Evidence for 2p Radioactivity in ^{17}Ne ◇

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So far all experimental attempts to identify 2p-radioactivity at or near the proton dripline have been unsuccessful (e.g. [1]). A promising candidate is ^{17}Ne, where the first excited state ($J^{\pi} = 3/2^{-}$, $E^{*} = 1.288$ MeV) is bound by 168 keV with respect to one-proton emission but unbound with respect to two-proton emission by 344 keV (for details see [2,3]). Therefore this state can decay via a simultaneous two-proton decay to ^{15}O, since the widths of the low lying states in ^{16}F are too small ($\simeq$ 40keV) for a sequential decay via their tails. The 2p-decay is in competition with the γ-decay to the ground state in ^{17}Ne. In a recent intermediate energy Coulomb excitation experiment the γ-decay from the first excited state to the ground state ($J^{\pi} = 1/2^{-}$) has been measured and the experimental yield has been compared to the theoretically expected cross section. The measured γ-ray yield accounts for only 43% of the predicted yield from an excitation cross section of 18.7 mbarn, thus encouraging the investigation of a potential two-proton decay branch. The experiment to search for the 2p-decay of ^{17}Ne was performed at the National Superconducting Cyclotron Laboratory at Michigan State University and is described in details in [4]. The incoming ^{17}Ne was identified via TOF-measurements and the experimental setup allowed for the identification of the decay products ^{15}O +2p and a complete kinematic reconstruction of the decay products. The particle identification is described in the previous annual report [6]. With the information of the energies of the outgoing fragments and their trajectories the transformation into the cm-System can be performed in order to obtain the invariant mass spectrum (fig 1.).

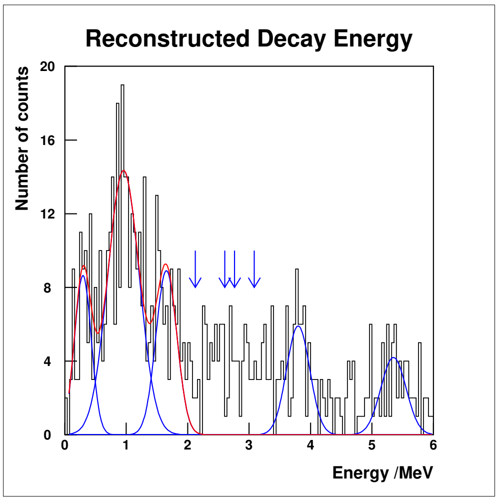

Fig. 1: Reconstructed decay energy of ^{17}Ne.

The gaussian fit curves indicate the preliminary assigned peaks, the lowest one at an energy of $295 \pm 40^{stat} \pm 50^{syst}$ keV corresponding to the simultaneous 2p-decay of the first excited state in ^{17}Ne. The measured decay energies agree with the known values [7]. The arrows between 2 and 3 MeV indicate positions of known transitions, which could not be resolved. The energy resolution is on the order of 250 keV, mainly influenced by the error in the determination of the interaction point on the target. The decays of the higher lying states proceed predominantly sequential via intermediate states in ^{16}F. This can be extracted from the center-of-mass spectra of the individual protons. The preliminary decay scheme with the identified transitions is shown in fig. 2.

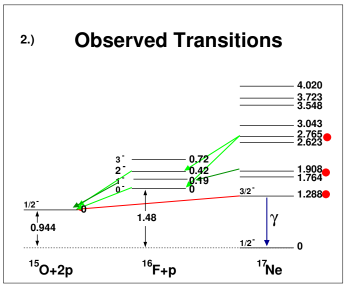

Fig. 2: Preliminary decay scheme of ^{17}Ne. The dots and their arrows indicate observed states in ^{17}Ne and preliminary identified decay steps, respectively.

The decay of the first excited state can only be explained by a simultaneous 2p-decay. A preliminary analysis of the lifetime indicates a 2p-lifetime in the order of a few picoseconds, compared to a lifetime of $\simeq$ 0.1 ps for the γ-decay from the first excited state in ^{17}Ne. In order to investigate this evidence for 2p-radioactivity a new experiment is going to be performed at the NSCL, using an improved setup, with a higher energy-resolution due to improved tracking detectors and a higher efficiency due to an increase in granularity of the proton-detectors.

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