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RESEARCH GROUP

NUCLEAR PHYSICS DIVISION PROGRESS REPORT

For the period

1st November 1967 to 30th April 1968

Editor: C. F. COLEMAN

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Nuclear Physics Division,

Atomic Energy Research Establishment,

Harwell, Berkshire.

1968

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INTRODUCTION

Dr. B. ROSE

During the past year or so there has been a marked resurgence of interest in fission theory, originating in the calculations of Strutinsky, who showed that the curve of potential energy against deformation parameter for heavy nuclei should have two minima. The first of these corresponds to the normal equilibrium configuration, the second to a state of higher deformation and higher energy, from which in certain cases delayed fission may occur. The existence of the second Strutinsky minimum may manifest itself in many different phenomena. Some examples reported here are the sub-threshold neutron-induced fission of ^{234}U, fluctuation analysis of the fission cross section of ^{239}Pu and the anomalously large value of $\alpha(E)$ for ^{239}Pu in the 1-10 keV region.

A particularly difficult measurement which has now been completed is the measurement of the neutron scattering cross section of ^{10}B in the energy range 1-80 keV. The motivation here was the need to establish the energy variation of the $^{10}B(n,\alpha)^{7}Li$ cross section for standardisation purposes, but it has led to a direct observation of the theoretically expected small constant term in this cross section.

A study of the energy dependence of the neutron capture cross section of iron and of a sample of stainless steel has revealed the potential value of such high resolution measurements for detecting small amounts of neutron absorbing impurities and has also provided a possible explanation for the large variations in the values of the iron resonance-integral measured by reactor methods.

A detailed study of the measurement of a particular nuclear gamma ray lifetime by the Doppler-shift technique has revealed that the apparent value of the lifetime obtained in this way depends markedly on the nature of the material in which the recoiling nucleus is slowed down. This fact implies that the conventional theory of the slowing down of such nuclei is very unsatisfactory, and that measurements of apparent lifetimes may be used to provide a critical test of such theories. In this connection a promising start has been made on a theoretical explanation of a related phenomenon - the large variations of atomic stopping power with the Z of the moving ion.

The division's work is of course largely centred around its accelerators. Several of these are undergoing extensive modifications. During the last six months the '5 MV' Van de Graaff has been rebuilt, and has achieved 7.5 MV without an acceleration tube. A new ion source has been installed on the tandem generator and has delivered greatly improved analyzed beams of protons, deuterons and oxygen ions. Finally the Cockcroft-Walton set, which has been rebuilt primarily for work associated with the ion-implantation and channelling programs, has delivered its first full energy beam. These modifications will help to maintain the high standard of the division's work in the future, and to provide an improved service to other Harwell programs.

EDITORIAL NOTE

Since the results obtained from the various machines are not easily classified according to the energy of the charged beams, individual research items are labelled with a single letter indicating on which machine the experiments were performed. These labels are as follows:-

Cockcroft Walton Generator (A. T. G. Ferguson)	A
3 MV pulsed Van de Graaff Generator IBIS (A. T. G. Ferguson)	B
5 MV Van de Graaff Generator (A. T. G. Ferguson)	C
13 MV Tandem Generator (J. M. Freeman)	D
45 MeV Electron Linac (E. R. Rae)	E
50 MeV Proton Linac : S.R.C.	F
Variable Energy Cyclotron : Chemistry Division	G
Synchrocyclotron (A. E. Taylor)	H
Nimrod Proton Synchrotron : S.R.C.	I

The running analyses for the various machines operated by the division are presented as far as possible in a uniform format, but some differences exist in the way in which the scheduling is arranged, and machines such as the Electron Linac can accommodate several experiments simultaneously.