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Hands-On Universe: A Global Program for Education and Public Outreach in Astronomy

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Abstract. Hands-On Universe (HOU) is an educational program that enables students to investigate the Universe while applying tools and concepts from science, math, and technology. Using the Internet, HOU participants around the world request observations from an automated telescope, download images from a large image archive, and analyze them with the aid of user-friendly image processing software. This program is now in many countries, including the USA, France, Germany, Sweden, Japan, and Australia. A network of telescopes has been established, many of them remotely operated. Students in the classroom are able to make night observations during the day, using a telescope in another country. An archive of images taken on large telescopes is also accessible, as well as resources for teachers. Students deal with real research projects, e.g., the search for asteroids, which resulted in the discovery of a Kuiper Belt object by high-school students. Not only does Hands-On Universe give the general public access to professional astronomy, it also demonstrates the use of a complex automated system, data processing techniques, and automation. Using telescopes located in many countries over the globe, a powerful and genuine cooperation between teachers and children from various countries is promoted, with a clear educational goal.

1. Introduction

The advantages of using astronomy in the classroom are several. The Universe and its objects have to be learned in most of the curricula, either as part of physics courses, or on its own. Astronomy may provide a good application of many of the concepts developed in physics and mathematics curricula. Astronomy is at the intersection of many areas of the knowledge, either in fundamental and applied sciences. It is a good illustration of the usefulness of an interdisciplinary approach. It is also a good illustration of the emergence of science over the past centuries, and of the idea (still developing) of the place of mankind in the Universe. Many of the astronomical concepts have been developed in various historical areas (Mesopotamia, Egypt, ancient Greece, Arabic countries, Occidental world...).

The goal of the Hands-On Universe (HOU) program is to promote the use of astronomy within the high and middle schools, and to enable students to use data or to request their own observations from professional or dedicated observatories. HOU has historically been developed at the University of California Berkeley, as a curriculum program. In this framework, dedicated software to analyse astronomical images has been written. Now, HOU has been extended to more than nine countries over four continents, and promotes the use of a global network of telescopes.

In this paper we present the main features of the HOU program, and its global approach.

2. Main Teaching Goals of HOU

As explained above, beside astronomy one of the main goals of HOU is to use the concepts and data acquired in Astronomy to introduce the scientific notions in physics and mathematics, for high-school students. As an illustration these concepts may be introduced using astronomical data: In physics, the notion of speed of light may be illustrated by reproducing Romer's experience. In mathematics, notions such coordinates, maps, and transformations may be illustrated using celestial reference systems. Astronomical observation brings these abstract transformations to real life. In image and signal processing, concepts like contrast may be approached when pupils work with actual images. An astronomical observatory has many complex instruments, and if automated, it is a good illustration of automation for a technology course (e.g., housekeeping). Of course, an actual exploration of solar system bodies brings "life" to an introduction to astronomy.

Though HOU has as main goal teaching at the high and middle school levels, many demonstrations have been performed for the general audience, e.g., at the open days of the U. C. Berkeley, at the Science Museum of Tokyo, at the SITEF technological exhibition in Toulouse, and at the Villette Science Museum in Paris.

A specific computer program has been developed to simplify access to most of the functions available in astronomical data processing software. It has been written for PC and Macintosh type computers, and gives a clear interface for pupils. The data processing functions include various color tables, computation

