**PHYS358: Session 13**

**Bayesian Model Comparison**

**(1) Model Comparison:** Given a set of models $k = 1 \ldots K$ with parameter vectors $\theta_k$, and a set of measurements $y_i$, $i = 1 \ldots N$ at positions $x_i$, the goal is to decide which model best fits the data. This can be done by either calculating the *evidence* for each model $k$,

$$p(y|k) = \int_{\theta_k} p(y|\theta_k, k) p(\theta_k|k) d\theta_k \tag{1}$$

and calculating the *posterior model probability* via

$$p(k|y) = \frac{p(y|k)p(k)}{\sum_{j=1}^{K} p(y|j)p(j)}. \tag{2}$$

Or, we can calculate the posterior probability for the parameters and models, given the data,

$$p(\theta_k, k|y) \propto p(y|\theta_k, k) p(\theta_k|k) p(k). \tag{3}$$

Eq. 2 we can determine with the tools we already have available.

- Why is $\chi^2$ minimization not an ideal approach for model comparison?
- What problems to you foresee when implementing eq. 3? *Hint: Metropolis-Hastings, polynomials.*

**(2) The code:** Check out `bayes_infer.py`, run it with the parameters `bayes_infer.py 20000 2 3 0.2`, and answer the following questions:

- What parameters is the program taking?
- The program generates a polynomial data set - which order does the polynomial have?
- If you tried to test polynomials of order 4, what problems do you foresee?
- What's the advantage of "Reversible Jump MCMC" in this specific context?