Study of decay mechanism of resonance state of ^{12}C populated *via.* p + ^{11}B reaction

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Introduction

Resonance particle spectroscopy is a unique tool to populate and study a state in compound nucleus at desired excitation energy. The states above 16 MeV of excitation can be populated by proton capture reaction on ^{11}B in which several prominent resonances have been reported in literature [1]. The reaction at the energy of protons around 7 MeV shows a wide resonance in p-capture, α-decay, which has been attributed to the giant dipole resonance in ^{12}C centered at excitation energy ~ 22.65 MeV. In the α-decay channel more than one resonance component have been identified by previous workers [1]. In the present paper, the decay mechanism of the resonance state of ^{12}C around the excitation energy of 22 MeV has been studied *via.* p + ^{11}B reaction in complete kinematics.

The experiment was performed at the Variable Energy Cyclotron Centre, Kolkata, using proton beams of energies 6.8 MeV - 7.6 MeV in 400 keV steps on ^{11}B target (thickness ~ 15μg/cm^2 of ^{11}B backed by ~10 μg/cm^2 of ^{12}C) to populate the resonance states of ^{12}C around the ~22 MeV region. The decay α-particles emitted from the resonance excited state of ^{12}C have been detected using four 1000 μm thick double-sided silicon strip detectors [DSSD: 16 strips (each of 50 mm × 3 mm) per side in mutually orthogonal directions]. Two strip detectors were placed in the forward direction covering the angular range from 25^0 to 98^0 (detector 1 from 25^0 to 60^0 and detector 2 from 66^0 to 98^0) and the other two strip detectors were placed at opposite side of the beam axis at backward angle covering the angular range from -82^0 to -155^0 (detector 3 from -82^0 to -114^0 and detector 4 from -120^0 to 155^0). Energy calibrations of all the strip detectors have been carried out using the known energy five intense peaks of ^{229}Th α-source.

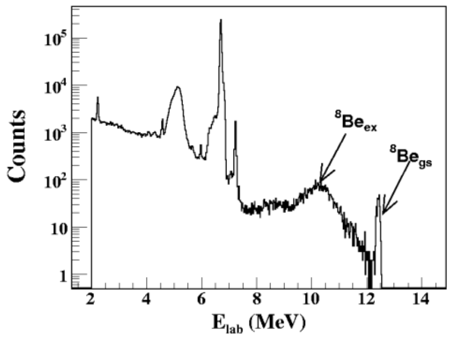

Fig.1: Typical energy spectrum obtained from a single stripat 6.8 MeV proton energy.

The typical energy spectrum obtained from a single strip of a DSSD is shown in Fig.1. The highest energy peak (sharp peak) in Fig.1 corresponds to the energy of first α particle emitted in the sequential decay of the resonance state of ^{12}C via. ^{8}Be ground state (^{8}Be$_{gs}$). The second highest broad energy peak corresponds to the energy of the first α-particle of the resonance state decay via. the first excited 2^+ state of ^{8}Be (^{8}Be$_{ex}$). Only completely detected events (three hits per event), i.e., the events where all three decay α's of ^{12}C were detected, have been processed for further analysis to study the decay mechanism. The genuine events have been extracted by filtering the raw data with proper cuts on the TDC time signal as well as total energy and momentum conservation gates [2]. The total energy of the three α's at three different

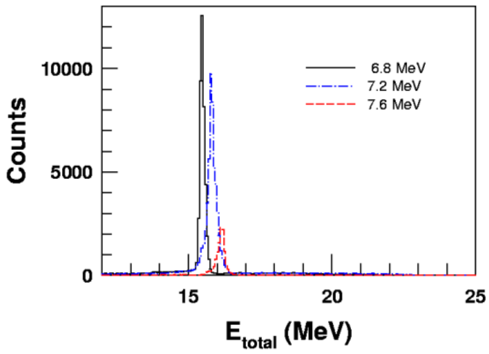

Fig.2: Total energy of the decay 3α of ^{12}C in laboratory for three different beam energies.

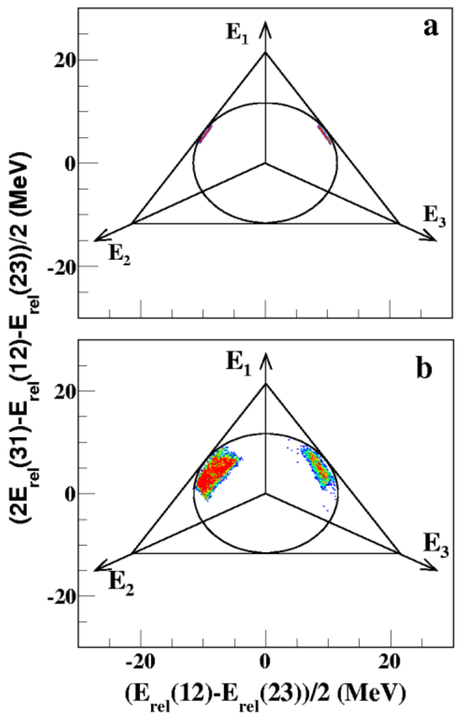

Fig.3: Dalitz plot, for the decay of the resonance state of ^{12}C through $^{8}Be_{gs}$ (a) and $^{8}Be_{ex}$ (b) for the experimental data.

beam energies are shown in Fig. 2. It is clear from the Fig. 2 that the total energy of the ^{12}C decay three α's in laboratory frame was peaking around the expected sum of the beam energy plus Q-value (+8.68 MeV) of the reactions.

In order to estimate the decay branches, a Monte Carlo simulation program has been developed. In this simulation program, all the experimental effects such as the finite granularity of detector, multiple hits in single strip rejection, intrinsic energy resolution of the detectors, the detection thresholds, beam resolution etc. have been taken into consideration. In the simulation, an isotropic decay of the resonance state was assumed to calculate the efficiency of the experimental setup. Initially, the investigation on the nature of the decay of the resonance state has been carried out using Dalitz plot technique utilizing the relative energy spectra of the decay particles [3]. The Dalitz plots for the resonance state decays via $^{8}Be_{gs}$ and $^{8}Be_{ex}$ have been shown in Figs.3a and 3b, respectively, for the beam energy 6.8 MeV. From the Figs.3a and 3b, it has been observed that the decay mechanism is sequential in nature [2]. In order to estimate the branching ratio precisely for the resonance state of ^{12}C decay into $^{8}Be_{gs}$ or $^{8}Be_{ex}$ channels, further details comparison of experimental data with the Monte Carlo simulation is in progress. The details of which will be discussed in the conference.

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