Astronomy 1 – Introductory Astronomy
Spring 2014

Making a Plot in Kaleidagraph

First, you need to enter your data into a data table. You will want to name your columns something descriptive. Change column headings in your data table by simply double-clicking on the header. The default column headings are capital letters. These headings will appear on the axes of any graphs you make using this data table, so it is best to put both a descriptive word and the units in these headings.

(For example, in the speed of light lab, you need columns for path length difference, arrival time difference, and columns for uncertainty in each.)

Next, make a plot. You can make a graph of your data by choosing one of the options from the **Gallery** menu (not the **Plot** menu as you might reasonably assume). The usual one for laboratory data is the Linear-Scatter graph. When you select it, it will ask you which column you want on which axis. Select "New Plot", and the program produces the graph immediately. Kaleidagraph automatically chooses the minimum and maximum values for each axis and how to scale each axis. To change the appearance of the graph (change axis limits, plot symbol, etc.), go to the **Plot** menu.

The next step is to add error bars to your graph to show how precise your measurements are. In the **Plot** menu, select "Error Bars…". A dialog box comes up with check boxes labeled "X Err" and "Y Err" next to the column name of the data graphed on the y-axis. To add error bars for the x-axis data, check "X Err". A new box comes up with pop-up menus that allow you to select the source of the error bars. You entered the uncertainties into a data column, so select "Data Column" the name of the column containing the uncertainties in the x-axis data. Once you do this, click "OK". You are now back at the first dialog box. Check "Y Err" and repeat the process to select the data column containing uncertainties for the y-axis data, then click "Plot" in the first dialog. When you are done, you should see your graph with error bars added. (If your measurement uncertainties are very small, the error bars may not be much bigger than the plot symbol.)

Now you are ready to find the line of best fit to your data. The graphical package does this by trying many possible straight lines and determining by how much the line vertically misses each data point. Since these "miss distances" (more properly called residuals) are both positive and negative in general, it makes no sense to add them together to see what the total "miss distance" is. Instead, the residuals are each squared and then added together, creating a single number representing how well the line follows the data. The fitting procedure finds the straight line that minimizes the sum of the squares of the residuals and prints out the slope and y-intercept of this line. The application also estimates the uncertainties in the slope and y-intercept by testing how much variation in these two parameters are necessary to cause the sum of the squares of the residuals to increase significantly. You will do a weighted fit, which means data points with smaller uncertainties "count" more than ones with larger uncertainties.

To do this, you need to use the "General" option under the **Curve Fit** menu. Choose "fit1", and then click "Define". This is the window in which you specify the function relationship to be used in the fitting procedure. The application uses M0 for the independent variable and m1, m2, m3, etc., for parameters to be determined from the fit. You also must provide initial values for these parameters for it to use as it starts the searching procedure. Since the equation of straight line involves two parameters (the slope and y-intercept), the appropriate formula is as follows.

m1+m2*M0;m1=1;m2=1

Notice that the initial values of the y-intercept (m1) and the slope (m2) are given as 1, even though you could have come up with better trial values. In a linear fit, these starting values are usually sufficient. (If you are graphing very large or very small numbers, you will need to give a better estimate.) These initial values give the computer a starting point for its fit procedure.

When the formula and initial values are correct, check "Weight Data" and click OK to return to the previous Curve Fit window. Now, check the box next to the y-axis name. You should now be prompted to choose a column to use for the weighting. Click the arrows to scroll to the column containing the uncertainties for the y-axis. (The mathematical routines used can only weight the data based on the y-axis errors.) Click "OK" twice, and the fit routine begins. Once it is finished, you should see a best-fit line and an information box on your graph. If you don't see the box, select "Display

Equation" from the **Plot** menu. The box contains the best values of the slope and y-intercept and the uncertainties in each. Note that sometimes you might want to weight the data (to give data points with smaller error bars more "influence" over the curve fit), but other times you will not want to do so.