Searching for resonance states in $^{22}Ne(p,\gamma)^{23}Na$

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Globular clusters show strong correlations between different elements, such as the well-known sodium-oxygen anticorrelation. One of the main sources of uncertainty in this anticorrelation is the $^{22}Ne(p,\gamma)^{23}Na$ reaction rate, due to the possible influence of an unobserved resonance state at E_x = 8862 keV ($E_{r,c.m.}$=68 keV). The influence of two higher-lying resonance states at E_x =8894 and 9000 keV has already been ruled out by direct $^{22}Ne(p,\gamma)^{23}Na$ measurements. We studied excited states in ^{23}Na above the proton threshold to determine if the unconfirmed resonance states in ^{23}Na exist using the nonselective proton inelastic-scattering reaction at low energies. Protons scattered from various targets were momentum-analyzed in the Q3D magnetic spectrograph at the Maier-Leibnitz Laboratorium, Munich, Germany. The resonance states previously reported at E_x=8862, 8894, and 9000 keV in other experiments were not observed in the present experiment at any angle. Combined with the non-observation of these resonance states in most other experiments, we have concluded that these proposed states likely do not exist and should be omitted from future evaluations of the $^{22}Ne(p,\gamma)^{23}Na$ reaction rate.

Fig.1 shows the excitation-energy spectrum assuming ^{23}Na kinematics. The hollow spectrum is taken with the NaF target and the solid red from the LiF spectrum. Vertical lines show the positions of ^{23}Na excited states. The black lines with blue boxes show the known energies and listed uncertainties, the green dotted lines show the proposed states at E_x = 8862, 8894 and 9000 keV which, on the basis of the available evidence, do not appear to exist and which should be omitted from future evaluations of the ^{22}Ne(p,γ)^{23}Na reaction rate.

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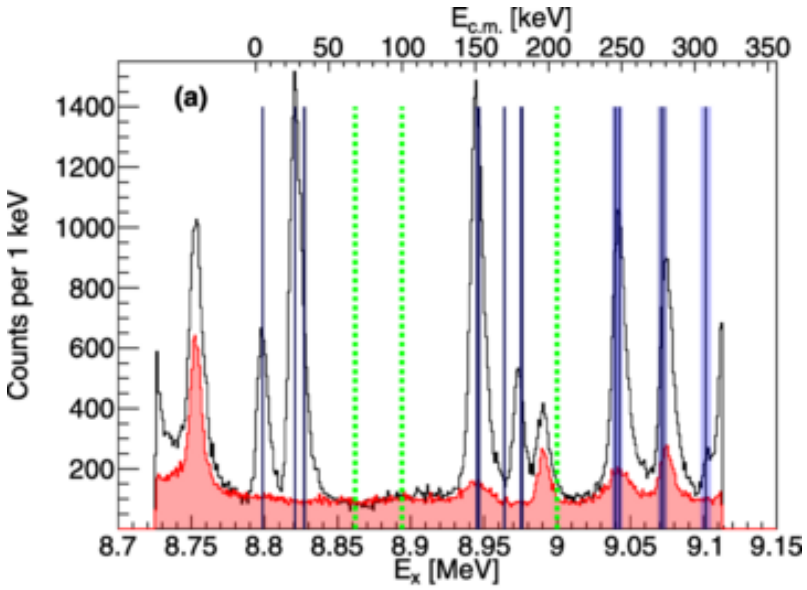

FIG.1. Excitation energy spectrum of the ^{23}Na(p,p') reaction taken of Θ_{Q3D}=70°. Black : NaF target. Red: LiF Target. Blue lines/boxes: Energy of 23Na states with uncertainties. Green:missing ^{23}Na states.