Title
SUMMARY OF THE RESEARCH PROGRESS MEETING OF JULY 13, 1950

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Publication Date
1950-10-24

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Effects of Radiation on Bacteria. R. L. Dobson.

Bacteria are useful in the study of the effects of radiation on biological material since they represent simple forms of life where the specific action on the cell independent of structural relations between cells can be observed; since because of the large number of separate individuals that is available their study furnishes good data from a statistical point of view; and finally since they are easily manipulated and controlled genetically. The facility of genetic control has made it possible to develop a radiation resistant strain of E.coli which in this work is used for comparison with an ordinary strain.

E.coli were exposed to bombardment by neutrons, accelerated deuterons, and α-particles by allowing a water solution containing them at a known density to be soaked up by a cube of agar $1 mm^3$ in volume which was then placed on a table that could be moved in and out of the beam with fine adjustment. After bombardment, the agar containing the bacteria was dissolved in saline solution, and this solution soaked into fresh agar. After an incubation of 24 hours, visible bacterial colonies on the fresh agar plates were counted. Each such colony was considered as having grown from a single surviving bacterium. On the basis of this count and the known density of bacteria in the bombarded solution, the survival fraction S,

$$S = \frac{\text{no. of colonies}}{\text{no. of exposed bacteria}}$$

was computed and plotted on semi-log paper as a function of dose received by the bacteria. A typical plot of this kind for neutron irradiation is shown in Fig. 1.

Here, B/r represents the survival curve for the radiation resistant strain and B, the curve for the sensitive strain of E.coli.

To explain curves of the type of Fig. 1, some authors have prepounded the "one-hit theory" of destruction of cells by radiation. To account for the exponential character of survival curves, the absence of a dosage threshold for cell destruction and the instantaneous proportionality between the number of cells destroyed in unit dosage interval (time interval) and the number of cells present were interpreted as indicating an independence between the killing mechanism for individual cells and dosage. These facts were considered evidence for the theory that cell destruction occurred by the effect of a radiation unit, particulate or electromagnetic, on a sensitive volume of the cell.

According to this theory a fixed dosage of radiation (dosage being measured in terms of ionization) from a beam of highly energetic particles would be expected to have a more destructive effect (survival curve with gentler slope) on cells than a beam of slow particles since highly energetic particles are less ionizing than slow particles and therefore more energetic particles than slow particles must impinge on a certain volume to make up a fixed dose. An experiment was carried out to test this prediction of the "one-hit" theory. The energy of deuterons was degraded by varying thicknesses of absorbers and it was found that the survival curve due to particles of the low-range portion of the Bragg curve had a gentler slope than that due to particles of the peak. Thus it was found that the destructive effect of a certain dosage due to energetic particles is less than that due to less energetic particles. This result is quite contrary to the conclusion from the "one-hit theory". The cross section exposed to the beam of the sensitive volume postulated by this theory was found to vary with energy as set forth in the following table.

Strain of E.Coli	Deuterons at	
	Beginning of Bragg Curve	End of Bragg Curve
B	.004	.031
B/r	.0021	.017
Cross Sections of Senstive Volume of Cells (square microns)		

A similar result was obtained by exposing bacteria to α-particles from a polonium source.

Energy Distribution of Cyclotron Beam in Targets. W. J. Knox.

In a previous report measurements of the average number of traversals of targets of different thicknesses by the cyclotron beam were discussed. Empirically determined correlations of the average number of passages through targets of different materials at different thicknesses were presented and compared to a first order calculation that took account of multiple small angle scattering in the target, energy loss through attenuation, and beam losses through the impact of scattered, oscillating particles with the dee structure. Reasonably good agreement was found between the results of the calculation and the measurements. Therefore, the reasoning used in the calculations was deemed to be sufficiently valid to be applicable to the formulation of preliminary estimates of the energy distribution in targets of protons which had been accelerated by the cyclotron to 350 Mev. These estimates are shown in Figs. 2 and 3. For ease in comparison, the areas under the curves have been normalized to the same value.

Study of Excited States in Be^7 Using the Li Technique. G. Keepin and F. Gilbert.

In order to verify the surmised existence of excitation levels at 220, 430, and 750 Kev in the Be^7 nucleus, the energy of neutrons arising from the reaction $Li^7(p,n)Be^7$ was measured by the Li^6 loaded photographic plate technique.

