# Observation of the $\gamma$ Decay of the First Excited State of $^{17}$Ne ◇

M. J. Chromik, P. G. Thirolf, B. A. Brown [a], M. Fauerbach [a], T. Glasmacher [a], R. W. Ibbotson [a], H. Scheit [a], and M. Thoennessen [a]

[a] National Superconducting Cyclotron Laboratory, Michigan State University

The search for the di-proton ($^2$He) radioactivity is one of the exciting topics of nuclear physics at the proton-dripline. In lighter nuclei $^{17}$Ne is the most promising candidate, because the first excited state in $^{17}$Ne is bound with respect to one proton emission but unbound with respect to two-proton emission. This possible di-proton branch would be in direct competition with the $\gamma$-decay to the ground state in $^{17}$Ne. So far none of these decay modes has been observed.

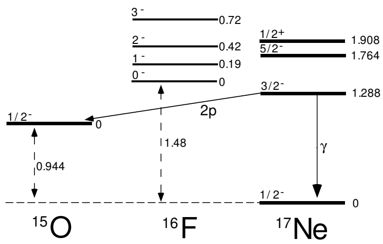


Fig. 1: Level scheme of the low lying states in $^{15}$O, $^{16}$F and $^{17}$Ne. The sequential decay from the first excited state in $^{17}$Ne will be suppressed, since the low lying states of $^{16}$F are too high and their width too small.Thus the only two remaining possible decay-modes are the two-proton decay to the ground state in $^{15}$O or the $\gamma$-decay back to the ground state in $^{17}$Ne.

Since lifetime estimates are favouring the $\gamma$ branch, the search for the $\gamma$-decay of the first excited state in $^{17}$Ne was our first approach to this nuclei (see e.g. [1]).

The present experiment was performed at the National Superconducting Cyclotron Laboratory at the Michigan State University. We extracted a 100 MeV/nucleon $^{20}$Ne beam from the K1200 cyclotron and bombarded a $^9$Be target. The fragments were then mass analysed with the A1200 fragment separator and the beam of interest ($^{17}$Ne with 60 MeV/nucleon) was sent to the experimental area. To populate the first excited state in $^{17}$Ne we used the method of intermediate energy Coulomb excitation. Our experimental setup had to fullfill the following requirements: The projectile had to be Coulomb-excited and the projectile-like reaction products had to be identified after the target in coincidence with the deexcitation $\gamma$-rays. Moreover, in order to allow for the Doppler correction ($\beta \approx 0.3$) the measurement of the emission angle $\theta$ as shown in fig.2 was required. The latter implies the measurement of the trajectory of the projectile and the angle into which the $\gamma$-ray is emitted. In order to get a sufficient position-resolution a phototube was connected to each end of the NaI-crystals. From that the position of the incident photon could be determined with an accuracy of $\approx$ 2cm, which corresponds to an accuracy for $\theta$ of $\approx 10°$. 38 of these detectors were placed in concentric rings around the beam axis. The experimental setup is shown in fig. 2 and described in more details in ref. [1,2].

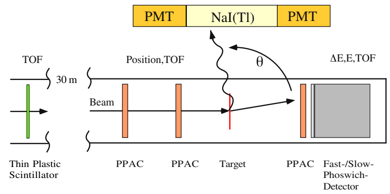


Fig. 2: The experimental setup used for the intermediate energy Coulomb excitation experiment. The ΔE,E Fast-Slow-phoswich detector and TOF measurements provided the particle identification. The trajectory of the projectile was measured with PPACs in front of and behind the target. The energy of the emitted $\gamma$-rays and their emission angles were measured with the NaI-detectors.

The measured decay spectra for both the target rest frame and the projectile rest frame are shown in fig 3. We observed the $\gamma$-decay from the first excited state of $^{17}$Ne to the ground state at an energy of 1275(22)keV.

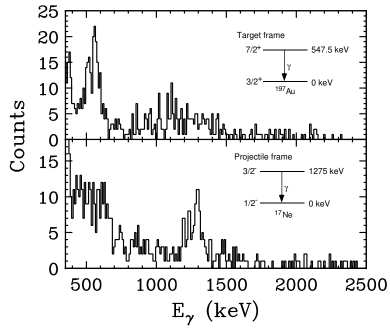


Fig. 3: The measured decay spectra. In the projectile rest frame (top) the 7/2- to 3/2- transition in the $^{197}$Au target appears. In the projectile rest frame this peak broadens, but at 1275(22)keV a sharp peak from the projectile appears, while the peak corresponding to the transition in $^{197}$Au broadens.

In order to obtain an estimate of the branching ratio between the observed $\gamma$-decay and a potential two-proton decay, we calculated the excitation cross section using the virtual photon method (see e.g. [3]) and compared the number of expected decays with the number of observed decays. The measured $\gamma$-branch accounts only for $\approx$ 43 % of the total excitation cross section, which could be an evidence for the existence of a two-proton decay branch. However, this would be in disagreemeent with the calculated lifetimes which strongly favour the $\gamma$-decay. Motivated by these findings a dedicated experiment was performed to search for the 2p-branch, which is described in [4].

## References

[1] M.J. Chromik *et al.*, submitted to Phys. Rev. **C**
[2] H. Scheit *et al.*, Phys. Rev. Let. **77** (1996) 3967
[3] C.A.Bertulani and G.Baur, Phys. Rep. **163** (1988) 299
[4] P. G.Thirolf *et al.*, this report, p. 17

◇ One of us (MJC) acknowledges the hospitality of the NSCL, made possible by the support of the "Studienstiftung des Deutschen Volkes". This work was supported by the National Science Foundation under grants PHY95-28844 and PHY94-0366.