Download the template Jupyter notebook `HW2_Template.ipynb` from Canvas and work from that template. Also download `SpectralLine1.dat`. You will need this in Problem 1.

1. **CODING:** We discussed in class the *Spectral Line Problem* for the data shown in Figure 3.3 and Table 3.1 of our textbook. We computed the unnormalized posterior PDF for the line strength T, assuming model M_1, and got results that match the curves shown in Figure 3.6 for the uniform and Jeffreys priors.

   (a) (2 pts) Calculate $p(D|M_1, I)$ for the uniform and Jeffreys prior cases. The numerical answers are given in (3.45) and (3.47), respectively. There are typos, however, in both equations (see errata), but the numerical answers are correct. To carry out the integrals, you can use simple numerical integrators such as `np.trapz` or one of the "fixed-samples" methods in `scipy.integrate`.

   (b) (2 pts) Calculate the odds ratio O_{12} (Equation 3.31) for the uniform and Jeffreys prior cases. The numerical answer is given in the text on page 58.

2. **CODING:** In this problem, we will simulate another data set that resembles the one shown in Figure 3.7, which has a higher line strength than the first example.

   (a) (2 pts) Taking $T = 5.0$ mK, simulate a new dataset D' by sampling the signal in each channel from a normal (gaussian) distribution with a mean given by the model and $\sigma = 1.0$ mK. You can use `np.random.normal` to sample from a normal distribution. Plot the new dataset and confirm that it roughly resembles the left panel of Figure 3.7.

   (b) (3 pts) Using the Jeffreys prior for T in the range $0.1 \leq T \leq 100$ mK, calculate the posterior PDF $p(T|D', M_1, I)$ and the 95% credible region for T. Make a plot of $p(T|D', M_1, I)$ vs T.

   (c) (1 pts) Calculate the new odds ratio O'_{12}.