The experimental arrangement is sketched schematically in Fig. 4. The proton beam from the Van de Graaff machine is passed through the steering magnet and thence through a 90^o analyzing magnet after which it is collimated further by two narrow slits separated by 35 inches in order to obtain monoenergetic protons of 3.0, 3.6, and 4.35 Mev with an uncertainty of ± 15 Kev. The target of natural lithium evaporated onto a copper plate to a thickness of less than 25 Kev was contained together with the proton trajectory in an evacuated volume from which carbon vapor was trapped by a cold finger. Neutrons emitted incident to the reaction $Li^7(p,n)Be^7$ were captured in lithium impregnated photographic plates placed at three angles, 0^o, 30^o, and 90^o to the direction of impinging protons.

Neutrons were detected and analyzed as to energy by observing the α- and triton tracks arising from the reaction $Li^6(n,\alpha)H^3$, noting the sum of the track lengths and the angle at which the tracks are inclined to the direction of incident neutrons. The details of this procedure are described in UCRL-790, 'Improvements in the Li^6 Technique' by George R. Keepin Jr. 700 tracks were observed at each angle and energy. The results of measurements at 3.6 Mev and 90^o are shown in the graph of Fig. 5.

Peaks of neutron intensity at certain energies indicate the possible existence of an excited level in the Be^7 nucleus that remains after the compound nucleus Be^8 has emitted a neutron. High observed neutron energies are correlated with low energy levels in the Be^7 nucleus. Preliminary indications are that levels at 220, 430 and 750 Mev do indeed exist. Definite conclusions can however not be stated at present and must await more careful analysis of the data.

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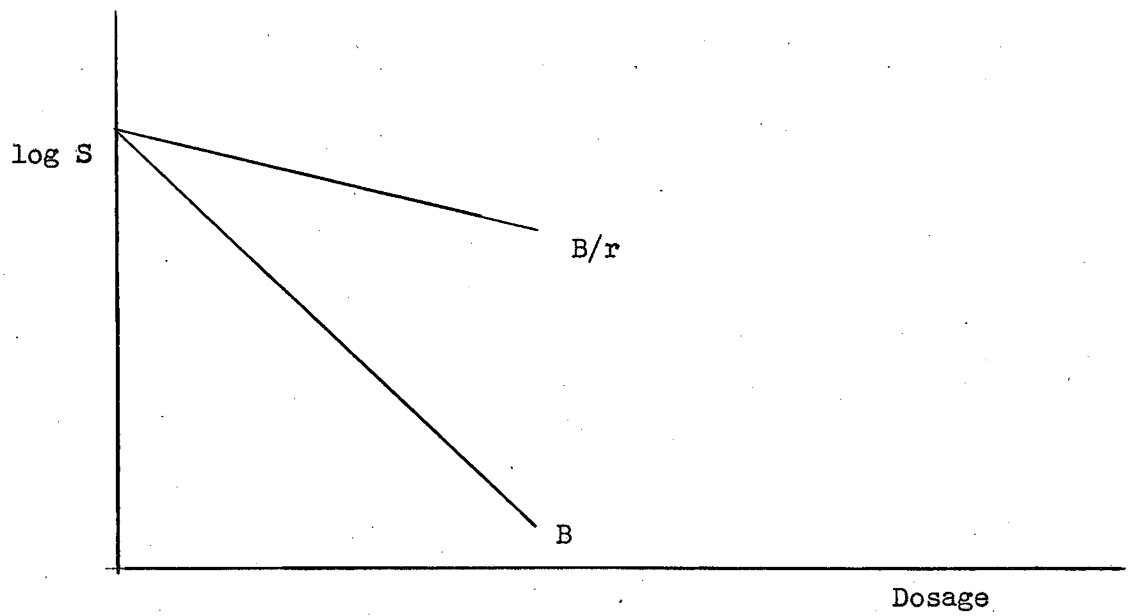


Fig. 1

Log Survival Fraction vs. Neutron Dosage for E.Coli B and B/r.

