DETECTION OF ^{8}BE USING A SURFACE BARRIER DETECTOR TELESCOPE AND ITS DETECTION EFFICIENCY CALCULATION

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As ^{8}Be nucleus even in its ground state is 92 keV unbound for decay into two alpha particles, the detection of ^{8}Be particle involves detection of its breakup α-particles in coincidence[1]. Here we report on a simple ΔE-E surface barrier detector telescope[2], which was employed to identify ^{8}Be besides other charged particles.

When the two α-particles of similar energy from the breakup of ^{8}Be, enter simultaneously into a conventional telescope it is identified as a ^{7}Li particle in the ΔE-E plot. This is because ΔE is proportional to $\sim mZ^2/E$ which is equal to 1/E, 16/E, 63/E and 64/E for protons, alphas, ^{7}Li and ^{8}Be of energy E. Though ^{7}Li and ^{8}Be are very close in ΔE-E plot, the Q-value corresponding to ^{8}Be exit channel is often more positive than the ^{7}Li exit channel. Hence upto ~15 MeV excitation range ^{8}Be can be detected without any interference from ^{7}Li.

In Fig.1(a) the velocity diagram is shown to illustrate the kinematic focusing of breakup alphas from a ^{8}Be of velocity V_8 (energy E_8), into a narrow cone of half angle $\beta_{max} = \sin^{-1}(\bar{v}/V_8) = \sin^{-1}\{(Q_8/E_8)^{1/2}\}$. Where Q_8 is the Q-value of ^{8}Be decay into two α-particles and $\bar{v}$ is corresponding c.m. velocity of each alpha particle. In Fig.1(b) the radial distribution of α-particles on detector corresponding to a given direction of ^{8}Be is illustrated, where $r_m = D\tan(\beta_{max})$ and R_d is the radius of the detector. As β_{max} is small (< 4° for E_8> 20 MeV), the lab. angles β_1 and β_2 are approximately equal. With this approximation one can derive the fraction

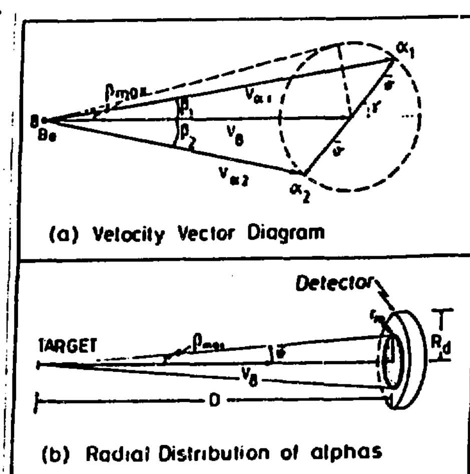

Fig.1

F(r)[1], for both breakup α-particles to fall in the annular region between r and r_m as $[1-(r/r_m)^2]^{1/2}$. If the ^{8}Be incident direction points close to perifery of the detector, only part of α-particles' cone will be intercepted by the detector and hence probability of ^{8}Be detection will accordingly be less than 1. By integrating the ^{8}Be detection probability over the entire area of the detector one can calculate the ^{8}Be detection efficiency. A computer program CEFFA is written to compute the ^{8}Be detection efficiency.

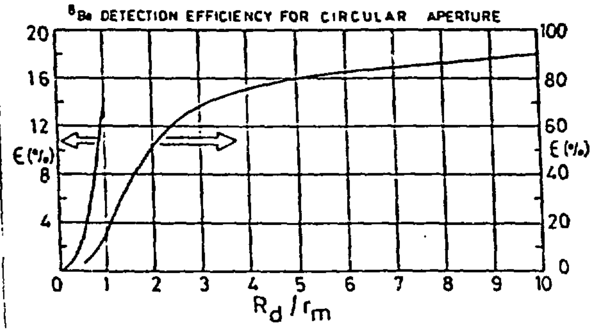

Fig.2

As the detection efficiency depends only on the dimension of the detector relative to r_m, the ^{8}Be detection efficiency, for circular aperture, plotted against (R_d/r_m) in Fig.2 which is applicable in general.

Such a telescope consisting of 30 μm ΔE and 2 mm E surface barrier detectors with radius R_d of 11 mm at a distance D of 13.4 cm was employed to study[2] the reactions $^{12}C(^{16}O,{}^8Be)^{20}Ne^*$ and $^{12}C(^{16}O,\alpha)^{24}Mg^*$ for ^{16}O beam energy from 60 to 90 MeV. The alpha and ^{8}Be spectrum were obtained using two dimensional gates on ΔE-E spectrum. An example of ^{8}Be spectrum obtained from the telescope at 63 MeV is shown in Fig.3, where the ^{8}Be peaks corresponding to low lying states of ^{20}Ne can be clearly identified. The efficiency of the telescope which varies with ^{8}Be energy is shown in the inset, where arrows indicate the position of the four marked ^{8}Be peaks in the spectrum.

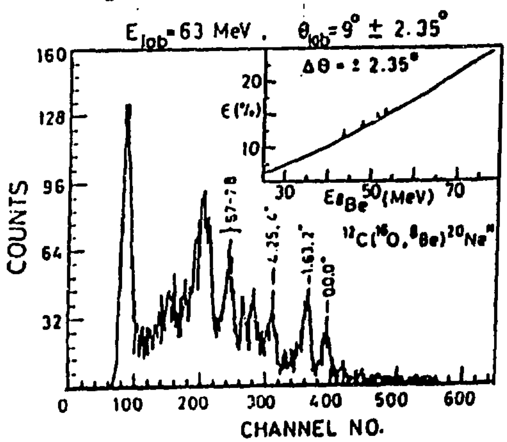

Fig.3

1) G.J.Wozniak et.al. Nucl.Inst.& Meth. 120 (1974) 29
2) Suresh Kumar et.al. NP Symp.(DAE) Madras (1990)103