Physics Research in a Small Institution

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Research in physics has long been regarded as belonging primarily to universities and larger institutions. Because of the greater concentration in these centers of conditions favorable for research, it is to be expected that they will continue to lead the way in this field. However, we have come into a day in which there is a growing feeling that a modest research program is not inconsistent with the teaching function of a liberal arts college and that it may well serve to round out the contribution a small institution is able to make.

Since a small institution must usually operate on a very limited budget and is probably more often than not understaffed, any proposal that a research program either large or small be added is not usually received enthusiastically. With the press of departmental duties and the added responsibilities imposed by the administration to keep the institution running, it seems to the harassed faculty member there can be no time left for anything as elusive as research. Also, however enthusiastic the college teacher may have been about the research problem he undertook in his graduate program the problem may now have become obsolete or else the project was too unwieldy to lend itself to any facilities he may now have available. Other than that no worthwhile project seems to present itself, and without a research project he correctly reasons no research will be possible. Furthermore, the department is rigidly budgeted and to ask for any major increase in his budget would be unfair to other departments, and probably institutional funds would not be adequate to cover his request in any case. These three obstacles of no time, no project, and no money cannot be taken lightly, for it may well be they can be overcome only with difficulty. But if our experience in the physics department at Manchester College is any criterion these obstacles are not insurmountable. Our experience is outlined with the thought that it might be of some value to others who may be interested in developing a research project.

We have found at Manchester that no activity of the department makes more of an appeal to our best students than does our research project. It has therefore been comparatively simple to form a small research group of good students who are eager to help to the limit of their ability. In addition to the benefits accruing to the students involved, their help with details has served to greatly extend the time the research director has had available.

The selection of a suitable project was made possible by the advice and help of those in research in larger centers. Many of you remember the Nuclear Emulsion Conference held at DePauw in April, 1955. This conference sponsored by the DePauw department of physics and the National Science Foundation was a frank attempt to bring together those who were experts in nuclear emulsion research and those who were interested but who only vaguely sensed the possibility of research in this field. For some of us in attendance a chief value of the Conference was the revelation that those in larger institutions were deeply interested in sharing their experiences and know-how with those of us in small centers and in helping us initiate research programs suitable to our limited facilities. As a direct result of this inspiration, visits were made from Manchester to several institutions for consultation on the best research project suitable to our situation. Excellent help was gotten from various members of the Purdue staff and from Dr. M. L. Pool of Ohio State. Later conferences with Dr. S. B. Burson of Argonne and Dr. P. R. Bell of Oak Ridge provided extremely valuable help. In all of these contacts a genuine interest which extended beyond the call of duty for the men involved was shown in helping to initiate a research program at Manchester on an elementary level. As a result of these contacts it was decided to attempt work in gamma ray spectroscopy.

Since this would require funds beyond our budget, a number of possible sources for financial help were considered, with the final decision to apply for a grant from the Research Corporation through their midwest representative, Mr. Walter E. Thwaite. The problem in which we wished to work was definitely phrased and our application submitted. Before presenting our application to their Board, Mr. Thwaite made a personal visit to acquaint himself with our situation, and in due course we were notified of the consideration of our application and of favorable action on it.

After securing advice from those who were working in gamma ray spectroscopy, equipment for constructing a single channel gamma ray spectrometer was secured and assembly begun. The apparatus includes a scintillation probe followed by a linear amplifier and pulse height analyzer with power supply, scaler and register. The probe consists of a thallium activated NaI crystal, 1¾″ in diameter by 1″ thick, optically sealed to the face of a photomultiplier tube. A gamma ray entering the crystal produces a scintillation which is translated by the photomultiplier into an electrical pulse whose energy is proportional to the energy of the gamma ray. The linear amplifier serves to amplify these pulses still maintaining the proportionality of their energy to the energy of the gamma ray which gave rise to them. The pulse height analyzer permits only those pulses to pass whose energies lie within a range determined by the setting of a pulse height or energy range window. The pulses which are allowed to pass are recorded by the scaler and register for a predetermined length of time or the time of a predetermined number is taken. The pulse height analyzer may be adjusted to respond to pulses through a wide range of energies. It is thus possible to record and plot the number of gamma rays per minute of specific energies entering the probe over a wide range of energies. This constitutes a gamma ray spectrum characteristic of the source in which the gamma rays originate.

Since this is not an absolute method for determining gamma ray energies, comparison must be made with the known gamma ray spectra of various radioactive standards. This is in effect a calibration of the instrument and for accurate work this calibration must be rechecked each time an unknown spectrum is run. We have had this apparatus in use for somewhat more than one year. This has been long enough to learn something of its possibilities and its limitations.

