

INTERNATIONAL SUMMER SCHOOLS "ROZHEN"  
AND THEIR ROLE IN ASTRONOMY  
EDUCATION FOR STUDENTS AND TEACHERS

V. RADEVA

*Public astronomical observatory and planetarium, Varna, Bulgaria*  
*E-mail: veselka.radeva@gmail.bg*

**Abstract.** For the past seven years teachers and students from different European countries have attended the International summer schools at the National Astronomical Observatory "Rozhen", Bulgaria. During the schools there is a cycle of theoretical astronomy education, a series of practical tasks and a rich observational program. In the observational program, whose completion is the primary task of the students, two professional telescopes are used - a 50/70 cm Schmidt telescope and a 60 cm telescope - together with astronomers from the National astronomical observatory. During the completion of the program, the students become familiar with the work of astronomers, they learn how to work with observational equipment, astronomical software for controlling CCD cameras and for image processing. The students make astrometric observations of comets and asteroids, they observe extrasolar planets, supernovas, star clusters, galaxies and nebulae with the goal to prepare a student Messier catalogue; they observe Saturn, Jupiter and its satellites, and the Moon, with the goal to register short-term lunar phenomena. The intensive training during the international astronomical observing summer schools contributes to the enrichment of the astronomical knowledge of the participants and the development of their skills in working with observing equipment and analytical software. A significant success of the schools is the large percentage of student-participants who continue their careers in the field of astronomy.

## 1. INTRODUCTION

Observations have a major role in astronomy education in high schools. It is difficult for science teachers to systematically organize astronomical observations during the school year. Usually during the process of astronomy education it is feasible to organize only one or two observations. Thus, it is not possible for students to improve their astronomical knowledge and skills in observing astronomical events and objects.

In Bulgaria there is a good practice during the summer for teachers from public astronomical observatories to organize observing schools and expeditions. In many European countries, however, astronomical summer schools are not organized and this is a problem for European astronomy education. The International summer schools at the National Astronomical Observatory "Rozhen", Bulgaria are a very successful effort.



Figure 1: Some of the participants at the Schmidt telescope.

## 2. THE INTERNATIONAL SUMMER SCHOOLS "ROZHEN"

The Institute of Astronomy, the National Astronomical Observatory - Rozhen, Bulgaria, and the Society of Innovative Teachers in Bulgaria have organized International Youth Astronomical Summer Schools since 2003.

The Bulgarian National Observatory gives students and teachers the opportunity to use all professional equipment and astronomical facilities. Students in their final years in high school, who are interested in astronomy, participate in observations of astronomical objects, listen to interesting lectures and participate in discussions at the National Astronomical Observatory - Rozhen. The lecturers and educators are professional astronomers, and with their assistance during the schools all young participants become astronomers, too.

More than 220 students and 30 teachers from different countries have participated in the summer schools (Fig. 1).

Among them, 32 students have continued their education by studying astrophysics, and are going to become professional astronomers. The students who participate in the summer schools are exceptionally motivated; they are interested in astronomy and strive to learn how to work with telescopes and how to use astronomical software for image processing. The physics and astronomy teachers, who are leading the student teams, increase their qualification by participating in the series of lectures, practical exercises, observing tasks and pedagogical discussions for exchange of successful educational practices.

## 3. EDUCATIONAL AND OBSERVATIONAL PROGRAMS DURING THE SUMMER SCHOOLS

In the observing programs, whose completion is the primary task of the students, two professional telescopes are used: a 50/70 cm Schmidt telescope and a Cassegrain-telescope "Zeiss-600".



Figure 2: Andromeda Galaxy and Pleiades.

During the completion of the program, the students become familiar with the work of astronomers, they learn how to work with observational equipment, astronomical software for controlling CCD cameras and for image processing. The students make astrometric observations of comets and asteroids, they observe extrasolar planets, supernovas, star clusters, galaxies and nebulae with the goal to prepare a student Messier catalogue; they observe Saturn, Jupiter and its satellites, and the Moon, with the goal to register short-term lunar phenomena. Some of the obtained images are shown in Fig. 2.

During the summer schools, astrometric observations of the following comets were made: 2003 K5, Q4 NEAT, K4 LINEAR, 9P Tempel 1, C2004 Q2, C2004 B1, C2001 Q5, C2007 W1, 17P/Holmes, 124P/Mrkos, C2006 W3, C2005 L3 and 22P/Kopf. Astrometric observations of 37 asteroids were made - mostly NEOs and the asteroid Tautatis. The supernovas 2005cs in NGC 5194 (M51), 2009 dd in NGC 4088 and 2009dq in IC 2554 were observed.

Images of 74 objects (galaxies, star clusters and nebulae) from the Messier catalogue were acquired with the Schmidt telescope for the observational project "Students' Messier catalogue" in paper and electronic format. The images of objects from the Messier catalogue are used by teachers in the school program topics "Stars, stellar evolution", "Galaxies" and "Galaxies, cosmology". The students do photometry of stars and measure the characteristics of galaxies with the help of astronomical software adapted for student work.

The students use these images for preparation of educational projects, with which they participate in the National competition for Astronomy in the Internet "Sky treasure hunters" and in ESO's competition "Catch a star". Until now the participants in the summer schools have participated with 17 projects in the competitions and have received awards, among which 2nd place out of 200 projects from Europe.

The students in the summer schools study the work of the Schmidt telescope and the 60 cm telescope. They learn how to work with the software of the CCD cameras of the telescopes, and the software for analysis of the acquired images. For the processing of the comet and asteroid images, the students study and apply the software *ASTROMETRICA*, which is provided by its author Herbert Raab (Killer asteroid project - International Astronomical SearchCollaboration), especially for the International summer schools at NAO-Rozhen.

During the last two schools the students learned how to work with the software *MAXIM DL*, with which extrasolar planet and variable stars images are also processed, and photometry of the observed supernovae is done. The students work on the astronomical observational programs during the entire night. During the day the students process the images and attend lectures and practical exercises. The main topics of the theoretical and practical astronomy education are: Astrophysics, Optics and telescopes, Astrophotography, CCD observations, Star evolution, Galaxies, Life in the Universe, Sky orientation, Moon and Planet observations, Deep sky observations, Comet and asteroid observations, Extrasolar planets, Variable stars, Space research.

The intensive training during the international astronomical observing summer schools contributes to the enrichment of the astronomical knowledge of the participants and the development of their skills in working with observing equipment and analytical software. A significant success of the schools is the large percentage of student-participants who continue their careers in the field of astronomy.

#### 4. CONCLUSION

The international astronomical schools that take place at NAO-Rozhen, are the only of their kind in Europe, which provide a team of teachers and students with the opportunity to learn by working on specific observing programs, make observations and process them. Seeing the work of professional astronomers, the personal contact with them, and the responsibility that they have by working at NAO-Rozhen as astronomers, all develop the participants' very strong interest in astronomy. They build motivation for working in the field of science, and acquire competence in their knowledge and capabilities. The excellent results achieved during the summer schools and the data processing, are presented at student conferences and through projects. A large number of participants in the schools continue their careers in the fields of astronomy and other sciences.

This demonstrates the need to have this and similar summer schools. Astronomy education has good results when the science is in close contact with the teachers and students. This is achieved at the maximum level at NAO-Rozhen, which makes the observatory an important educational center for teachers and students from Bulgaria and other European countries.

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