Report for C1 paper (4^{th} Year Astrophysics 2007

Total Number of Physics Students taking exam- 31
Mean grade- 59%
Standard Deviation- 24%

Problem 1

Topic: Cosmology
Number- 17
Mean grade- 16
Standard Deviation- 5
All students understood that they had to take the relativisitic limit but many of them then made a mistake in working out the number density. Almost all could figure out the expression for fractional density but the many got the actual numbers wrong.

Problem 2

Topic: Cosmology
Number- 21
Mean grade- 14
Standard deviation- 6
A surprising number of students could not work out the time dependence of the scale factor for matter dominated universe. They were able to solve the Jeans equation and understood the physics behind it. Hardly anyone could link it to surveys of galaxies.

Problem 3

Topic: Galaxies
Number- 11
Mean grade- 17
Standard Deviation- 5
The first sub-question went generally well, although the second question led to some confusion by asking to derive a "similar" relation, while in fact what was wanted was to derive the Faber-Jackson relation itself. Most students could derive the Fundamental Plane relation, although for many an ultimately flawed relation ignoring the virial theorem (just using the definition of surface brightness, i.e. $I = L/R^2$). The second sub-question was also generally successful, although many did not realise that $M_*(t = 0) = 0$ and so $M_tot(t = 0) = M_g(t-0)$, which can lead to complications later on, e.g. for the first part of the third sub-question (see below). Most students started to struggle at the third sub-question. The first question concerning the dynamical time was generally fine, but the calculation of b often proved difficult. Especially, the calculation/definition of ¡SFR¿ can be done in many different ways, some more complicated than others to calculate. Many algebra and/or arithmetic mistakes were made there, often leading to wrong values of b (and thus difficulties to comment on it!). The success for the last/fourth sub-question was rather polarised.

Many students assumed the same dynamical timescale as before, rather than calculating a new one based on the numbers given, which then leads to complications.

Problem 4

Topic: High Energy Astrophysics
Number- 5
Mean grade- 21
Standard Deviation- 2.0
Very few students answered what seems to be a very straightforward question. Those who did got high marks. No amnbiguities in the answers, very much a textbook problem.

Problem 5

Topic: High Energy Astrophysics
Number- 30
Mean grade- 20.0
Standard Deviation- 4
This question was far too easy. Very much a repetition of what had been done in the lectures. A few students obtained the wrong timescale yet stil tried to answer as if they had obtained the timescale they expected from class.

Problem 6

Topic: Advanced Stellar Structure- binary systems with black holes.
Number- 16
Mean grade- 18
Standard Deviation- 3
The first sub-question was not as succesfull as one might have expected for a number of reasons. First, many ignored Big Bang nucleosynthesis. It is not entirely clear why, but perhaps because the emphasis on the word ”site” in the question... Big Bang nucleosynthesis hardly being confined to a given/well-defined location. There was also considerable confusion as to the meaning of ”light elements”, many commenting on elements such as C, N, and O rather than Li, B, and Be. S-process elements were also seen more narrowly than the answers provided suggest. Furthermore, despite a clear request, many student did not write down any reactions. The second sub-question was very successful. The third sub-question led to mix results. Many could not write the simple equations describing the evolution of O and Fe, thus loosing most marks from that point on. Also, many assumed an ”initial” star formation lasting for 20 rather than 17 Myrs, which leads both to wrong equations and a wrong ”asymptotic” ratio. Furthermore, there were surprisingly many arithmetic mistakes, a rather worrying fact given the simplicity of the calculations! Many students also failed to explicitely consider t¿1000 Myrs. Lastly, the plots were generally qualitatively good, despite using wrong values from wrong calculations above. Few students succeeded in the last sub-question, either because the results from the previous sub-question were wrong, and thus the ratios discussed unrelated to previous answers, or simply because they seemed to think of

the abundances as being ISM abundances rather than stellar ones, thus leading to a conclusion exactly opposite to that desired. In fact, it was surprising to see how many argued that ellipticals are young (¡ 100 Myrs!) and still forming stars, while spirals are old and not forming stars. One would have thought that the exact opposite would have been stressed in other parts of the course.

Problem 7

Topic: Advanced Stellar Structure- molecular clouds and protostars.
Number- 13
Mean grade- 14
Standard Deviation- 5
The first sub-questions was generally fairly succesful, many discussing the observed properties of gamma ray burts. However, few mentioned beaming effects, amd many were confused as to the exact acceleration mechanisms of e.g. electrons, and the exact role of shocks in producing a non-thermal spectrum. In the second sub-questions, most succesfully identified and calculated the inner disk radius. However, the vast majority did not know how to impose/calculate the outer edge of the disk. There was much confusion about using either forces or conservation of angular momentum, and in the latter case on treating the now complex disk geometry (i.e. not pure sphere or disk). There was similar confusion about specific versus standard angular momentum. The third sub-question was generally ok, most student being able to calculate the Keplerian timescale and even more the dynamical timescale, although the degree to which the (mean) density was approximated for the latter did lead to significant variations in the actual values obtained (easily by an order of magnitude). Most students could succesfuly relate those timescales to the observed bursts behaviour. The last sub-question was much less succesful. Many failed to apply conservation of angular momentum properly to get the spin rate of the progenitor, and for some reason many did know (or could not figure out) how to calculate the break-up rate.

Problem 8

Topic: Atomic Physics and Stellar Atmospheres- planetary enubla, emission lines of OIII.
Number- 10
Mean grade- 10
Standard Deviation- 4
Surprisingly, despite clear guidelines, the first sub-question was rather disastrous. Many students talked about the chromosphere and corona themselves rather than the conditions below the photosphere which relate to them. And those few that talked about the conditions below the photosphere generally missed most important points (e.g. rotation, differential rotation, dynamo, etc). I do not think a single student properly discussed the trends in emission lines. The second sub-question was very successful. Most students were able to have a go at this sub-question, but very few were able to succesfully complete it. Many made the mistake of considering the radiative power loss per unit volume dF_r/dh to be the function given $\alpha T_e^{-}0.5$ rather than $N_e^2 * T_e^{-}0.5$. Similarly, many made the mistake of considering the thermal conductivity flux F_c to be the function given $\kappa_0 T_e^{2.5}$ rather than $-\kappa_0 T_e^{2.5} * DT_e/dh$. This obviously led to problems (which should have been spotted by simply cheking dimensions), although many tried to fudge their way around them... Only a few properly and thoroughly addressed the difference between predictions and observations in the

last sub-question.