Using of current solar data bases in problems for astronomical Olympiads

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Organization of the project and educational-research activity of students of Public Astronomical Observatories and Planetaria (PAOP) in Bulgaria requires suitable combination of pedagogical technologies and means of teaching. Their active participation in the National Olympiad on astronomy is especially useful. It forces using of original methodological approaches during the process of training for effective mastering of the subject as well as creation of practical models for individual educative programmes and algorithms helping problem solving. Computer and communication technologies are actively used in different teacher-training elements on didactics of astronomy problem solving.

Using of theoretical, practical and observational problems on solar physics thematically connected with solar-terrestrial relations is particularly beneficial to students' training. That is why hands on educative-methodical materials are created for the students in PAOP as such based in Internet are also used. As an example of interesting theme with a possibility of large spectrum of individual problem conditions is "Investigation of the current cycle of solar activity". The basic method used for solving of the problems includes analysis of photographs from the SOHO Space Observatory and their own observations, analysis of Internet based data on solar activity, astronomy and climatology.

Problems for astronomy Olympiad

Theoretical tour

Problems are particularly ingenious and unconventional, sometimes with unnecessary or missing data, for which students should make suppositions. Original thinking is encouraged.

Practical tour

Problems consist of observational data from the host institution and put students in a situation maximally close to that of professional astronomers solving a scientific problem.

Observational tour

Problems are connected with naked eyes observations or with a telescope and need a lot of knowledge about the starry sky.

Introduction of basic solar activity phenomena as spots, prominences, evolution of spot formation activity, etc. to students is easy with their active participation in concrete demonstrational observations and web sources. Along with this students obtain information about phase of the current solar cycle.

Basic skills, which students acquire in the process of teaching, are as follows:

- work with a small telescope and observations of the photosphere through filter and on a screen;
- drawing of the sunspots' disposition;
- determining of the size of the sunspots and prominences using photographs;
- comparing size of the Earth with the size of different heliospheric formations;
- determining of the solar activity phase using different parameters.

Basic peculiarities of such lessons are connected with integration of sciences physics and astronomy considered in Astrophysics part.

Examination of solar activity using visual observations and photographs

Theoretical aspect: Solar activity is characterized with different physical phenomena and processes. Mainly, they are number of the sunspots connected with regions of strong magnetic fields and lower temperature on the solar surface. Strong magnetic field of the spot delays the convective current, which transfer energy from the nucleus regions of the sun to the surface. Temperature of the spot is 4000K – 5000K. Energy of the plasma in the region around the spot remains the same. That is why a bright aureole with a higher temperature is formed around the spot. Existence of multiple solar bursts, prominences and coronal holes also characterize solar activity,

Statistics of the sunspots includes calculations of the number of groups of sunspots g and number of all spots f in groups and separately. Wolf number W is determined by the formula $W = 10g + f$.

If the mean Wolf number is more than 200 and the mean number of groups of spots is more than 10, it is an epoch of maximal sunspot formation and maximum of the solar activity. On July 2000, mean monthly Wolf number reaches the anomalous value of 300 units. As a result of this over centennial maximum of solar activity, on July 15 and 16 aurora was observed even over Bulgaria ($\varphi = 42° - 43°$).If the angular dimension of the spot is equal to 17″, its linear dimension is 12 363 km, which is equal to the Earth's radius:

$$L = 17'' \cdot \frac{150 \text{ млн.км}}{206256} \approx 12363 \text{км}$$

Problem 1. Determine Wolf number W using photographs of the sun. Compare data for Wolf number for the indicated years. Make calculations about manifestations of the solar activity during the 23 rd cycle.

Reference data:

TABLE I

Wolf number – visual mean monthly indices of solar activity during 1999.

01	02	03	04	05	06
55.3	85.8	57.1	78.4	110.3	118.9
07	08	09	10	11	12
147.9	118.7	87.0	145.1	176.7	95.5

TABLE II

Wolf number – visual mean monthly indices of solar activity during 2000.

