

ADVANCED SOLAR PHYSICS AND SPACE WEATHER

List 5

1. What are the Alfvén waves and Alfvén speed? Provide examples based on the solar corona. Discuss Alfvén's theorem regarding the behaviour of the magnetic field in plasma. Present its consequences for solar physics, providing relevant examples.

2. The prominence (bright knot) is located 50 000 km above the solar surface (above the photosphere). How much of the Sun's surface illuminates this structure? What percentage of the total solar surface is responsible for illuminating the prominence's knot? [$R_{\odot} = 6,96 \times 10^5$ km]

3. What is the limb darkening? Why do we observe limb darkening? What factors does it depend on? Is limb darkening uniform across different wavelengths? For example, does it differ in the visible range for $\lambda_1 = 4000 \text{ \AA}$ and $\lambda_2 = 6000 \text{ \AA}$? How much (in percentage) would the Sun appear brighter if limb darkening did not occur?

4. What is the insolation (definition, equation)? How does it differ from irradiance? Calculate the insolation for the following cities: Quito (Ecuador), Bhopal (India), and Wrocław (Poland) on: December 21, March 20, and April 21.

For the calculations, assume that there are no obstacles on the horizon (e.g., mountains, trees, buildings) and that the sky was clear during the measurements. The variable Earth-Sun distance for the specified dates should not be taken into account. The necessary data for calculating the insolation should be sourced independently.

5. What is the GOES X-ray classification of solar flares? How are the individual classes of flares defined and denoted? Why was this particular range of electromagnetic radiation chosen for the classification of solar flares?

The largest solar flare observed at the Białków Observatory was classified as X17+ (within the GOES X-ray classification) and occurred on October 28, 2003. Below are X-ray graphs registered by GOES satellites: on the left, from October 27-30, 2003; on the right, from November 6-9, 2009.

a) How many seconds would the entire solar corona need to emit in the 1-8 Å range at the radiation level observed on November 7, 2009, to match the emission recorded during the peak of the X17+ flare on October 28, 2003, in the same energy range?

b) Why the graphs are flat (in right panel) for the X-ray emission on November 6-7, 2009?

