

Exam

Plasma Physics of the Sun

2025

This exam counted for 12/20 points and needed to be finished in 3 hours. For students who wanted so, you could afterwards discuss the questions together with a prof (Jasmina Magdalenić or Marian Lazar) to ameliorate your score.

MHD part (7 pt)

1. (a) What do you know about the structure of the Sun: its interior and atmosphere?
(b) what is limb darkening and why does it appear?
(c) What are coronal mass ejections and why are they important? (1.5 pt)
2. (a) What are magnetic flux tubes? Where do they appear on the Sun?
(b) What do you know about magnetic flux in magnetic flux tubes? Derive this law in case of ideal MHD. (2 pt)
3. (a) Define plasma beta, Alfvén velocity and sound speed. Why are they important in solar physics? (0.75 pt)
(b) Define the shock and shock conditions. What is the difference between fast, intermediate and slow shock? (1.25 pt)
(c) What type of MHD waves do you know? Summarise their characteristics. Define phase and group velocity. (1.5 pt)

Plasma kinetics (5 pt)

1. (a) Provide arguments for a kinetic (microscopic) treatment of the Solar wind. (0.5 pt)
(b) Write and explain the Vlasov-Maxwell equations used in a kinetic approach of magnetised plasmas. (1.5 pt) Hint: no need to derive dielectric tensor or dispersion relation !
2. (a) Explain why wave fluctuations observed by spacecrafts are important constituent of SW plasma. Take one example of plasma waves reported by observations, also describing their nature, and mention one plausible source. (1.5 pt)
(b) Use figure 1 to identify main properties of such an anisotropic velocity distribution for electrons, in presence of uniform magnetic field along the y-axis.
(c) Describe nature of EM instability predicted by this case and identify the wave instability with dispersion curve in Figure 1, right panel.