01	02	03	04	05	06
94. 6	114.9	207.4	201.8	155.0	188.3
07	08	09	10	11	12
304.2	210.7	207.6	155.0	140.5	125.3

For solution of this problem, students should find 3 photographs of the Sun from sites with photographic archives: http://sohowww.nascom.nasa.gov/ or http://www.sel.noaa.gov/solar_images/. They should save them in jpg format for a following analysis of the solar activity. At http://www.chat.ru/~aryback/ Wolf number can be found for July 2000. On July 19, 2000 Wolf number is W=450.

Fill in report N 1:

Number	Number of the groups of spots, g	Number of spots, f
Number	Wolf number, W	Determining of the level of solar activity

Problem 2.

Determine angular and linear dimensions of a sunspot. Find out photography of a large sunspot at the following website: http://antwrp.gsfc.nasa.gov/apod/ap000925.html. It is one of the largest spots registered on the solar surface during the 23rd solar cycle. Compare dimensions of this spot with dimensions of the Earth. It is curious that at the end of March 2001 a group of spots with huge dimensions occurred on the sun.

Image of a spot, which is one of the largest ones observed in the whole history of the solar physics can be found at http://www.spacew.com/sunnow/index.html. It is 13 times larger than the Earth's diameter.

Fill in report N 2:

Linear dimensions of the sun	Linear dimensions of the sunspot	Angular dimensions of the sun

Angular dimensions of the sunspot	Comparison of dimensions: Rspot/R⊕

Problem 3.

Determining of the physical effects of solar activity using photographs of solar bursts accompanied by large coronal mass ejections obtained with the TRACE satellite (http://antwrp.gsfc.nasa.gov/apod/ap001115.html) and photographs of a huge prominence. See also: http://antwrp.gsfc.nasa.gov/apod/ap990923.html http://seds.lpl.arizona.edu/nineplanets/nineplanets/sol.html .

Control questions:

- What is the period of sunspot formation maximum?
- What is the period of solar activity maximum?
- Make conclusions about basic phenomena and processes specific for the sun during the 23rd cycle of solar activity.
- Compare the 23rd solar cycle with other solar cycles.

Another big class phenomena observed on the celestial sphere are eclipses in the Earth–Moon–Sun system (www.sunearth.gsfc.nasa.gov/eclipse/eclipse.html). Lunar eclipses happen more frequently than solar ones during the year, and are more informative, taking into account the class of observational equipment at teachers' disposal. Except traditional measurements – determining of the moments and positional angles of the contacts – Lunar eclipses give a possibility of qualitative and quantitative analysis of the eclipse course from astrophysical point of view. Observers register and evaluate colour of the eclipse during the totality phase, which can be used for correlation with phases of solar activity in the current solar cycle (www.mreclipse.com/MrEclipse.html). Qualitative evaluation and explanation of colour distribution on Lunar disk, using basic references for Earth's atmospheric refraction, are also interesting and can be made. Photometric (qualitative or quantitative) observation of partial phases of the eclipse can also be conducted. Observing with a telescope with low magnification, unequal structures in the Earth's penumbra, generated by volumes of air with different density and transparency in the atmosphere are clearly tracked. Decreasing of the brightness of the illuminated part of the Lunar disk becomes evident near the Earth's umbra. It is interpreted with the fact that in the same time partial solar eclipse carries out at the Moon. Microdensitometry of the Lunar disk photographs made during all the eclipse phases gives the possibility of studying variations of the Moon's illumination during the eclipse.

Eclipses of artificial satellites from the Earth's penumbra have a great cognitive role. Brightness of the satellite rapidly decreases before its entrance in the Earth's umbra. Determining of the time for passing the Earth's umbra gives the possibility of determining its width near the Earth according to the distance to the satellite.

Considering the dynamics of the Earth's atmosphere, these observations are still of scientific importance, which make them more interesting for students.

Conclusions

Astronomy Olympiads are challenge for both students and teachers. Process of training gives a possibility of finding young talents in astronomy and natural sciences who bind their lives to science and discovery.

Using of current solar data bases in problems for astronomical Olympiads is of great importance for reaching the aim for more qualitative knowledge and stimulation of students' thinking – beneficial to personal advance: knowledge applying, mind training, provocation of thinking, education, discovery, making models, etc.