Introduction

This booklet is a companion to the A-level computer software - '**L**ancaster **P**article **P**hysics'. The software itself contains enough information to 'stand alone', but this booklet covers in greater depth the information and help pages contained within the program and it is recommended that, where possible, both are used in conjunction.

The software package is designed for use by students studying A-level modules in particle physics. Its main aim is to allow students to conduct particle physics experiments, in the classroom, via computer simulation (PC based). This booklet shows how to install and run the program and takes the user through each exercise in detail. The students should already be aware of most of the terminology and formulas, contained in the software, before starting the various exercises. Where needed, additional information and discussion is given and the derivation of some formulas shown, making the booklet of use to both students and teachers. However, if the user wishes to disregard this preamble then all the important formulas (those required for each exercise) are shown boxed for easy reference. In places the software introduces physics which goes beyond the A-level syllabus, this is intended to extend the students' knowledge and stimulate discussions.

The five sections of this booklet correspond to the five 'Options' in the software, of which the first four include exercises. It is estimated that each exercise will take a student between one and three hours to complete, but this is only a guide. The actual time will probably be influenced more by the teachers discretion and the availability of PC's than student ability.

Section 1 covers the exercise **'Billiards'** which re-familiarises the student with the conservation of energy and momentum in a non-relativistic system, i.e. when playing billiards or pool. Section 2, **'Particle Annihilation and Creation'**, compares i) stationary target experiments with ii) colliding beam experiments and serves as an introduction to the following options, which are all concerned with particle physics. Section 3, **'Charged Particle Motion in a Magnetic Field'**, allows the student i) to make measurements of charged particle tracks, ii) to use their knowledge of the relativistic equations of the conservation of energy and momentum to calculate the particle masses, iii) to identify the particles. Section 4, **'Lifetime'**, simulates the decay of the neutral particle, the kaon (K^0), into two pions (p^+, p^-). The student can make measurements and use their data to determine i) the K^0 mass and ii) mean lifetime. Finally Section 5, **'ALEPH'**, shows the students some real data from an ongoing experiment.

ALEPH is one of four detectors at CERN detecting the debris from high energy electron-positron annihilations.

Computer Requirements:

'**L**ancaster **P**article **P**hysics' is intended to be PC based. The minimum computer requirements are:

Computer:	IBM PC compatible 386, 486 or higher; with mouse.
	Minimum 16 MHz CPU (33 MHz or higher recommended)
Memory:	4MB (8MB recommended)
Video:	VGA 16 colours, 640 × 480 resolution (or higher)
Operating System:	DOS 5.0 or higher and Windows 3.1, 3.11 and Windows 95.
Sound:	no sound card needed.

How to Install:

To install your copy of '**L**ancaster **P**article **P**hysics'

1. Insert the distribution disk into your A: or B: drive.

2. Start Windows.

3. *Either*: from the Microsoft Windows Program Manager, select Run from the File menu and type:

a:setup

Or: run File Manager and open a window for the distribution disk in your A: or B: drive. Click on the file:

setup.exe

'**L**ancaster **P**article **P**hysics' will now be installed. Follow the dialogue boxes which ask you in which directory you want the software installed. If you have no preference then the installation program will create its own directory on your computer hard disk drive called **'collisn'**. Once installation is complete a dialogue box will inform you; click the OK button.

A window and program icon for '**L**ancaster **P**article **P**hysics' will then appear. You can now remove the distribution disk.

(Warning: During installation you may get a message box which says that file A:\DDEML.DL_ is already in use. Don't worry! If this happens click the OK button and the installation will continue as normal)

To Start '**L**ancaster **P**article **P**hysics' double-click on the program icon with the mouse pointer.

