

Cluster Structure in Light Nuclei

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Clustering of α particles plays an important role in light nuclei. The prime example is the 1st excited 0^+ state in ^{12}C that was postulated by F. Hoyle 60 years ago close to the α emission threshold and thus responsible for the He burning in stars and the production of carbon. This state is believed to be well represented by an almost linear chain of three α -particles. Clusters consisting of α particles and neutrons exist as well. In a little heavier systems also molecular structures play a role as pictured in Fig. 1 for the structure of ^{18}O . We are investigating such systems with the Q3D magnetic spectrograph.

Using the $(^7\text{Li},p)$ reaction on ^{12}C and ^{13}C targets we studied states, where an α -particle and two neutrons are added to the target nucleus. A spectrum of ^{18}O states up to 20 MeV of excitation is shown in Fig. 2 [1]. Even far above the particle emission thresholds narrow states exist. Many states are observed for the first time and some can be grouped into rotational bands. Similar results were obtained for ^{19}O [2].

α -transfer with the $(^6\text{Li},d)$ reaction was used to study states in ^{13}C [3] and ^{16}O [4]. Here we used in coincidence with deuterons, detected in the focal plane detector of the Q3D, breakup particles of the residual nuclei to measure absolute values of the partial decay widths. The break-up particles were detected in large area, position sensitive Si detectors. Thus, the different breakup channels and even the states in the nucleus, breaking up, can be distinguished. From this information and the particle decay widths some of the observed states can be characterized with respect to their underlying molecular structure.

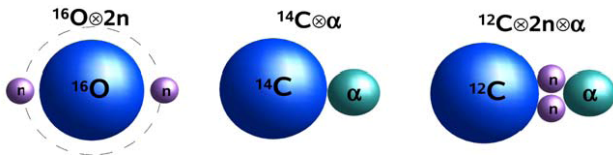


Fig. 1 : Possible molecular configurations of ^{18}O

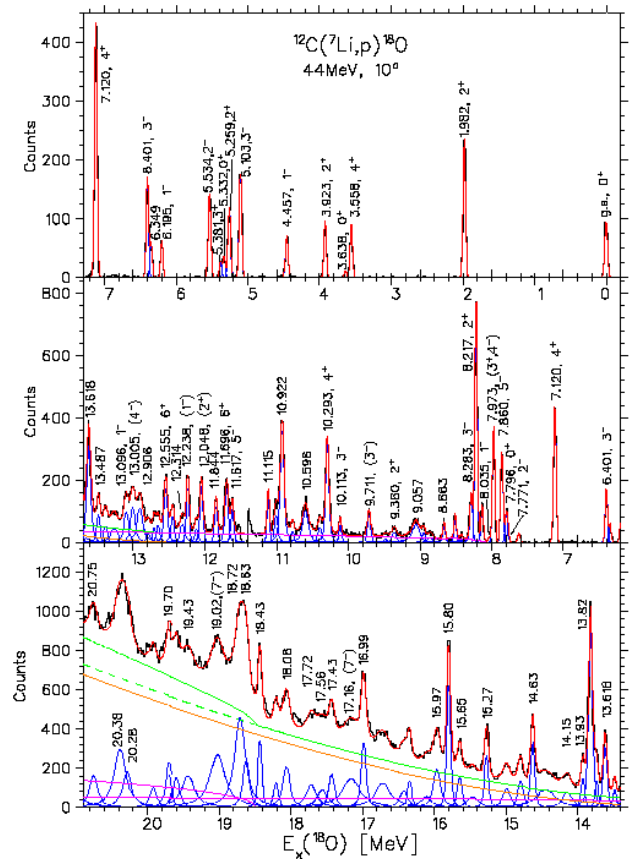


Figure 1: Energy spectrum of protons obtained with the Q3D spectrograph for the reaction $^7\text{Li}+^{12}\text{C}\rightarrow\text{p}+^{18}\text{O}$ measured at 44.0 MeV incident energy and $\theta_{\text{lab}}=10^\circ$. The smooth lines represent the continua above the thresholds for α , n, $2n$ and p emission.

REFERENCES

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