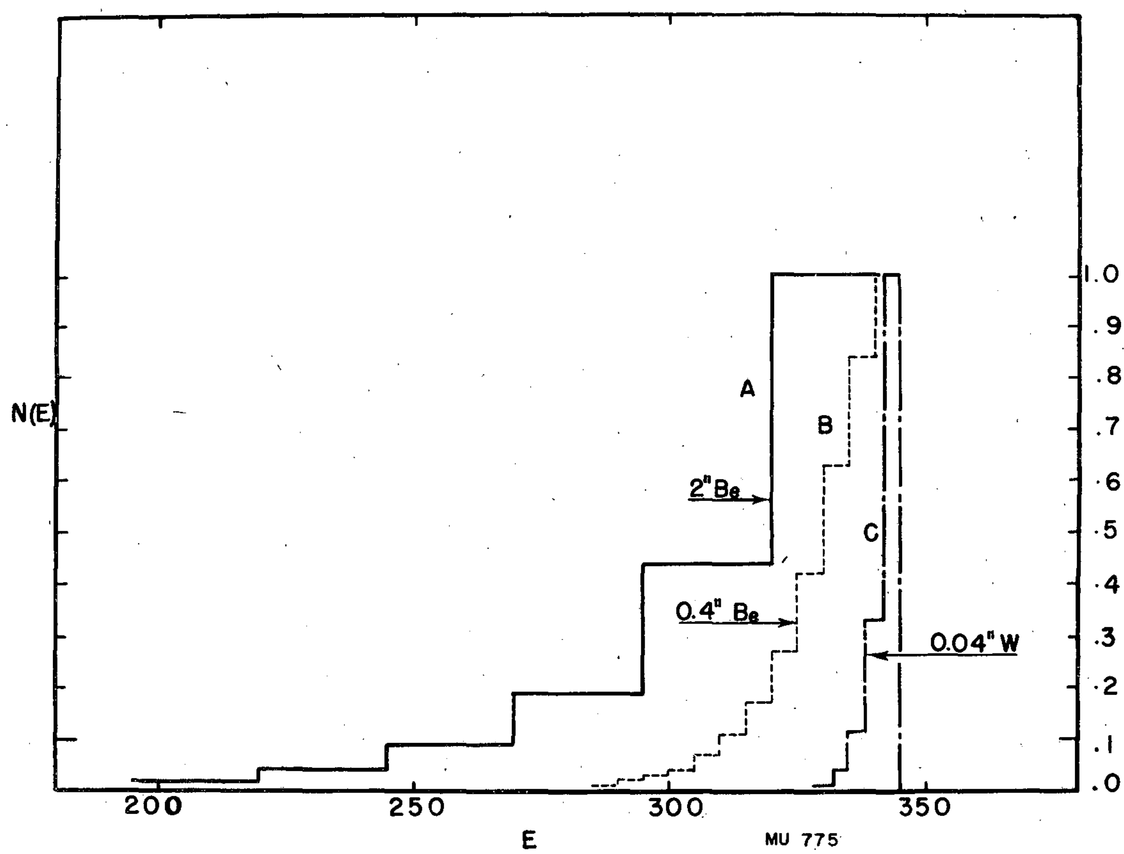


Fig. 2

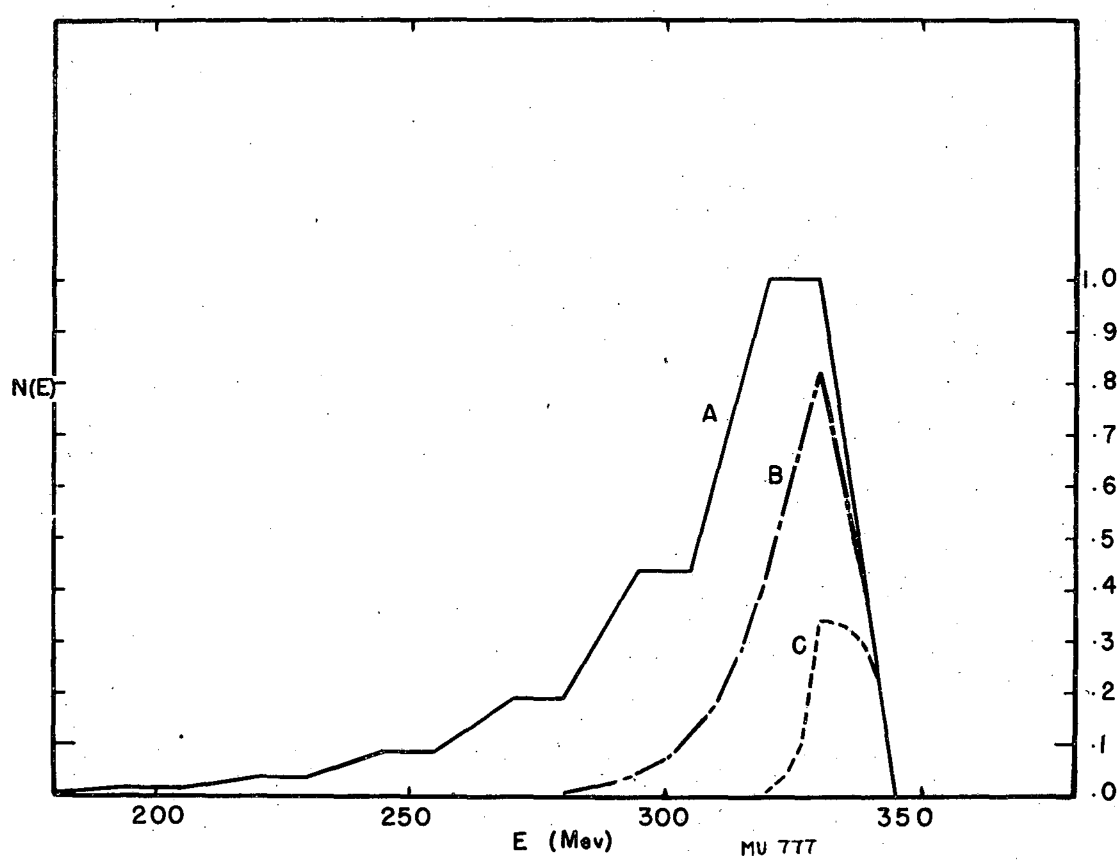


Fig. 3

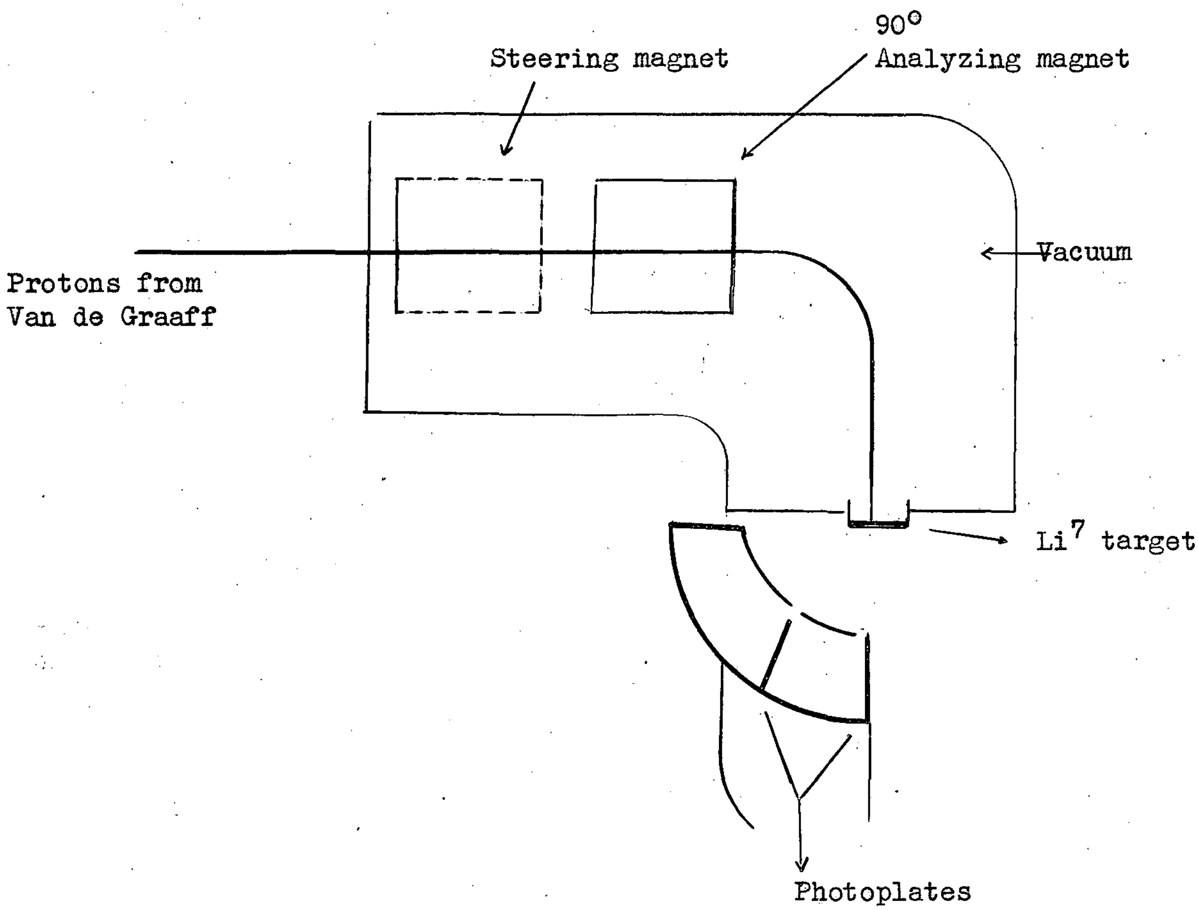