Navigating your way around '**L**ancaster **P**article **P**hysics'

Upon starting '**L**ancaster **P**article **P**hysics' you are presented with the Lancaster University logo page. Click the OK button and the logo page disappears to be replaced by the window shown in Figure I. As you can see this window contains a smaller window with text and four command buttons. This is the start-up page for the exercise 'Billiards'; the text describes how to run the exercise and what to calculate. (Each new option/exercise starts off with a text page and it is recommended that the student reads this before continuing)

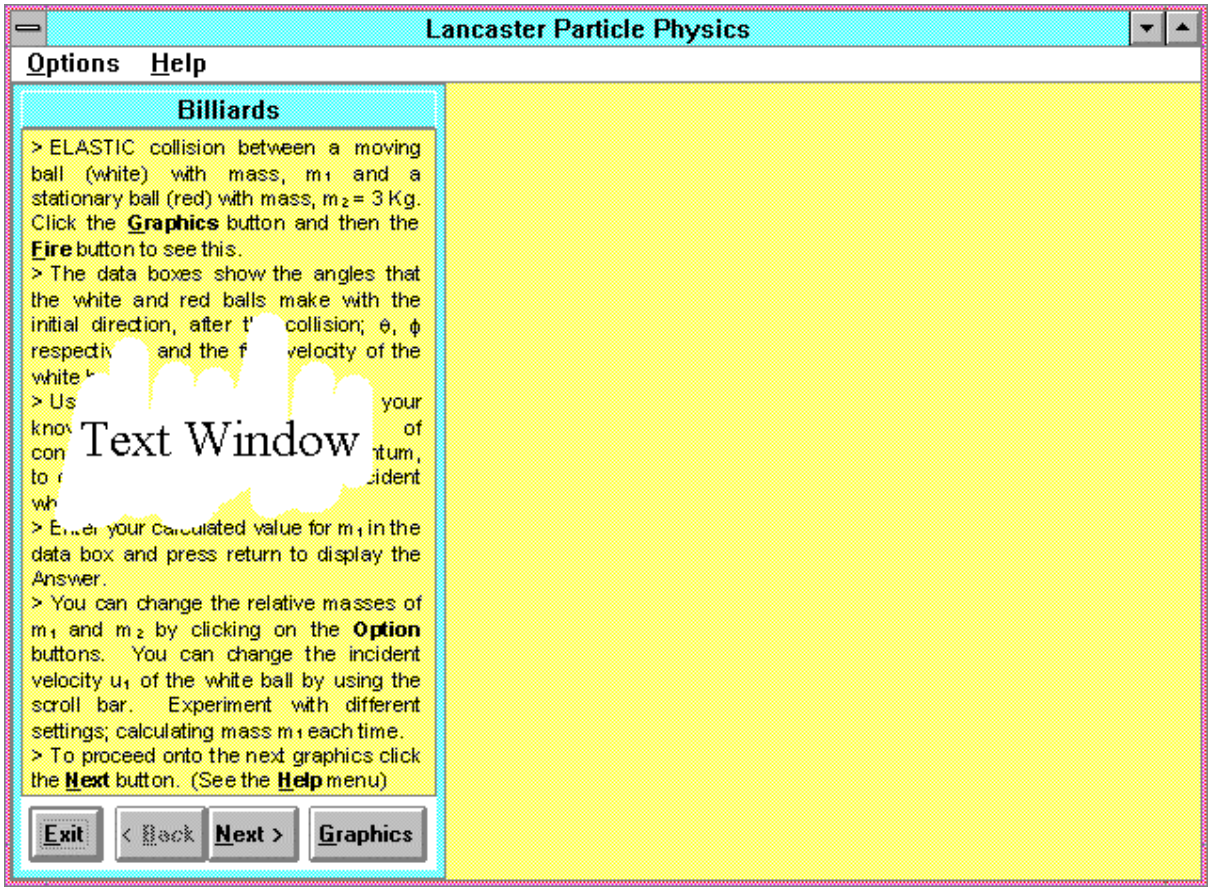

Figure I 'Text window'

The four command buttons are: 

- When you click the Graphics button a new window is displayed as shown in Figure II. This is the graphics window associated with the 'Billiards' option. (Each new option/exercise has a graphics window which can be opened by clicking the Graphics button in the text window. It is in these graphics windows that the simulations of particle interactions take place)

