АСТРОНОМИЧЕСКОЕ ОБЩЕСТВО

EURO-ASIAN ASTRONOMICAL SOCIETY

XIII Международная астрономическая олимпиада
XIII International Astronomy Olympiad
XIII Olimpiade Internazionale di Astronomia

Италия, Триест 13 – 21. X. 2008 Trieste, Italia

Round Th

Group β

язык / language English

Theoretical round. Problems to solve

General note. Maybe not all problems have correct questions. Some questions (maybe the main question of the problem, maybe one of the subquestions) may have no real sense. In this case you have to write in your answer (in English or Russian): «**situation is impossible – ситуация невозможна**». Of course, this answer has to be explained numerically or logically.

Data from the table of planetary data may be used for solving every problem.

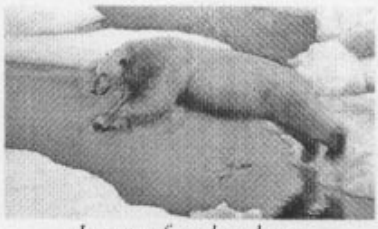
1. **Temperature of star's core.** We may consider, that the solar core consists of a mix of completely ionized hydrogen and helium, the part of atoms of helium is equal to $\alpha = 0.08$ (that is, the numbers of atoms of hydrogen and helium is 92% : 8%). The temperature in the centre of solar core is equal to 15 million degrees and the density is 150 g/cm^3. Let us assume that there is a carbon star (100% of completely ionized carbon) with the same parameters (the same density and pressure in the center and the same mass). Find the temperature in the center of the core of this carbon star. Atomic numbers and atomic masses of hydrogen, helium and carbon are equal accordingly to: $Z_H = 1$, $A_H = 1$, $Z_{He} = 2$, $A_{He} = 4$, $Z_C = 6$, $A_C = 12$. One may assume the gas in cores as ideal.

2. **Absolutely black cat.** Maybe you paid attention to that there are group of cats living in Grignano, to the right from the ICTP guesthouse, including four of them looking like absolutely black ones. Estimate the absolute bolometric stellar magnitude M_{abc} of an absolutely black cat (**abc**) as it is an absolutely black body.

Grignano cat
Photo 14.10.2008

3. **Great opposition.** You know that there are Great oppositions of Mars for citizens of Earth. The magnitude of Mars were even $-2^m.9$ during some of the very famous of these oppositions (like in August 27, 2003). But there are also Great oppositions of Venus for citizens of some planet(s). At what planet(s) is this possible? Find the apparent stellar magnitude of Venus visible from every such planet (or this planet) at such Great oppositions.

4. **Jump of bear.** The beginning of XXI century. One may find in guidebooks about Spitsbergen a phrase that "a polar bear jumps 8 meters without warning". The middle of XXVI century. In order for settling remote areas of Solar system by fauna, biologists plan to deliver polar bears from Spitsbergen onto ice asteroids of the Kuiper belt. However, physicists warn, that some jumping bears can become independent objects of the Kuiper belt. Estimate, on asteroids of what sizes (diameters) it is possible to place polar bears comfortably from the physicists' point of view. You should give an answer in form of formula-inequality.



Jump of polar bear

5. **Alternative theory.** The theory of an expanding Universe is the most popular and most believable modern cosmological model. They say more than 85% of astrophysicists follow this theory without any hesitance. Nevertheless some alternative theories exist as well. One of these theories proposes that the Universe is stable and the cosmological red shift appears not due to the Doppler effect, but due to "aging of photons", i.e. the energy of every photon becomes smaller according to the law $E = E_0 \cdot 2^{-t/T_0}$, where E_0 = initial energy at the appearance of a photon, t = time of life since appearance and T_0 = the so-called half-decay period of a photon, analogous of the half-decay parameter in nuclear physics. Estimate the value of the half-decay period T_0 (in years) in the model of "aging of photons" that corresponds to astronomical observations.