THE PERSONAL COMPUTER FOR TEACHING ASTRONOMY

R. Andreoni[1], G. Forti[1], P. Ranfagni[2]

[1]Osservatorio Astrofisico di Arcetri, 50125 Firenze, Italy
[2]Istituto di Astronomia dell'Universitá di Firenze

1. Introduction

The two interactive software packages, which we called *ASTRONOMIA 1* and *ASTRONOMIA 2* (in the following A1 and A2) and developed for a personal computer under MS-DOS, are primarily intended to be used in junior-high and high schools as tools for teaching astronomy. With the help of these programs and using the sky as a laboratory, the teacher can explain the most difficult parts of the astronomical geography: time and coordinates. Very few schools in Italy own the necessary educational tools such as a small planetarium, a sidereal clock, an oriented celestial sphere, *etc.*

We tried to exploit the capability of a personal computer to visualize and to present the results of a calculation as diagrams and tables. A limited interaction permitted by the programs allows the user to compare the results with other computations.

All the programs are written in such a way that it is difficult to make a mistake when entering data. The programs were first assembled and tested by us, then presented to the students and teachers to be evaluated and criticized. We obtained from them suggestions, advice, and, generally good reviews. Obviously, this special kind of reviewers had good backgrounds in astronomy in order to evaluate the programs completely.

A small booklet containing a description of the programs and a few worked-out exercises is available for both packages.

2. ASTRONOMIA 1: Time and Coordinates

The A1 package is devoted mainly to the understanding of the main astronomical phenomena, such as the rotation and revolution of the Earth starting from direct observation of the sky (Ranfagni, 1985). The programs allow the user to answer the question which, unconsciously or not, a beginner observer wonders about: "Where do I have to look to see a certain object?" The long and tedious computations necessary to answer this question usually discourage the beginner. In our case, the computer takes care of the computations and the user only has the task (undoubtedly more pleasant) of trying to understand the meaning and to verify the results directly from the sky.

The A1 software is divided into four sections: the programs in the first three (OROL4, EUROPA, EQTEMPO) and those dealing with the systems of coordinates in the last one (APPLICAZIONI) aim at explaining the measure of time and the

angular quantities used in astronomy. The results are visualized in the most suitable form for the quantity considered: time is represented by analog and digital clocks, the geographical coordinates by a cursor moving over a map, and the astronomical coordinates by a drawing of the celestial sphere.

In the section OROL4, four analog and digital clocks are shown: a couple of them tick the civil time, and the others the local sidereal time, the mean local solar time, and the true local solar time. The equation of time and other parameters are shown in a small window in order to understand the various kind of times.

In the section EUROPA, the longitude and latitude of a place in Europe or in Italy can be obtained and propagated to the other programs with the help of a cursor moving on the screen and a small menu.

The section EQTEMPO deals with the equation of time and its variation.

The remaining programs of the last section, called APPLICAZIONI, are utility tools: it is presumed that the user is more interested in the value of the quantities rather than in their meanings. They include the change of the coordinates, the calculations necessary for the pointing of a telescope, a method to find the observer's geographic coordinates by taking only two height measurements of a known celestial object. These programs may be useful to the student as well as to the amateur astronomer since the results are immediately applicable.

It is possible to pass from a section to another one with the help of a small menu. Appropriate explanations can be obtained in each program.

3. ASTRONOMIA 2: Movements on the Celestial Sphere

This second package, A2, is mainly dedicated to obtain on the screen and on the printer (if available) the sky for every time and place on the Earth (Andreoni, et. al., 1987). The projection of the sky on the plane of the screen is chosen such that all the angular distances of the objects remain almost unchanged and the representation of the sky is rather similar to what we could really see by looking at the sky in the same direction.

The programs of A2 are divided in four sections, as those of A1.

The first section, TERRA, is the natural evolution of Europe in A1: the geographic coordinates of the observer can be found with a cursor on the celestial globe. The coordinates found can be passed to the next section, CIELO. This set of programs deals with the representation of the sky. The input data are: the date, the hour, the geographic coordinates, the limiting stellar magnitude and a flag to compute or not the precession (necessary if the date is very far from 2000.0). The time zone is automatically computed as soon as the location coordinates are entered (time must be specified in U.T.). When the data are ready to be plotted on the screen there might be two choices according to the time of the day: a) the daily movement of the sun across the sky and the sun among the stars; b) the night sky. Other features can be obtained when the sky is drawn: a cursor to identify the objects, height-azimuth and equatorial grids, the possibility of bringing an object to transit, *etc.*