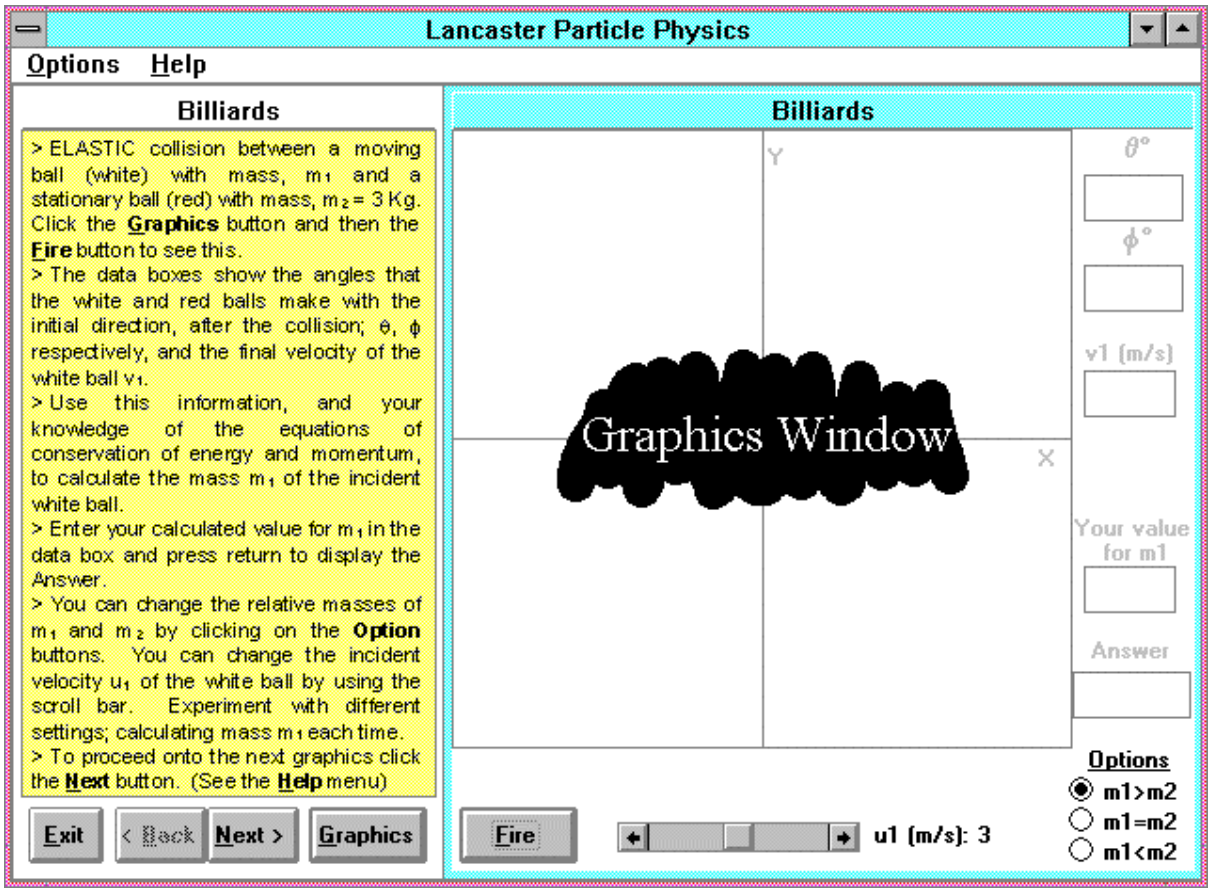

Figure II 'Graphics window'

- When you click the Next button you move on to the next option/exercise and a new text box appears. (All previous windows for the last option are automatically closed. In essence each option or exercise is a mini self-contained program)
- When you click the Back button you move back to the previous option/exercise. In 'Billiards' the Back button is disabled and inoperative (appearing dimmed) because there are no previous exercises. (Once you click the Next button the next option/exercise is loaded and the Back button is now enabled. Hence by clicking the Next and Back buttons

one can move sequentially, forwards or backwards, through the various sections of '**L**ancaster **P**article **P**hysics')

- To terminate the program click the Exit button.

Note: the underline on the prefix character of the command buttons allows the user to either click the button, using the mouse and mouse pointer, or press Alt-*key* (where *key* is the underlined character).

Alternatively by pressing the Tab key the user can move the keyboard focus from control to control. You can easily recognise when a control has the focus: when a command or option button has the focus, a dashed rectangle surrounded its caption; when a scroll bar has the focus, its thumb starts to blink; when a text box has the focus, a cursor inside the text box blinks.

