Evaluation guidelines for part 1 of project 3 in AST3220, 2024

In general, the main error I expect to see is units, i.e., comparing datapoints with units of MJy/sr and kJy/sr without properly converting. In general, this will give results with uncertainties that are either too small by several orders of magnitude or too large.

1a) Simply plotting the data points with visible errorbars, labeled appropriately, will give 2 points.
b) Looking at this requires noting something either about the detectors, the model, or some other source of uncertainty. This is worth 1 point, with an extra point given if the brightness of the galaxy is mentioned.

2a) The log-likelihood should be given assuming the Gaussian expression. Two points will be given for the standard ln L = K - \chi^2/2. One point will be removed if the explicit analytical expression does not explicitly include the blackbody function.
b) Two points for correctly coding up the expression in the previous example. One point will be deducted if the units are not explicitly checked to be correct, either by making sure that blackbody(nu, T) is in the same units as S, or that Serr does not share the same units.

3) The point is to note that each independent step should be nearly independent of the previous one, which essentially means that the MCMC curve does not have any long-term drifts, and there are not any sets of correlated deviations. If the student mentions anything about the chain being fully burned in, long-term drifts, or any of the above, a full two points will be given. If they something “shallow” but “correct”, such as “it should look random”, 1 point will be given. If the answer doesn’t mention any of the above, no points will be given.

4) The maximum likelihood solution gives very small error bars, much smaller than that given by the official publications. I found uncertainties of around 10^-5 K, about 100 times smaller than that given in the FIRAS analysis. If the students did not correctly convert the uncertainties to kJy/sr, they would have gotten an uncertainty of around 10^-2 K, about 10 times larger than reported.

To get four points on this question, the student should (a) get the correct answer of 2.725 K, (b) get the unreasonably small uncertainties, (c) note that it is smaller than reported by Fixsen et al., and (d) note the things that could make the uncertainties smaller, including instrumental uncertainties, galactic uncertainties, or the fact that the three different analyses gave differences of this order.

Extra credit of one point will be given if the students look at the paper and assert that the statistical methods used in the paper were not sufficiently rigorous.

Note the next questions are labeled 4. The next questions will be on spectral distortions.

4) 2 points is given for the correct derivative, one point is deducted for minor errors.

5) 2 points is given for the correct derivative, one point is deducted for minor errors.

6) Two points are given for finding the 95% upper limit of the deviations from zero. One point will be deducted if the values are nowhere near the reported values of 10^-5 and 10^-6 without commenting on it.

Two points are given if the students include discussions about the propagation of errors or the neglecting of uncertainties from the instrument or the galaxy. One point will be removed if the student asserts that the smaller uncertainty is fine.

19 points total.