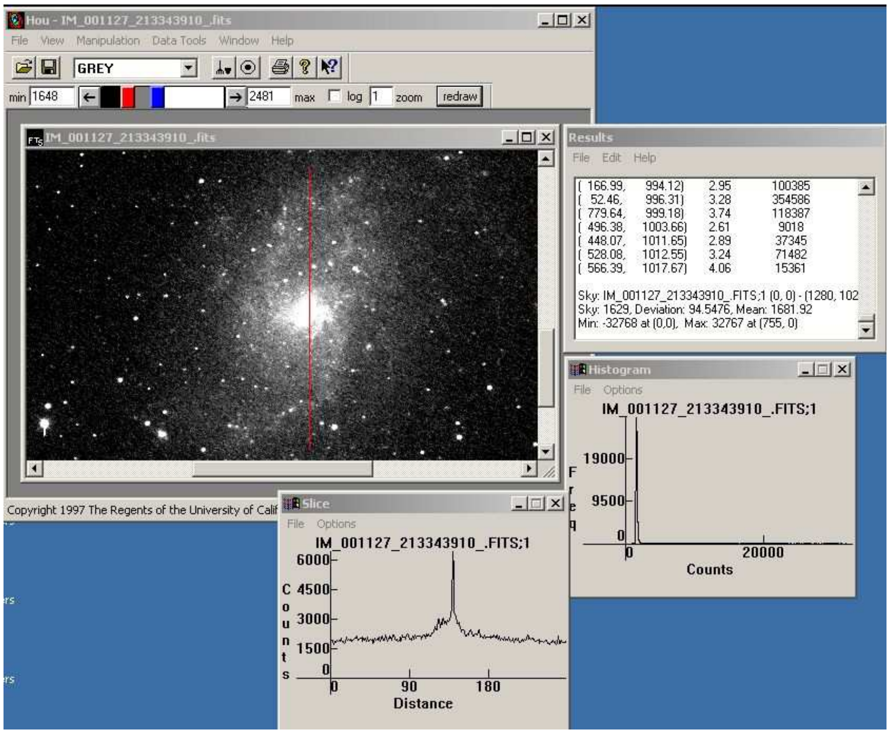

Figure 1. The Messier 33 galaxy displayed using the HOU software, and featuring the "sky" and "slice" tools (image from TAROT, Boër et al. 2001)

of sky level, aperture photometry, slice extraction, histogram, axes plotting, etc. Several of these features are illustrated in Figure 1 on an image of M33 taken by the TAROT telescope (Boër et al. 2000; Boër et al. 2001).

3. Global HOU

Global HOU (G-HOU) is an open network of teachers, high-schools, EPO, and research institutions, whose goal is the use of astronomy in the various curricula. Several resources are shared, like exercises, images, and telescope time.

Several telescopes are giving time to the G-HOU network, e.g., the TAROT instrument in France, the Keio observatory in Japan, the Katzman observatory in the USA, etc. Some of them are professional research instruments, while several others have been developed primarily for educational purposes. Most of these telescopes are able to be remotely operated. This global network is widely spread in longitude (and also in latitude) and has the advantage that pupils may access telescopes during normal classroom hours, while it is the night at the telescope site. Several successful sessions have been made, e.g., during the open days of U. C. Berkeley, the SITEF exhibition in France, or within the framework of the astronomy class of the Tokyo Science Museum. They all bring the powerful (and somewhat magical) possibility of seeing the night sky of other countries. This feature, together with the use of archival, or pre-requested data, open the possibility for students to perform their own scientific program. As an example, for a study of the colors of stars, a sequence of multi-color observations may be requested and the HR diagram built directly from the data by the pupils. Another striking example is the discovery of a Kuiper belt asteroid by the astronomy class of Northfield Mount Herman School.[1] This discovery has been confirmed by another high-school class, showing the level of cooperation reached within the G-HOU program. More generally speaking, G-HOU is a means for children from various countries and languages to exchange and collaborate.

There are, however, some difficulties because educational programs may be quite different in various countries. For instance, there is no dedicated "astronomy" course in France (and in most countries), while there quite often is one in the USA. This means that astronomy has to be used as a tool to introduce other concepts in physical sciences or mathematics, e.g., distance, color, and temperature. The use of astronomy, with "real data" at hand, has proven to be very effective to stimulate pupil interest in science courses, including unpopular areas.

4. Conclusion

We presented the Hands-On Universe program.[2] The most interesting features of this program are the use of actual and archived data within the classroom, and the ability of students from various countries to build their own research program and to work with "their" data.

Several exercises have been designed by the teachers participating in the program, most of them aimed at introducing the notions and concepts used in physical sciences, technology and mathematics courses. Last but not least, through the use of telescopes located in many countries over the globe, a powerful and genuine cooperation between teacher and children from various countries is promoted, with a clear educational goal.

References

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Boër, M., et al. 2001, this volume, 111

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[1] `http://www.nmhschool.org/astronomy`

[2] `http://hou.lbl.gov/global/`