Report on S16: Plasma Physics

A total of 12 students sat the paper. The mean mark was 37 (out of 50), ranging from 19 to 48, with a standard deviation of 9. This is in line with previous years' marks, and appears reasonable for a short option. For the first year since this option has been running there were attempts to all of the questions (in previous years students had shunned the questions with any astrophysical relevance). As can be seen from the statistics below, the most popular questions were those on waves, with 10 candidates attempting question 2, and 7 question 3. These appear to be the most straight-forward questions on the paper, and all students who attempted question 3, also attempted question 2, and the lowest mark for this combination was 36.

1. **Attempts 4, Mean Mark 13, Standard Deviation 4**: The aim of this question was to test whether students had understood that the Saha equation predicts ionization when electrons have thermal energies which are low compared with the ionization energy, owing to the high statistical weight of the continuum. All 4 students who attempted this question completed the first half, but only one student could show that the rate of change of ionization with temperature was also very rapid. None of the students could iteratively solve the Saha equation to compute the temperature at which the system was half ionized, although this has been set in previous years without causing major problems.

2. **Attempts 10, Mean Mark 22, Standard Deviation 3**: This was the most popular question on the paper, with only two students scoring less than 20. All students knew the difference between electrostatic and electromagnetic waves, and the vast majority derived the difference in group velocities for two electromagnetic waves, closely spaced in frequency, propagating through a sparse plasma. The marks that were lost were mainly due to silly calculator errors.

3. **Attempts 7, Mean Mark 18, Standard Deviation 4**: This was another straight-forward question on Faraday rotation in plasmas, and the rotation measure. Once more it posed little problem for the majority of students, and calculator errors were again to blame for loss of marks in many cases.

4. **Attempts 3, Mean Mark 15, Standard Deviation 6**: In many ways this was the simplest question on the paper, but as it looked long, I suspect some students were deterred from attempting it. The students who did attempt it were generally aware of why plasmas are referred to as collisionless, but only one of them remembered the simple method we had discussed in lectures for estimating the collision time. There were generally good qualitative descriptions of Landau damping. Although we had discussed laser-plasma accelerators in the lectures, only one student gave a satisfactory answer to the last part of the question, and when he/she (correctly) found that electrons could be accelerated to relativistic velocities within distances of order 10μm, was so surprised by his/her result, that they stated it could not possibly be correct!