PHYS 4580, 6/7280 – Molecular and Condensed Matter, and PV Materials and Device Physics Lab

Please Note! The exercises and reporting described in this Lab Guide are recommended but optional for Fall 2013 -- for those who feel they need additional practice with Igor Pro to develop better graphing and curve-fitting skills. Do not submit a lab report, but please feel free to ask questions and/or confirm your fitting results with the Professors.

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Supplementary Lab Guide on Igor Pro: Exercises for on Igor Pro graphing and analysis software

Now that you've covered the Introduction to Igor Pro and "Guided Tour" parts 1 and 2 from the Getting Started help file, you've gained a little experience with Igor Pro. Igor Pro serves as a very good graphing and analysis software program that you're free to use in any/all of your Physics and Astronomy Dept. coursework. You can use it to visualize data from functions you're working with in non-experimental courses; you can certainly use it to present any/all of your experimental data from this and other courses; you can use it to fit data and prepare high-quality graphs suitable for publications.

In this course, please use Igor Pro wherever possible to present your data in carefully-prepared graphs. That means using Igor Pro to fit data where appropriate, and including color-coded (and symbol- or line-style-coded, so that black and white print-outs are perfectly legible) graphs and legends, and any appropriate annotation such as labeling peaks, relevant physical parameters, etc. All of your data analysis and graphing should in general be completed using Igor Pro, or comparable quality analysis and graphs should be conducted/prepared elsewhere if you have another preferred option.

For this Lab Report, describe Igor Pro in your own words, noting the features you find especially useful/valuable (i.e., please take note of the sorts of things you can do in Igor Pro that perhaps would otherwise be difficult). Include a brief introduction, a summary of the skills and capabilities you practiced within the "Getting Started" training, and generally how you foresee using Igor Pro either within or outside of PHYS 4580, 6280 (you may be frankly honest if you do not foresee using it elsewhere – we'd like to know!).

Include also in your Report an analysis of the data contained in the data files named "20100907_gaussian_data.txt" and "20100907_exponential_decay_data.txt". As their names imply, they contain data based on a Gaussian function in one case, and an exponential decay in the other case. The functional forms of the data are as follows in these two equations:

$$y(x) = ae^{-\frac{(x-b)^2}{2c^2}} \qquad\qquad y(x) = y_0 + de^{-gx}$$

For each function, noisy data has been generated; your goal is to fit the data in order to extract both the "best fit" values for the fit function as well as the uncertainty in the fit values. Prepare a single Igor Pro experiment (call it "lastname_igorpro_lab_report.pxp", saving often as you do the work) in which you follow these general steps:

1. Load the Gaussian data as waves (call these waves gaussx and gaussy). You can use **Data…Load Waves** for this, and use **Load Delimited Text**.

2. Prepare a new graph with the Gaussian curve on it.

3. Use the **Analysis…Curve Fitting** menu option to fit a Gaussian curve to this data (use the full set of data, .i.e, the full range). Based on the functional form provided above (and not on the default fitting routine within the "Curve Fitting" capability of Igor Pro), determine the values for *a, b,* and *c*. Append this fit data to your graph (this may happen automatically), and include the uncertainties (based on one standard deviation) resulting from the curve fitting (these will be obvious once the curve fitting finished successfully, as they are presented along with the ± symbol). Note that one of the fit variables included in the Igor Pro Gaussian function, y_0, is not required since our function f(x) does not have any constant offset in the y-values. Try the fit with and without setting y_0 to zero. How do the results vary?

4. For your graph, choose the colors/line types, symbols, etc. to look good and be decipherable in either color or black-and-white. Include a legend and label the curves "Gaussian data" and "Gaussian fit". Label the curves (arbitrarily, since this is fictitious data) with the y-axis as "Intensity (W/m^2)" and the x-axis as "Position (mm)". Annotate the graph with the values and uncertainties for a, b, and c (this may be done automatically). Include this graph in your lab report by using either the **Edit…Copy**, or **Edit…Export Graphics** options.

5. Load the exponential decay data using the same approach, calling the waves expy and expx. Make sure you have the x- and y- waves correctly identified and named, or the graph will be confusing.

6. Prepare a new graph with the exponential decay data on it. Use **Analysis…Curve Fitting** again to fit, in this case, the *exp* function which has the same form as shown above. Again, prepare the graph to look good and include the same info as before (legend etc.); you can label the axes however you wish, but do label them – it's good practice and normally there will be actual measureable values associated with the data.

7. Most importantly, be sure that each of your two graphs is clear and easy to read, includes the relevant information (i.e., what are the fit values, which one could imagine are important for determining physical quantities), and what functional form (equation) did you use to fit the data? Again, include the graph in your lab report. Equally important, include the fit values (and their standard deviations) in your write-up, perhaps as a table.

8. Provide some sort of summary of what you've managed to show. Send the lab report as a .pdf, and also attach your Igor Pro "lastname_igorpro_lab_report.pxp" file to the email (*use your last name in place of "lastname").