Single and double proton emission from the ^{14}O + ^{4}He interaction

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Reactions between unstable nuclei and helium influence a variety of astrophysical processes [1]. The present measurements were made with the aim to understand the origin of the protons emerging in interactions of ^{14}O with helium.

By using a 32.7 MeV ^{14}O beam provided by the MARS at TAMU [2] and a modified Thick Target Inverse Kinematics (TTIK) technique, we have measured the excitation function for (α, 2p) reaction. The conditions of the experiment were tuned to obtain a unique kinematics interpretation of the double proton events for the broad excitation energy region of the TTIK technique. The measured excitation function is shown in Fig.1. It clearly shows that the process is dominated by resonances in ^{18}Ne in the region between 7.5–12.0 MeV, which should be very unusual for the (α, 2p) reactions on stable nuclei. The large, resonance yield of protons, mainly from the successive decays, makes suspicious former astrophysically important interpretations of the proton spectra from the $^{14}O(\alpha,p)$ reaction [3]. We showed how the single proton measurements can be improved by using a time-of-flight method.

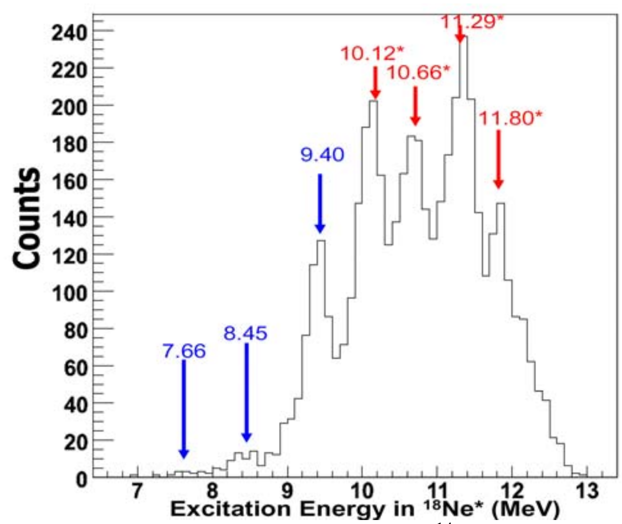

Figure 1. The excitation function for the $^{14}O(\alpha, 2p)$ reaction.

Most of the resonances (levels in ^{18}Ne) were not observed before, and spin assignments of these levels are not known. The proton decay of the ^{18}Ne level at 8.45 MeV differs from the clearly sequential decay of other ^{18}Ne states. To describe it, we calculated the two proton relative energy distributions for this decay using the Faddeev approach. Fig. 2 shows these energy distributions for different angular orbital moment for the decay of ^{18}Ne and with/without the virtual level in the pp interaction. The shape and the probability of the decay in question could be considered as an evidence for the decay by the correlated proton pair.

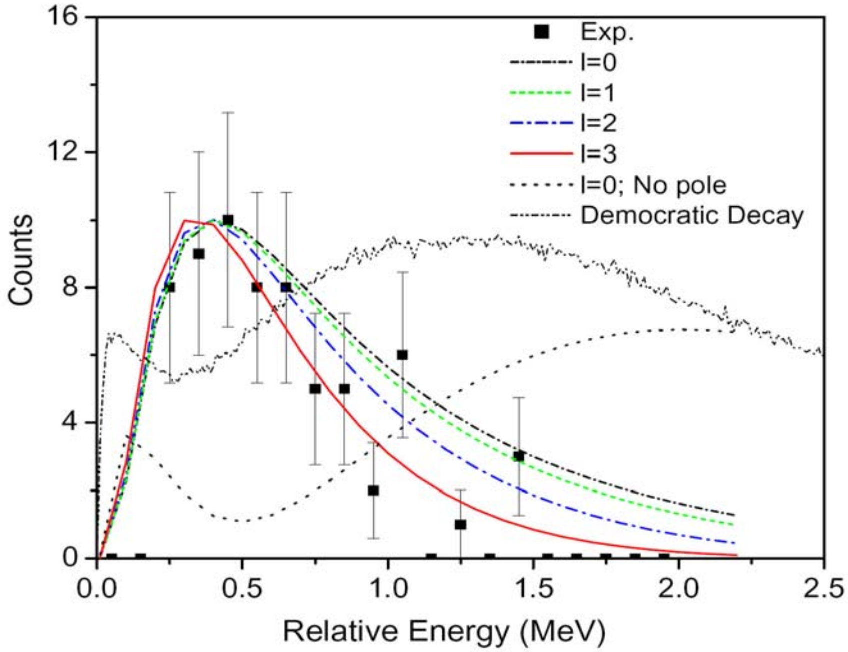

Figure 2. The relative energy between two protons emitted from the 8.45 MeV level in ^{18}Ne.

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[3] M. Notani *et al.*, Nucl. Phys. **A746**, 113c (2004); Eur. Phys. J. **A27**, Supplement 1, 327(2006).