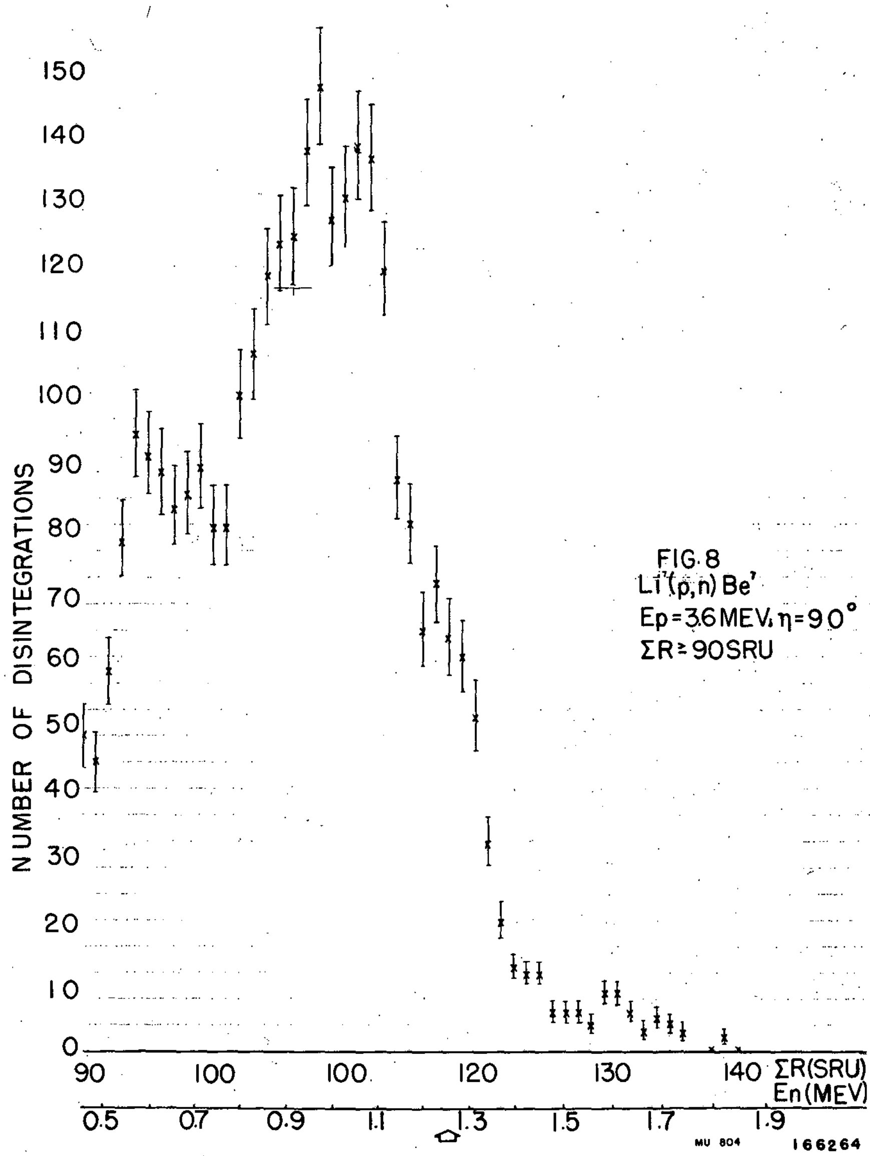


Fig. 4

Apparatus for Investigating Excitation Levels in Be^7.



NUMBER OF DISINTEGRATIONS
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
90
100
100
120
130
140
ΣR(SRU)
En(MEV)
0.5
0.7
0.9
1.1
1.3
1.5
1.7
1.9
FIG. 8
Li⁷(p,n) Be⁷
Ep=3.6 MEV, η=90°
ΣR≥90SRU
MU 804
166264

Fig. 5