One limitation is the inability with a single channel instrument to distinguish between gamma rays resulting from successive energy changes in a given nucleus from those which result from single energy changes in different nuclei. In the search for nuclear energy states this may give a false picture of energy transitions. This difficulty can be relieved by developing a coincidence circuit and the possibilities of the spectrometer thereby greatly extended.

To achieve this end in our project at Manchester application was made to the Research Corporation for a renewal of their grant. This request was considered favorably, and we are now in the process of adding equipment and building a coincidence circuit. To detect gamma rays which result from successive nuclear energy changes and are practically coincident we are using a second probe. This necessitates a second amplifier and pulse height analyzer. We will also add two scalers and registers. One high voltage supply will serve both photomultiplier tubes. The block diagram, Fig. 1, indicates the relation of the component parts, ignoring the high voltage supply. The coincidence circuit is a set of trigger circuits so designed that it will register counts only when pulses are fed into it simultaneously or nearly so from both probes 1 & 2.

In use, analyzer 1 may be set on a chosen gamma ray of any energy and analyzer 2 moved through the spectral range. Scaler 3 will then record counts on those gammas from circuit 2 which are in coincidence with the gamma ray setting of circuit 1. What seemed before to be unrelated gamma rays from energy changes of different nuclei of the isotope under investigation are now seen to be successive energy changes of the same nucleus. This makes possible a more certain identification of energy level transitions in whatever radioactive nucleus is under investigation.

For those who are already expert in the theory and operation of this type of scintillation spectrometer this account will seem completely elementary. For the rest of us, at least for those of us both students and faculty who are developing this equipment at Manchester, it is an exciting and rewarding adventure. We will, of course, be constantly endeavoring to secure data that will make a valuable contribution to this field of physics. It seems worthwhile to point out, however, that whether or not there are significant findings in the special problem under investigation some extremely valuable by-products are accruing. Among these it may be noted there is a general increased interest in physics in the institution, intellectual horizons in the department have been widened, and a definite stimulus toward graduate study and advanced research on the part of the better physics students has been aroused. Perhaps the by-products may in the long run prove to be the most important.

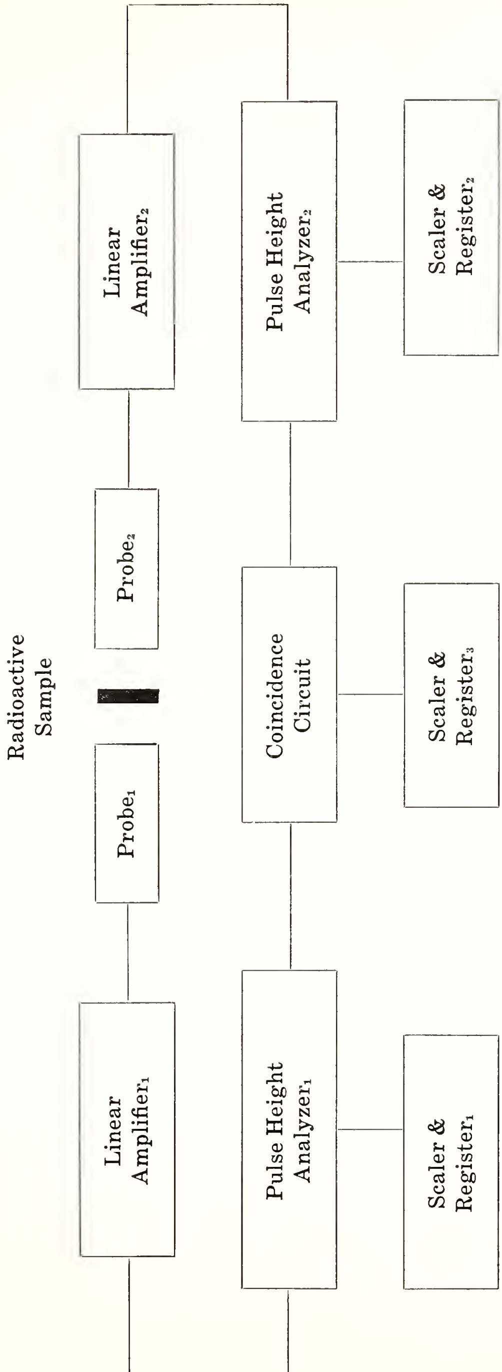
Radioactive Sample
Probe$_1$
Probe$_2$
Linear Amplifier$_1$
Linear Amplifier$_2$
Pulse Height Analyzer$_1$
Pulse Height Analyzer$_2$
Coincidence Circuit
Scaler & Register$_1$
Scaler & Register$_2$
Scaler & Register$_3$

FIGURE 1