ADVANCED SOLAR PHYSICS AND SPACE WEATHER
List 1

1. What star is the Sun? How is our Sun classified? Describe the location of the Sun and its closest surroundings. How does the Sun (Solar System) move in the Galaxy?

2. Define, describe and discuss:
a) Stefan-Boltzmann law
b) Planck's law
c) Wien's displacement law
d) solar constant "*I*"

3. Calculate the absolute brightness of the Sun, knowing that its distance from the Earth is: d = 1 AU, observed brightness of the Sun is: M = -26^{m},86, and 1 PC = 206265 AU. Could the Sun be observed (in this case) with the "naked" eye (without using a telescope or binocular)?

4. Calculate the surface of the sunspots on the visible part of the solar disk that would reduce the solar constant by 1%. It should be assumed that:
- energy emitted by a solar photosphere has max for a wavelength: λ_{ph} = 480 nm
- energy emitted by a sunspots has max for a wavelength: λ_s = 630 nm
- the Sun radiates like a black body.

5. How much will the value of the solar constant increase (in percentage and in physical units) at a distance of 1 AU, if the effective temperature of the Sun (T = 5800 K) increases by ΔT = 100 K, and its size ($R_\odot$) will not change?

6. How much mass the Sun loses during the one year as a result of thermonuclear reactions necessary to maintain the observed emission of our star's electromagnetic radiation.

- solar constant: $I = 1.36 \cdot 10^{3}$ Wm^{-2}
- distance Earth-Sun: $a_z = 1.469 \cdot 10^{11}$ m
- speed of light: $c = 3 \cdot 10^{8}$ ms^{-1}

7. How much coal (expressed in kg and in the masses of the Sun) should be burned to get sufficient energy for an electromagnetic emission of a star such as our Sun for 1 000 000 years? Comment the result (referring to the result of the exercise 6).

- heat of combustion for coal: $c_s = 3.4 \cdot 10^{7}$ $J \cdot kg^{-1}$
- the mass of the Sun: $M_\odot = 2 \cdot 10^{30}$ kg
- solar luminosity: $L_\odot = 3.82 \cdot 10^{26}$ W

8. What is the PP cycle and how is it different from the CNO cycle? What process dominates in energy production in the solar core and why (specify the criteria determining the occurrence/dominance of a given process)? Present and compare the energy balance for PP and CNO cycles. Discuss the meaning of the differences.

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