When an object has the focus you can use the keyboard, instead of the mouse, to control this object. With a command or option button, pressing Enter/Return (or the space bar) has the same effect as clicking the button with the mouse pointer. With a scroll bar you can use the left and right arrow keys to move the position of the thumb.

If you have two windows open, as shown in Figure II, you can move the window focus by pressing Ctrl-F6, together. When a window has the focus (its border is shaded) you have access to all its controls using the Tab or Alt keys as before.

Certain command buttons respond to the Esc key irrespective of which control has the focus. These are the Exit buttons in the text windows and the OK buttons in the Help windows and *ERROR!* dialogue boxes. For example if a text window had the focus and the Esc key was pressed, the program responds as if the Exit button was clicked and so terminates.

There is a second method for navigating through '**L**ancaster **P**article **P**hysics'. Instead of using the Next and Back buttons one can click on the Options menu, displayed on the menu bar of the main window as shown in Figure III. The program responds by dropping down a list of all the options/exercises contained in '**L**ancaster **P**article **P**hysics'. A check mark indicates which option is currently open. Hence by clicking on an option one can 'jump' to that particular section without having to go through the previous exercises. (Note: this is only recommended for experienced users of '**L**ancaster **P**article **P**hysics'; beginners should work through each option, because each exercise is designed to follow on from the last) The Options menu can also be used to terminate the program by clicking the option Exit.

