

# **Lab Introduction: 33-353, INTERMEDIATE OPTICS**

Fall 2010

## **Lab Safety**

Respect all lab safety instructions. Lasers used in the lab are low-power devices which may seem innocuous. However, if you look into their beam through an optical instrument, they still may wreak havoc with your eyes. Above all, use common sense to avoid unsafe situations!

## **Lab Write-Ups**

### **Requirements for Laboratory Write-ups**

All data from your experiments, as well as all analysis, graphs, and written conclusions, should be recorded using the blue Laboratory Notebooks provided to you in class. If you fill up one of these books during the course of an experiment, ask the instructor for another book. Although most of you will carry out your laboratory measurements with a partner, each of you must submit a separate write-up, including all raw data as well as all details of the analysis performed. Your write-up should include the name of your partner, but at no place should it refer to the content of your partner's laboratory notebook, i.e. yours and your partner's write-ups should be separate and independent.

All of your records from the laboratory, as well as all analysis, should be recorded in your notebook. Handwritten entries are encouraged throughout, although they must be legible. If you find that some entry, e.g. the outline of a table, is incorrect, then it's fine just to draw a line through that page and go one to the next page. Don't waste time erasing things (and, in principle, it's better to work in ink than in pencil). Of course in some cases you will have computer generated graphs or tables as part of your analysis, and these should be taped or stapled into your notebook.

### **Contents of Write-up**

Your write-up should contain the following items:

- (1) A title
- (2) Purpose of the experiment (one page maximum)
- (3) Results:

This section must contain subsections clearly indicating the different parts of the lab exercise. A diagram of the apparatus should be included here *only if needed to define some dimension or angle of the apparatus*. Within each subsection you should list your results for that part of the lab, including raw data along with other sketches, diagrams, or explanatory information

about the data or the experimental procedure. Estimate of errors should be provided here along with an explanation of how those estimates are arrived at.

(4) Data analysis:

This section will contain the analysis (data reduction, error analysis, graphs, etc.) leading to the final conclusions for each part of the lab. Note that occasionally it might not be clear whether some item belongs in the Results or the Analysis section, but don't worry about that. Just list the work as you do it, having just one occurrence of each part of the laboratory exercise within the Results and Analysis sections.

(5) Conclusions of the experiment (one page maximum)

(6) Bibliography – this is only needed if your write-up utilizes some formula or other information that is not available in the lab description that was distributed in class. Number items sequentially, and refer to them in the text as "[1]" or "Ref. [1]".

### **Listing of formulas**

In the text of your write-up you should list all formulas that you use in analyzing your data. Such formulas include those used for error analysis and statistical analysis, as well as those used in deriving any intermediate or final results. The only exception to this rule is for error analysis on simple sums, differences, products or quotients, and for simple averages and standards deviations of sets of measurements. Always include an estimate of the uncertainty as part of any value you report, including all raw data and all derived results. If this final value depends on several measured values, each of these will have its own uncertainty. Please be careful to propagate these uncertainties correctly, and list the formula you used for this error propagation.

The origin of each formula should be given. Acceptable origins include "lab handout" or "standard error analysis", but more detail (such as a reference) is required for formulas not listed in the lab handout material. Also, in a few places the lab handout asks that you derive certain expressions. These derivations are best worked out and written in your lab notebook before you attend the lab, because the result will help you work more efficiently once you are in the lab.

All formulas for data analysis (including propagation of errors) should be included in your write-up. Listings of a spreadsheet or computer program are *not* suitable for this purpose. Rather, the formulas should be given in handwritten form.

### **Miscellaneous Standards**

In addition, please note the follow standards that must be followed in your write-up:

(1) Indicate the Results and Analysis headings discussed above, and under these headings clearly indicate the part of the lab exercise that you're discussing. (The ruled grids in the

Laboratory Notebooks are rather dark, so to highlight things it might be useful to try a high-lighter felt pen).

(2) Number all Tables with Roman numerals I, II, III, etc. and number all Figures with Latin numerals 1, 2, 3, etc. In this context, a Figure includes any graph, sketch or other pictorial entity, i.e. anything that isn't a Table or regular text. *All Tables and Figures should have titles, indicating their purpose.* Thus, with this arrangement, in your analysis you can refer back to, for example, Table II of p. 5 when referring to the source of some raw data, or Fig. 3 of p. 15 when referring back to some prior figure.

(3) The reporting of any final results must include three components:

- (a) A numerical value, e.g., 21.2
- (b) An estimate of the uncertainty, e.g.,  $\pm 0.4$
- (c) Units (unless the result is dimensionless) e.g., cm

Numerical values should be reported with an appropriate number of significant digits. For a more detailed discussion, refer to PART I of the Laboratory Manual for 33-104 (Experimental Physics) by Barry Luukkola.

Please give your final results some prominence in your write-up. Set them off on separate lines and draw boxes around them. Also, in cases where the final results can be compared to a separate determination of that quantity, then that comparison should be made (using a statistically proper method).

Most of the grade for your write-up will be based on the content, *including* whether or not the results are correct and properly done. Some elements of your grade, however, will be based on your degree of adherence to the above guidelines as well as the ease with which your results can be discerned from a reading of the write-up – see also the ***Policies*** section in the **Syllabus**.