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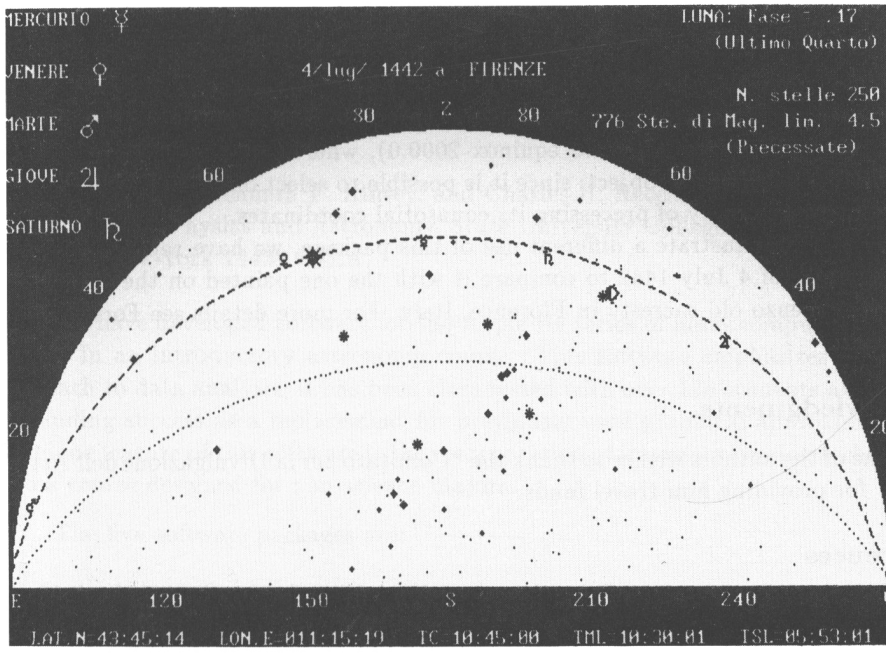

Fig. 1. The Florentine sky on 4 July 1442.

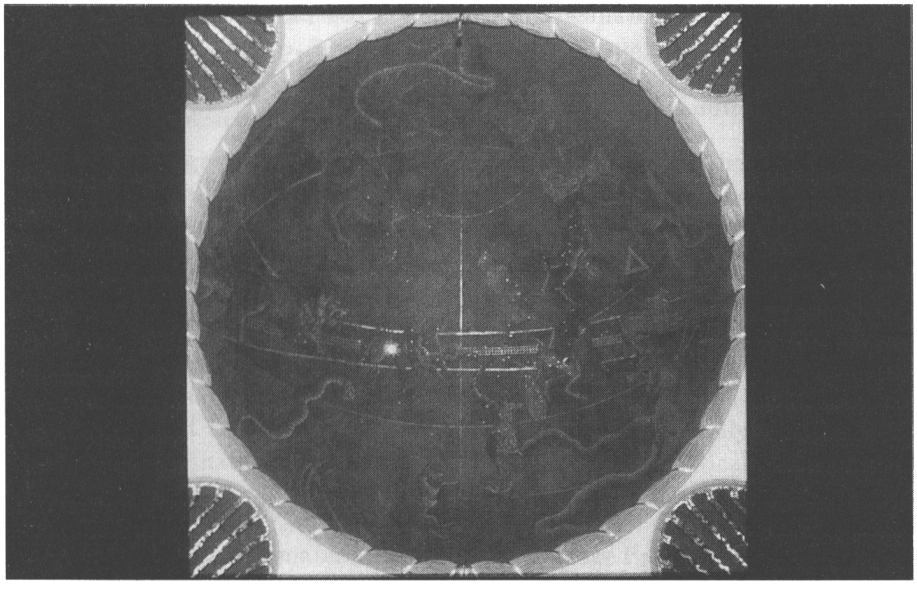

Fig. 2. The ceiling of the Saint Lorenzo old sacresty, Florence.

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The section, COSTELLAZIONI, shows each constellation (with or without objects other than stars) with the possibility of going back and forth in time to see their distortions due to proper motion.

The last section, CATALOGO, is a small catalog of about a thousand stars (limiting magnitude about 6 and equinox 2000.0), where a few physical data are stored for each individual object; since it is possible to select one star at a time, we provided the possibility of precessing its equatorial coordinates.

In order to illustrate a different use of this package, we have reproduced the Florentine sky of 4 July 1442 to compare it with the one painted on the ceiling of the Saint Lorenzo old sacresty in Florence, Italy. For more details see Forti *et al.*, 1987.

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