PROBLEM 3

For each trial step, I used the curvature matrix found in Problem 2. Taking the inverse of this matrix we get the parameter covariance matrix. We can then use Cholesky decomposition to then extract the L matrix (lower triangular) so that we can multiply this by a 6×1 matrix of random numbers between 0 and 1.

To make sure not to get unphysical values of τ, I constrained my mcmc to only accept values above 0.

Parameters were found by averaging all parameters in chain (chisq converged pretty fast)

H_0	68.0937029
$\Omega_b h^2$	2.23396802×10^{-2}
$\Omega_c h^2$	1.18234852×10^{-1}
τ	8.45486771×10^{-2}
A_s	2.22121047×10^{-9}
n_s	9.71161768×10^{-1}

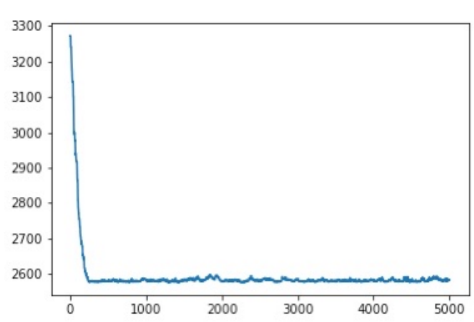
* I ran for 5000 steps

Note that my m0 was $[69, 0.022, 0.12, 0.06, 2.1\times10^{-9}, 0.95]$

It can be noticed that the τ value has a larger difference than the other values.
Also Note that my step acceptance rate went up to 70%. This doesn't seem normal since usually the acceptance percentage should be ~25%. Nevertheless, my parameters seemed good, especially with a χ^2 value of 2594 (lower than q1 & q2 χ^2 values).

χ^2 seems to have converged.

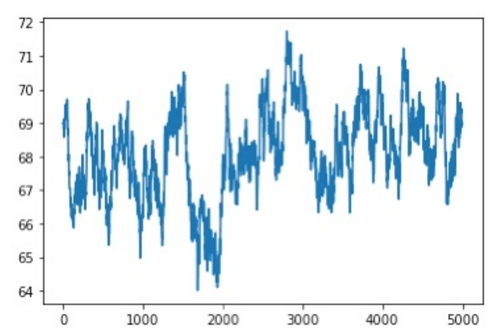
Graph 1: χ^2



χ^2

Steps

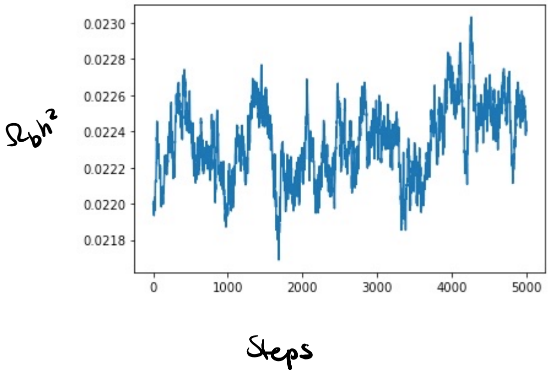
Graph 2: H_0



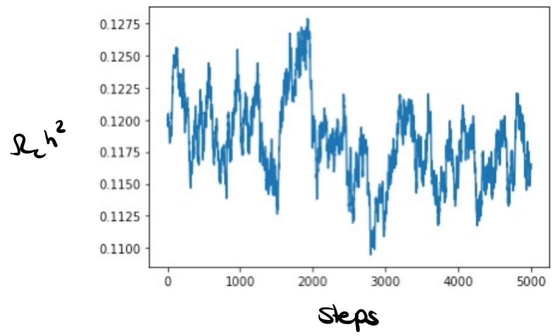
H_0

Steps

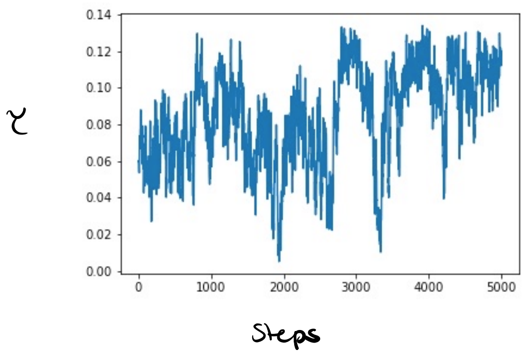
Graph 3: $\Omega_b h^2$



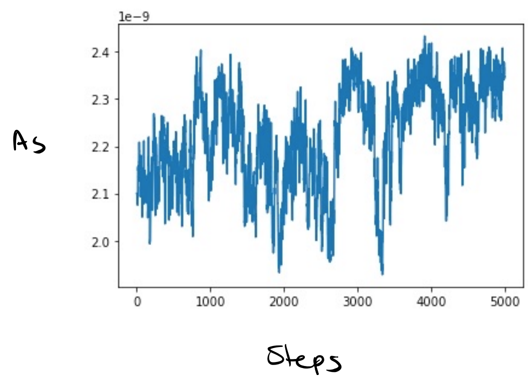
Graph 4: $\Omega_c h^2$



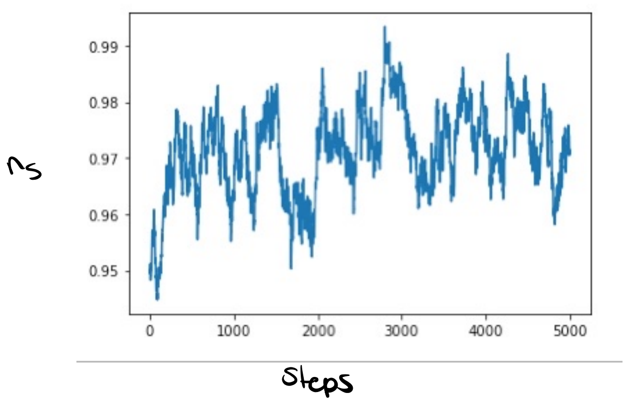
Graph 5: τ



Graph 6: A_s



Graph 7: n_s



From the parameter graphs, it is difficult to tell if the chains converged. The most obvious ones are H_0 and n_s, but the others look like they're only beginning to converge in the last ~1000 steps.

We would have to run longer (perhaps 10000 steps) in order to confirm convergence, or make sure that it isn't simply a local equilibrium.

That being said, χ^2 converged quickly, which is perhaps a good indicator that other parameters converged as well.

Estimate on mean value of dark energy:

$$\Omega_b + \Omega_c + \Omega_\Lambda = 1$$

$$\Omega_\Lambda = 1 - \Omega_b - \Omega_c$$

avg of $H_0 = 68.0937$

avg of $\Omega_b h^2 = 0.02234$

avg of $\Omega_c h^2 = 0.11823$

$h = H_0/100$

$\therefore$ mean value of dark energy ≈ 0.6968

Uncertainties:

$\Omega_b h^2 = 0.000205$

$\Omega_c h^2 = 0.003256$

$\therefore$ error is 0.007 for dark energy.

$$err = \sqrt{(\Delta a)^2 + (\Delta b)^2}$$