Search for quasi molecular states in interaction of ^{40}Ar with light nuclei

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During last few years, one can observe a renewed interest to the manifestations of the α clustering in the atomic nuclei. New possibilities of using rare beams, together with the permanent astrophysical interest to nuclear reactions involving helium and expectations of new effects of Bose-Einstein condensation make this field very broad and promising. One would expect similar developments for a very popular previously field of studies of quasi molecular states, which is also of the current astrophysical interest. However, after the controversy of the ^{16}O+^{40}Ca case [1], there is no evident progress in the studies of the quasi molecular resonances in the systems heavier than ^{16}O+^{16}O.

Many recent achievements in the investigations of the α cluster structure (see [2], for example) are related with the application of the Thick Target Inverse Kinematics method (TTIK) [3] which has the advantage of measuring excitation functions for the elastic scattering with a single beam energy. In this technique, the incoming ions (^{40}Ar) are slowed in the thick target (a gas as the target can be used) and the recoil ligher ions of the target are detected from a scattering event. These recoils emerge from the interaction with the beam and hit Si detector telescope located at forward angles while the beam ions (^{40}Ar) are stopped in the target, as the the lighter recoils have smaller energy losses than the ions of the beam. A very important feature of this approach is an easy access to measurements at zero degrees in the lab. system corresponding to 180 CM degree. At the extreme, CM backward, angles the potential scattering should be small and the resonance scattering should reach its maximum. It is especially important for the resonances with heavy ions, because one can expect a population of the high spin states in such cases. In this experiment the 220 MeV ^{40}Ar beam from the Warsaw Cyclotron, with intensity of 30 – 160 enA after collimating to 5 mm diam. (C1, see the Fig. 1), bombarded the 100 μg/cm^2 Au foil placed in the vacuum reaction chamber. Two semiconductor detectors (R1, R2) were placed upstream of the main scattering chamber and were used to monitor the beam intensity. Then, the beam passed through a window made of the 4μm Havar foil (H) and entered the main scattering chamber. In the main chamber we placed a solid carbon target (T) of 50μm thickness or 600 mm long cylinder filled with a gas (^{4}He, ^{20}Ne or CO_2). The target-like reaction products were detected by a telescope consisting of Si detectors of 10μm, 250μm and 1350μm thickness, placed on the beam axis, at zero degrees. The telescope provided for

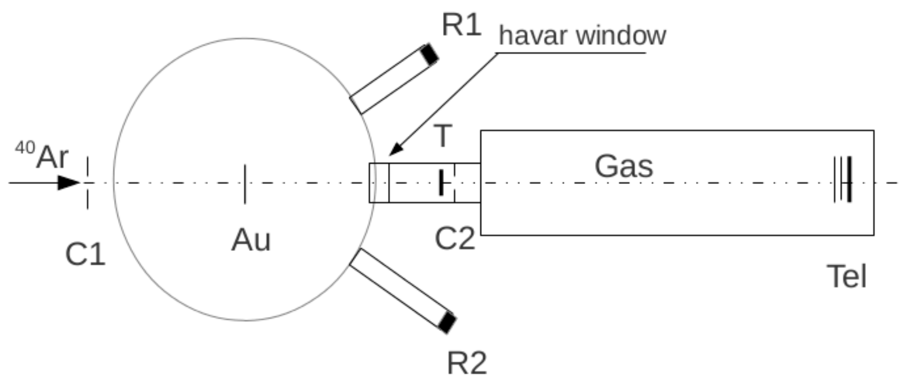

FIG. 1. Scheme of experimental setup**.**

resolution needed to separate elements up to Mg, but not good enough to separate the heavier isotopes (starting with A=12). As a result we have obtained thick target spectra of different light elements at the extreme CM angle (180^0) using targets of ^{4}He, ^{12}C, ^{20}Ne and CO_2 and the beam of ^{40}Ar. We observed sharp resonances (with CM resolution of 50 keV) in the interaction of ^{40}Ar with ^{4}He which were an evidence of the manifestations of the alpha cluster structure at the conditions of high density of the compound states and many open decay channels.

We did not observe evident resonances in any other studied cases as it is seen in Fig. 2.

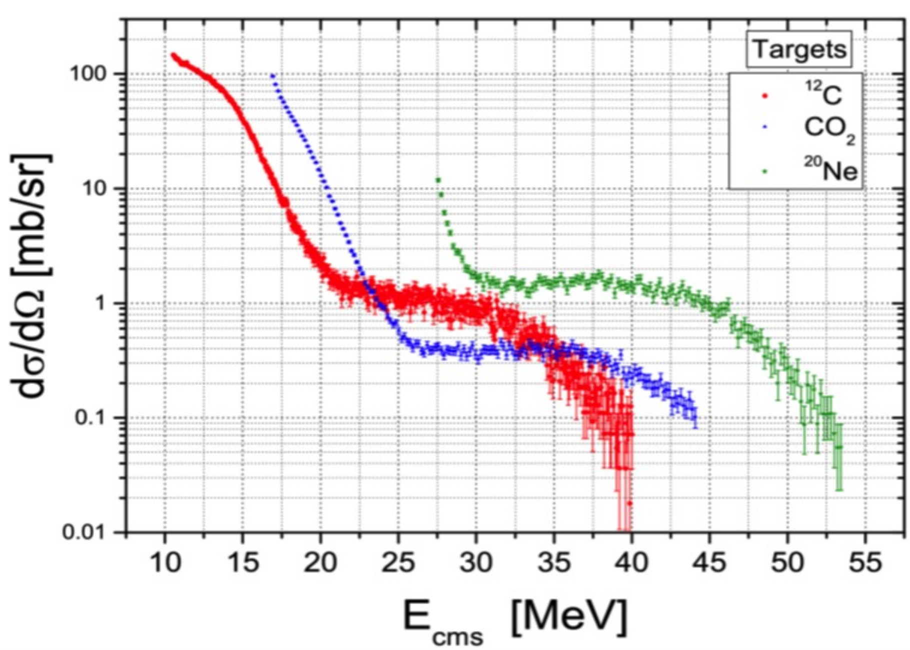

FIG. 2. Experimental excitation functions perimental excitation functions.

Fig 2 demonstrates the excitation functions for the interaction of Ar with C, CO_2, and Ne correspondingly.

At present we are trying to understand the origin of the continuous spectra of elements obtained in the unusual conditions of the present experiment.

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[3] K.P. Artemov *et al.,* Sov. J. Nucl. Phys. **52**, 406 (1990).