Laboratory Manual for Nuclear Physics

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Contents

A Note to the Reader

This Manual is intended for use in the Nuclear Physics Laboratory of the M.Sc (Previous) class.

The Manual is organised into 10 Chapters. The first 4 Chapters provide the theoretical background for the experiments which are performed in the laboratory. Chapter 1 is a fairly detailed introduction to the Statistical Tools which are required to analyse the experiments. It includes topics like distributions, Error Analysis and Goodness of Fit etc. Most of these topics are familiar to you from your undergraduate days. However, they are presented in enough detail here and they do not assume any prior knowledge of statistics.

Chapter 2 and 3 are a review of nuclear physics concepts which are required for the experiments. These include radioactive radiation (alpha, beta and gamma rays) as well as their interaction with matter. This material, once again, should be familiar to you and it is presented here for review. However, again, the material is complete and does not assume any prior knowledge. Most of the experiments carried out in the laboratory use a Geiger Muller counter. This is discussed in detail in Chapter 4. Although the first 4 chapters provide you with enough information to be able to do the experiments, they are **Not** meant to be a substitute for the books which discuss each of these topics in detail. There are many excellent books available on these topics and you are encouraged to go through them.

Chapters $5 - 10$ are detailed discussions of the experiments which are available in the laboratory. For each experiment, the procedure is discussed and sample data is given. This sample data is then analysed and the errors and results are obtained. It is important for you to understand well the calculations given here so that you can do the same with the data that you obtain in the laboratory yourself.

Each Chapter has some questions in the end which you are encouraged to attempt to answer to test your understanding of the theory and the experiments.

There are 7 Appendices in the Manual. There is an appendix which discusses the use of Microsoft Excel program to do data analysis and plot graphs etc. There is also an appendix which discusses the use of GNUPLOT to plot graphs in case you want to use a Linux platform. In addition, the detailed theories for radioactive equilibrium and alpha, beta and gamma decay are also given in the Appendices.

The computers in the Laboratory and possibly the one you have at home are using the Windows operating system which do not have a native C compiler or GNUPLOT. However, it is easy to install a Linux emulator on your machine.

Go to **https://www.cygwin.com/** and download and install the program Cygwin. This will come in two versions- Cygwin32 and Cygwin64. If you have a 64-bit computer then install Cygwin64, else install Cygwin32. Once installed, run the program as you run any windows program, that is by double clicking on the icon. This will open a small window. In this type **startx**. This will open a terminal on your screen, exactly like the one you see in the laboratory on the Linux machines. It is as if, your Windows machine has turned into a Linux machine. You can run all the Linux OS programs like **Gnuplot, gcc, emacs** etc. in this terminal. Once you are finished, just type exit and you will return to your Windows environment.

We would very much like to get your suggestions regarding how to improve this Manual. In addition, if there are any errors or misprints that are spotted in the Manual, we would like to hear from you. Please send a mail with the suggestions/errors etc. to **shobhit.mahajan@gmail.com** making sure you quote the version number of the Manual as well as the Modification date of the Manual you are using. The version number and date are on the title page of the Manual.

Finally, it is important to realise that this manual can only help you with your experiments. Ultimately, it is essential that you perform the experiments yourself and then do the data analysis with the help of the tools discussed in the Manual. Unless you do the actual experiment and the calculations yourself, you will never learn the subject.

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