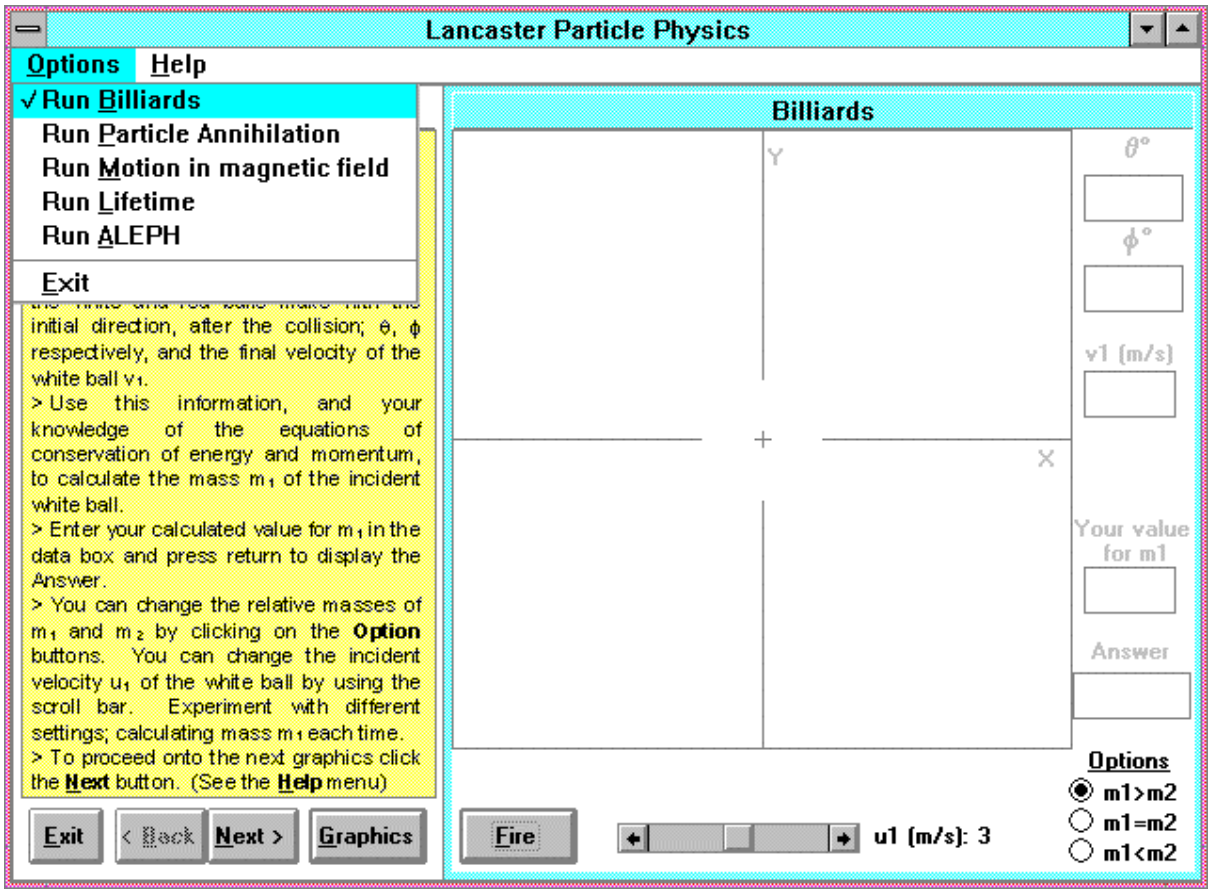

Figure III 'Options menu'

Help pages

The menu bar also contains the Help menu. Clicking this produces a drop-down list of help pages for each option, as shown in Figure IV. These help pages are very important because they contain additional information on how to run each exercise, including hints and answers. In some instances it may be beneficial for the user to read these pages first, before starting an exercise.

