PHY340 Data Analysis Feedback:

Group A05 doing Problem A2

# Data Analysis

The data analysis seems to have been carried out well, but the explanations vary from poor to non-existent. The radial velocity, which is a straightforward fit if assumed to be sinusoidal, was apparently fitted “using JMP software”, but no reference for JMP is given and nowhere is it explained what this package actually *does*. (Given that you chose to fit a simple sinusoid, using a software package looks like serious overkill—this would be a very easy χ2 fit.) The assumption inherent in using a sinusoid, namely that the orbit is circular, is not stated—but exoplanet orbits very frequently are *not* circular, so this is *not* automatically a safe assumption: it should be clearly stated *and justified*. The χ2 of the fit is not given, and there are no error bars on figure 2 (they are probably too small to see, but this should be *stated*), so it is not clear that neglecting eccentricity is indeed safe. The explanation of the equations used to fit the light-curve is extremely poor: equation 2 appears to be valid only for the case in which the whole of the planet is superimposed on the star, not for the entry and exit periods (during which the limits of the integral would *not* be $d\pm r\_{p}$), there is no explanation of *why* *d*(0) = *a* cos *i*, and *ω* is not defined at all (and is written correctly as *ω* in the diagram, but as *w* in the text: these are *completely different symbols*). The effect of limb darkening is not discussed at all, and the equations used for limb darkening are not quoted (so it is impossible for the reader to understand how the quoted limb darkening coefficient is actually applied).

As the limb-darkening fit is a generalisation of the fit without limb darkening (if you set *cλ* = 0, you recover the case without limb darkening), direct comparison of χ2 is not really the correct procedure: you should actually use the F-test, as discussed in the lectures. This is be­cause some of the variance in the data (the part outside the eclipse, and the middle of the slope) is common to both fits, so the χ2 values are not independent.

The comparison with literature values should be done in the text: Table 2 (why 2?) should be in the text, not in the abstract (abstracts *never* contain tables). The primary references should be given for the literature values: quoting your literature search implies that they are *your* values, which is certainly not true! Your fit results appear to be in agreement with the literature values that you quote: *there is no discrepancy between 1.28±0.06 and 1.216±0.013* (the difference of 0.06±0.06 is clearly consistent with zero). Wittering on about “a more in-depth equation for the planetary mass” (whatever that’s supposed to mean) just makes you look silly. Likewise, if the value of *i* that gave the lowest χ2 value was 87.5°, then that should be quoted as your central value (if your “acceptable” range was 86.0 to 90.0 degrees, then $87.5\_{-1.5}^{+2.5}$ degrees). You have not explained how you ob­tained your error estimates: since you are doing a “by-hand” χ2 analysis, you should use Δχ2 to determine your uncertainties, but there is no evidence that you did this, so where did the error estimates come from? You should note that the errors you quote are statistical only, i.e. they are the formal errors on your fit parameters: there are also systematic errors coming from the choice of model to fit.

It does not appear from the figure in the appendix that your fit without limb darkening is really the best fit: a deeper eclipse, passing below the points near entry/exit but above those in the centre, would surely have a lower χ2 (because of the square in the definition, χ2 exacts a high penalty for points that are a long way off the fit, and a deeper eclipse would reduce the maxi­mum distance from the line). Given that the period of this planet is *extremely* well known, it is not clear that plotting the two sets of observations separately is either necessary or sensible, though in fact the fit to observation 2 appears to be systematically shifted; this may be because you have rounded off the period in your code.

Average grade for this section: 29.5/50

# Data Presentation

Numbers are generally quoted to fairly appropriate precision, though most people would quote two significant figures in an uncertainty whose first figure is 2. As noted earlier, you should specify that these are statistical errors from the fit only, and do not include systematics due to model dependence. Table 2 should be removed from the abstract and put in section 3 where it belongs, and the sources of the uncertainties should be explained (it is not at all clear from the text that you actually fitted the limb darkening coefficient, so it is not clear whether this should even have a quoted error). As noted above, primary references should be given for the pub­lished values.

Graphical presentation is less satisfactory. The fitted light-curves certainly should *not* be rele­gated to an appendix: they are the main point of your analysis, and should be in section 3. There is, as far as I can see, no justification for removing 80% of the data points; the data points should not be joined with a line; the axis labels are too small; the figures all need captions. If the error bars on the radial velocity points are too small to show, this should be stated.

Average grade for this section: 16.8/30

# Style

Although the English is generally satisfactory, the format of the report is not right: the abstract should not contain a table and should not have a section number (it is really a separate entity). The report also suffers from a serious lack of proof-reading: the table is labelled “Table 2”, but there is no other table in the report; the first two figures have neither figure numbers nor cap­tions, the third figure is then labelled “Figure 2”; the remaining figures have neither labels nor captions (they do have titles, which they should not have; a title is not the same thing as a cap­tion). The equations are not well formatted (brackets should scale to match their contents: both Word 2003 and later and LaTeX do this, so I’m not sure how you managed not to!). There are errors of fact: you *cannot* use transits to determine the mass of a planet (this has to be done by radial velocity, unless you have multiple planets in the system and can use transit time varia­tions; not the case for WASP-4). Reference citation is poor: the citation for Triaud et al. (2010) is incomplete (“online” is obviously not sufficient), and (as noted above) primary references should be given for the literature values of parameters. This all looks very rushed.

Average grade for this section: 11.5/20