Some Simple Astro. Pracs.

Intensity vs Distance.

Preamble

As you get further from a source of light the light decreases in brightness. We are all familiar with the phenomena of placing a projector further from a screen. The image you are projecting gets bigger. This must mean that the image becomes less intense because the same amount of light is issuing from the projector, but it has to cover a bigger area. This prac. attempts to find the quantitative relationship between this decrease of intensity with increasing distance. If this can be achieved then we will be able to use the relationship to measure the distance to stars by measuring their brightness.

Aim

To find out how intensity varies with distance.

Apparatus

Slide projector, slide of an array of dots (Available from Peter Mansell <jupiter.sci@optusnet.com.au>, a small rectangular target, stand and clamp,tape measure (up to 4 m)

Method

Project the dots onto the small target which is held in the stand and clamp. This first position should be as close as the projector can focus clearly. Measure the distance from the target to about the front lens of the projector, and count the dots on the screen.

Retreat about 50cm, refocus the dots and repeat the distance measure and dot counting. Repeat this process of retreating, refocussing and recounting several more times.

Analysis

Since the number of dots that appear on the little target are like a model of intensity ie dots per area, plot a graph of No. of dots vs distance.

Note to teacher. You have to choose whether to use a log-log analysis or plot Count vs 1/ $(\text{distance})^2$

As a test, place the target at any random distance and count the dots. Use your graph to calculate the distance to where the target was and check it with a tape measure.

Expanding Universe Prac.

Place about 6 texta dots randomly along a 30-40cm piece of white elastic. (Use the wider stuff ‘cos it looks better.) Fasten one end to a solid fixture. Choose a home dot to represent your galaxy. Record the distance from home to all the other dots. Stretch the elastic out to any sensible length and measure the distance from your home dot to all the other dots. Say that the universe has taken the time of one yonk to reach its stretched state. Subtract the initial distances from the final distances and plot these on the vertical axis. Divided by one yonk, these represent the speed of recession of the galaxies. Plot these against the final positions of the galaxies. You will get a straight line, the gradient of which will be the same regardless of which dot was chosen as the home galaxy. (To prove this, get the students to repeat the experiment choosing another dot as the home and be sure to stretch the elastic the same amount as you did the first time. The reciprocal of the gradient is the age of the universe in yonks. Ie the time since all the dots were co-incident. Clearly this prac models the obtaining of Hubble’s Constant.

Using Parallax to Measure Distance.

In the old PSSC Prac book there is a prac entitled “Measuring Large Distances” It uses a simple wooden device that any school could make. It models the use of the Parallax method to measure the distance to stars. The first parallax of stars was measured in 1837 and today the method can be employed to measure stars out to 2-300ly. See the attached sheet for diagram of how to use the device.

The motion of Mercury.

Because Mercury is between the Earth and the Sun, it effectively does SHM across the Sun from our perspective. If you subtract the time of setting of the Sun from the time of Setting of either of these two planets you will get a slightly distorted sine curve over the period of a few months. These curves can be interpreted to find the period of revolution of the planet. The distortions can also be interpreted. This also holds for Venus but from our perspective the period is too long to be useful. (Contact <rdownie@plc.vic.edu.au> The data can be downloaded from a website and put into a spreadsheet if you don’t want to drag it out. www.museum.vic.gov.au/planetarium/sky.html

The size of the Sun.

This is a fabulous exercise in measurement and the impact of uncertainty on measurement. Use a pin hole in a card to project an image of the Sun. (Review the pin-hole camera with the students before you begin.) If you assume that the distance to the Sun is 150 million km, measuring the size of the image and the distance of the pinhole from the screen you can state the size of the Sun. Ask the students to critique their method and they will readily tell you what the problems were. They won’t be surprised at how poorly their estimate differs from the real value. What could they do to reduce their uncertainty? We made a pinhole camera with poly-pipe, Al foil and tracing paper held on with rubber bands.

Radius of orbit of Venus (& Mercury if you are lucky).

Watch the times of rising and setting for the times when Mercury or Venus When consecutive days show about the same time of setting then you can be fairly sure that the planet is at its maximum position from our perspective. Assume you know the distance of the Sun from the Earth (150 million km) . Make a direct measure of the angle between the Sun and the planet (rough!) using hinged sticks or similar and use simple trig to calculate the radius of orbit of the planet. Alternatively use the number of minutes between the set of the Sun and the planet as a fraction of 24hrs. Find the same fraction of 360^{o}. This will be the angle between the Sun and the planet. Proceed with the trig as before.