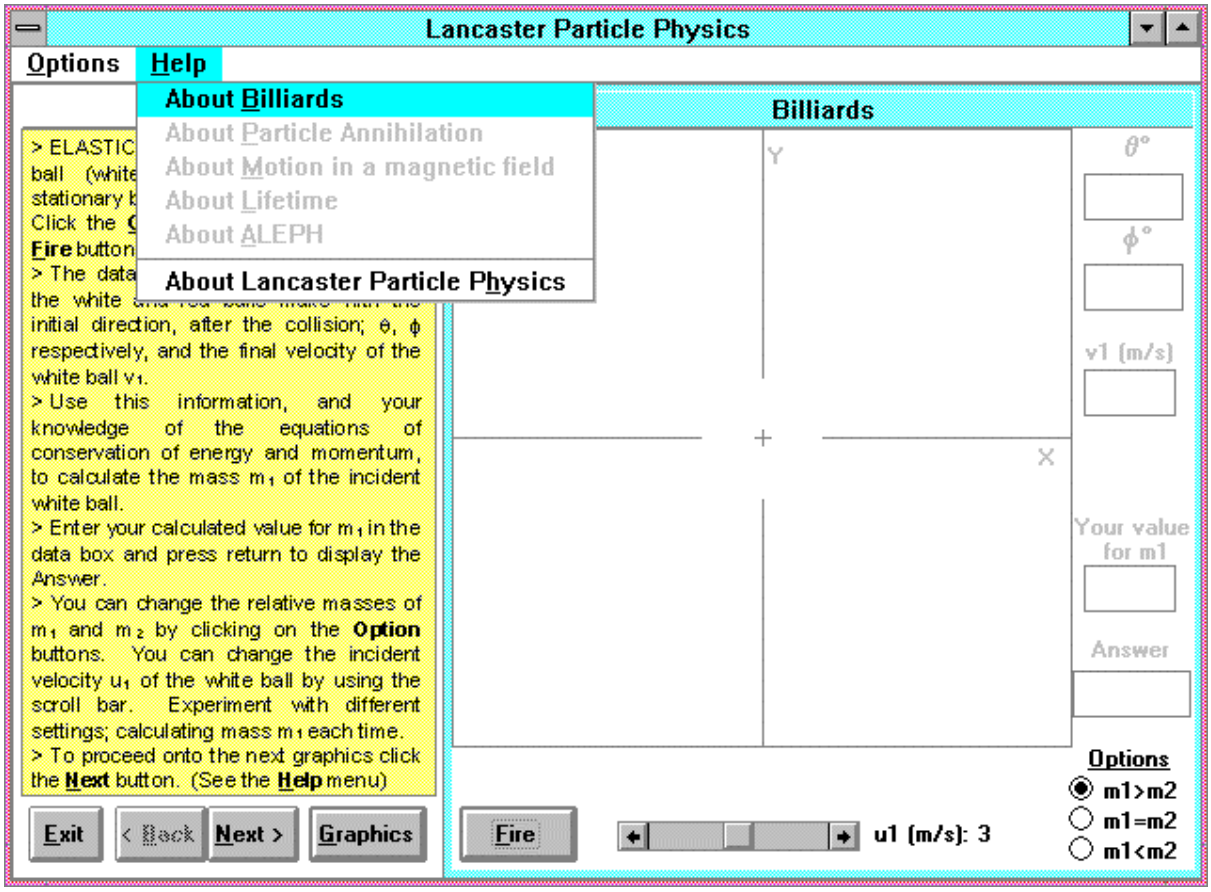

Figure IV 'Help' menu

Note: the Help pages for each option are only available when that option is open; the other help options being disabled and appearing dimmed. To open a Help page click on the menu title; this will open the help window as shown in Figure V. Click on the OK button to close the help window. In the later options/exercises the help windows have more than one Help page; these can be viewed by clicking the << >> buttons found at the bottom right hand corner of the window.

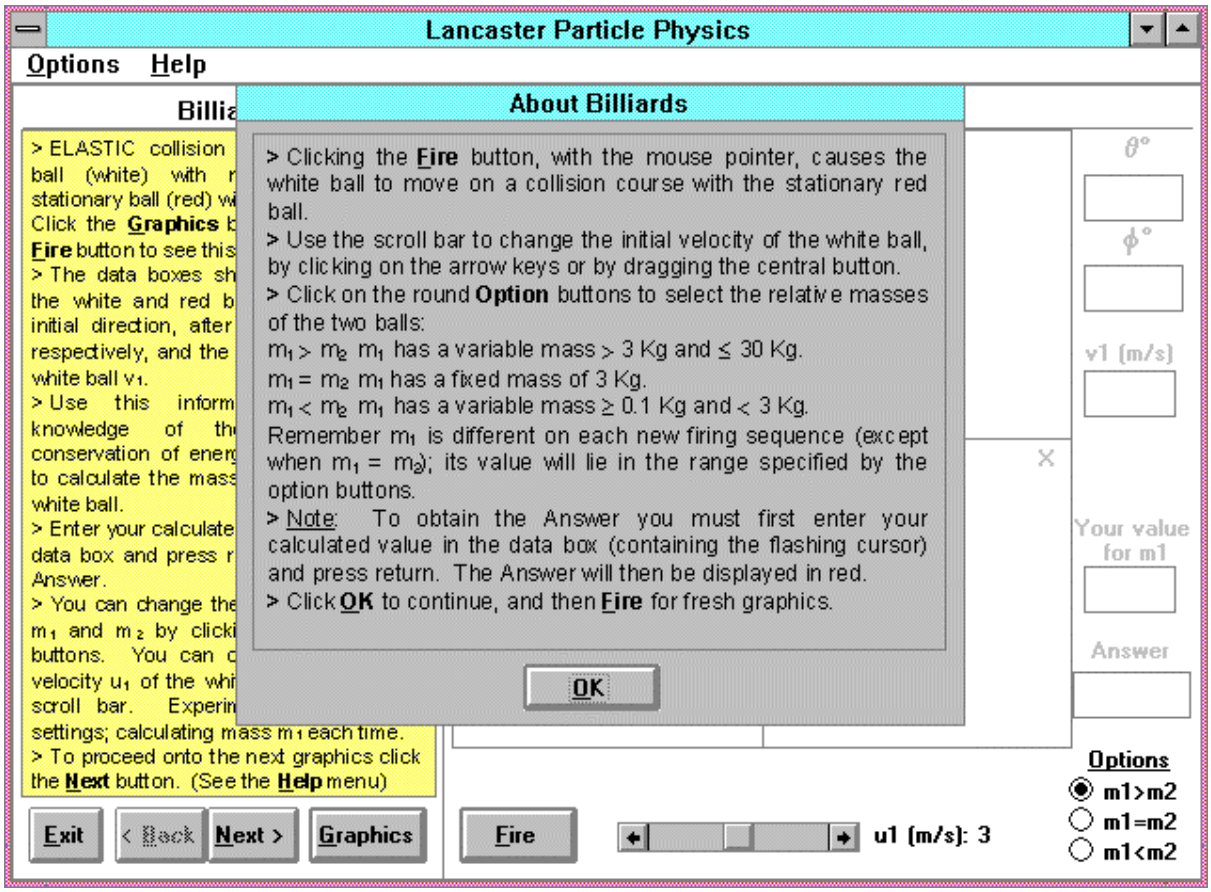

Figure V ‘Help window’