Resonance Scattering of Radioactive $^{11}\text{C}$ and $^{14}\text{O}$ on Hydrogen

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The experiments were performed at the Texas A&M University K500 superconducting cyclotron. Primary beams of $^{11}\text{B}$ and $^{14}\text{N}$ with energy of 12 MeV/A were used to produce $^{11}\text{C}$ and $^{14}\text{O}$ correspondingly. The recoil spectrometer MARS was used to filter reaction products into the secondary beams [1] of 99.9% purity. In both experiments we used the thick target inverse kinematics method [2] to study resonance scattering in the chamber filled by methane gas.

In the experiment with $^{14}\text{O}$ two resonances were observed, and unique assignments was made for the quantum characteristics of the lowest states in $^{15}\text{F}$, $1/2^+$ and $5/2^+$ correspondingly. The widths and the levels positions were also determined. The data obtained were used to define shell model potential for the $^{15}\text{C}$ and $^{15}\text{F}$ nuclei. A more general analysis brought evidence for unusually large diffuseness of the nuclear potential for nuclei at the borders of nuclear stability. The results were published in [3]. The main goal of the $^{11}\text{C}$ experiment was a search for states in $^{12}\text{N}$ near the threshold for the decay into $^{8}\text{B}+\alpha$, which could play an important role in nuclear synthesis in stars through the $^{8}\text{B}+\alpha \rightarrow ^{11}\text{C}+\text{p}$ process.

The measurements included a short (about one hour) run to observe elastic scattering and a 12 hours run to study elastic and inelastic resonance scattering near the $^{8}\text{B}+\alpha$ threshold. The intensity of the $^{11}\text{C}$ beam was $\sim 10^6$/s. A 20 µ Pt foil was positioned in the gas filled scattering chamber to eliminate elastic scattering on hydrogen in the region, where it could interfere with inelastic scattering peaks of excitation of states near the $^{8}\text{B}+\alpha$ threshold in $^{12}\text{N}$.

As can be seen in Fig. 1, we have observed a state (or states) near the $^{8}\text{B}+\alpha$ threshold in $^{12}\text{N}$ in

![Figure 1. Excitation functions (Laboratory system) for $^{11}\text{C}+\text{p}$ interaction. The upper curve is the yield of protons from CH₄ target (mainly the elastic scattering). The bottom curve is the proton yield with a Pt foil in the CH₄ gas. The proton in the energy region 11-22 MeV are mainly results of resonant inelastic scattering of $^{11}\text{C}$ on](image-url)
elastic as well in the inelastic scattering. The data are analyzed in the frame of R-matrix approach, which is complicated due to unusual experimental conditions and the presence of many broad resonances.

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