Phys 4910 Spectroscopy
Laboratory Assignment 5

Introduction

The limiting factor in the ability of a photomultiplier to detect very weak signals is its dark current. For light signals low enough that the PMT current is lower than its dark current special techniques, principally photon counting, have to be employed.

Assignment

1. Open the Monochromator Control program, and set the Diverter to the side (the position of the photomultiplier).
2. Turn on the power supply to the photomultiplier with a voltage of 700 V.
3. Switch to the Control panel, and set the wavelength of the monochromator to the center of any line from any one of the spectral lamps. Adjust for maximum intensity (that is, maximum current from the PMT.)
4. Adjust the slit width to get a current reading of about 100 nA (10^{-7} A)
5. Measure the current for a PMT voltage from 500 V to 900 V. (This is a relative measure of the gain of the photomultiplier as a function of applied voltage, although you cannot assign absolute numbers as you do not know how many electrons are being emitted from the cathode.)
6. Turn off the lamp, and block the input to the monochromator to prevent stray light entering the monochromator.
7. Measure the dark current for the same range of applied voltage. (You will need to change the sensitivity of the electrometer to the 10^{-8} A range (f.s.d.) as the dark current is very small.

Report

The report for this laboratory exercise has two parts:

1. A review of the nature of the dark current. The Hamamatsu Photomultiplier Handbook is a good comprehensive place to start, although a little long (see the class lecture notes for a link to the handbook.) You should be able to find other online resources also. You should introduce your literature search in the introduction part of the report, and then reference your results in the discussion following your data.
2. Analysis and discussion of your measurements
   1. The dependence of the relative gain on the PMT voltage (V). If we assume the the gain varies as V^n, then what is the power, n? (Hint: think logarithms.) Can the power n be identified in terms of the physical parameters of the PMT?
   2. The dependence of the dark current on the PMT voltage (V). Can you identify the different regions corresponding to different regions of the dark current?
   3. If you take the ratio of signal to dark current, this is the signal to noise ratio. What is its dependence on PMT voltage. Does that tell you anything about the optimal choice of parameters for operating your PMT?