimental issues must be addressed. First, the discrepancy between the present heavy-ion scattering experiment and the previous DSAM measurement of $B(E2;0^+_{g.s.}\rightarrow 2^+_1)$ in ^{18}Ne must be resolved, as discussed above. Second, the existing result for $B(E2;0^+_{T=1}\rightarrow 2^+_{T=1})$ in ^{18}F must be improved, although doing so will be quite difficult because of the short lifetime of the $2^+_{T=1}$ state. The upper limit on the lifetime of the $2^+_{T=1}$ state was set in DSAM measurements of the ^{3}He(^{16}O,p)^{18}F reaction reported by Ball *et al.* in 1982 [24]. In these measurements, the centroid shift of the 2020 keV γ ray was measured in targets in which the ^{3}He was implanted in three hosts (aluminum, niobium, and gold) with different stopping powers. The measured energy of the centroid did not depend on stopping power, and Ball *et al.* were only able to set an upper limit on the lifetime on this basis. It might be possible to improve this measurement by using the more efficient γ-ray detectors now available to improve the measured line shapes and, thus, to measure the centroids more precisely in the three target hosts. The branch ratio of the $2^+_{T=1}$ state to the $0^+_{T=1}$ state ($0.11 \pm 0.03\%$) was measured by Rolfs in 1972 [25] using the ^{14}N(α,γ)^{18}F and ^{17}O(p,γ)^{18}F reactions at resonance energies. The statistics accumulated in these experiments are impressive, and it is not clear that modern γ-ray detectors would provide a significant advantage in repeating these measurements.

Comparisons between M_0 values taken from $T_z = \pm 1$ nuclei and the $T=0$ states of the $T_z=0$ isobars for $4n+2$ nuclei in the mass range $A=18-42$ are shown in Fig. 2 (data are taken from Refs. [5,26] and the present work). Cottle *et al.* [5] noted that the error bars for the $T_z=0$ and $T_z=\pm 1 M_0$ values do not overlap in the cases of $A=34$,38, and 42, suggesting the possibility of measurable isospin purity violation in these nuclei. These cases merit further study, as does the case of $A=22$, where the experimental uncertainties for both $T_z=0$ and $T_z=\pm 1 M_0$ values are large.

In summary, we measured the $0^+_{g.s.}\rightarrow 2^+_1$ excitation in the proton-rich nucleus ^{18}Ne via intermediate energy heavy-ion scattering. The M_0 values obtained from the M_p results in the $T_z=\pm 1$ nuclei ^{18}O and ^{18}Ne are consistent with the lower limit on M_0 set with the $B(E2;0^+_{T=1}\rightarrow 2^+_{T=1})$ result from the $T_z=0$ nucleus ^{18}F, as would be expected if isospin purity exists in the $A=18$ system. We propose that the DSAM measurement of the $0^+_{g.s.}\rightarrow 2^+_1$ transition in ^{18}Ne be repeated with a lower neutron background and the present generation of high volume Ge detectors to resolve the discrepancy between the present ^{18}Ne result and the previous DSAM measurement of McDonald *et al.* [6].

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