



## Digitization of the Archives of Plates of the Italian Astronomical Observatories and of the Specola Vaticana \*

C. Barbieri<sup>1</sup>, C. Blanco<sup>3</sup>, B. Bucciarelli<sup>4</sup>, R. Coluzzi<sup>5</sup>, A. Di Paola<sup>5</sup>, L. Lanteri<sup>4</sup>, G.L. Li Causi<sup>5</sup>, E. Marilli<sup>3</sup>, S. Magrin<sup>1</sup>, R. Nesci<sup>6</sup>, A. Omizzolo<sup>2</sup>, F. Rampazzi<sup>1</sup>, C. Rossi<sup>6</sup>, R. Stagni<sup>1</sup>, R. Viotti<sup>6</sup>

<sup>1</sup> Department of Astronomy, University of Padova, Vicolo Osservatorio 2, 35122 Padova - Italy, e-mail: [barbieri@pd.astro.it](mailto:barbieri@pd.astro.it)

<sup>2</sup> Specola Vaticana, Castelgandolfo

<sup>3</sup> INAF and University of Catania

<sup>4</sup> INAF Osservatorio di Torino

<sup>5</sup> INAF Osservatorio di Roma

<sup>6</sup> Department of Astronomy, University of Roma I

**Abstract.** A two-year project to digitize the archive of plates of the Italian Astronomical Observatories and of the Specola Vaticana has started in 2002 with funds from the Ministry of the University and Research. Identical systems, composed by a commercial scanner plus dedicated PCs and acquisition software have been installed in all participating Institutes. The project means to provide high quality photometric sequences with the Campo Imperatore telescopes and to distribute the digitized information via the international Web. This paper concisely presents some of the activities carried out and results obtained so far.

**Key words.** Electronic archives – Scientific exploitation

### 1. Introduction

A great amount of highly valuable information is stored in the photographic archives of many Italian Observatories and in the Specola Vaticana. Digitization of this treasure is therefore of paramount importance

for the preservation of their support and for the fuller exploitation of the scientific content, see e.g. (Viotti et al. 1993), (Griffin 2001).

Among the possible scientific objectives: i – previous transits of NEOs; ii – high proper motion stars; iii – variable stars; iv – spectral classification over wide fields; v – time history of QSOs, etc. Following a pilot program funded by the University of Padova in 2001, see (Barbieri 2003, hereinafter Paper I), which gave several ele-

---

*Send offprint requests to:* C. Barbieri

\* Poster at [http://sait.oat.ts.astro.it/MSAIS/3/POST/Barbieri\\_archives\\_poster.pdf](http://sait.oat.ts.astro.it/MSAIS/3/POST/Barbieri_archives_poster.pdf)

*Correspondence to:* vicolo Osservatorio 2, 35122 Padova Italy

ments of knowledge, we have set up a collaboration among our six Institutes and have obtained national funds from the Ministry of the University and Research. This report covers the period from August 2001 to March 2003.

## 2. The Photographic Archives Censuses

The photographic plate is a perishable support with the risk, in time, to lose its entire information. It is necessary therefore to provide the means for an adequate conservation.

**Asiago:** the total number of plates is  $\sim 78000$ , in good general condition. The logbooks of all the Asiago telescopes are accessible on-line as PDF files in the Archive section of each instrument ([www.pd.astro.it/Asiago/](http://www.pd.astro.it/Asiago/)). The logbooks of spectroscopic observations (122-cm and 182-cm telescopes) will come in the near future.

**Torino:** The photographic material consists of  $\sim 6000$  plates exposed at different telescopes during a period of about 70 years, as early as 1920. This archive has to be inspected and suitably archived; a logbook has to be produced.

**Catania:** The photographic archive ( $\sim 3000$  plates) is based essentially on direct image plates (solar data are not treated in this program). Most of the Carte du Ciel plates are in very bad state and are probably lost for ever. We plan to start an inventory of the material, compile a digital logbook, and provide an envelope for each plate.

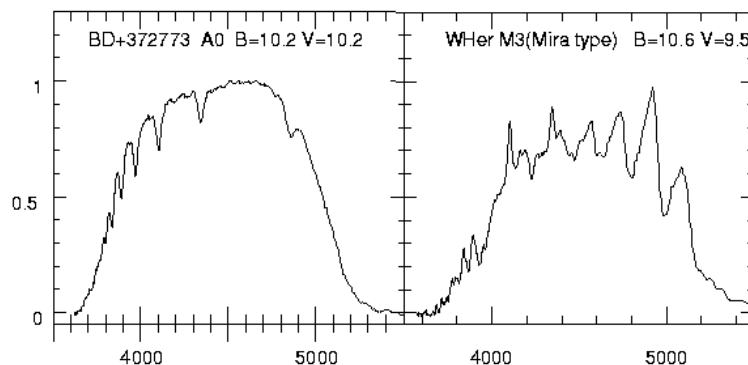
**Rome Monte Porzio Observatory:** Only the logbooks are available of the great amount of work produced with the S60/90 cm Schmidt telescope of Campo Imperatore Observatory from the early 1960s to the end of the 1970s.

**Rome University:** There are no proprietary plates. A collaboration has been activated with the Byurakan Observatory to digitize the objective prism plates of the Armenian Survey.

**Vatican Observatory:**  $\sim 10000$  plates from 1894 to 1986 of the 33-cm photographic doublet, the 40-cm Zeiss Refractor quadruplet, the 60-cm Zeiss Reflector and the 65 cm Schmidt Telescope. Systematic scanning of the entire archive of the Carte du Ciel is planned: these plates are in a very good state of conservation. An electronic catalogue of the logbooks of is in preparation.

## 3. Digitization of the Plates

**Activity in Padova–Asiago:** two scanners (Epson 1640 XL, A3 format, optical resolution  $1600 \times 1600$  dpi 14 bit) have been bought by the Department of Astronomy. S. Mottola of DLR in Berlin, has written for our computers routines working in the Windows operating system interfacing the scanner and providing as output a negative or positive FITS image that can be directly analyzed with IRAF or other software. The approximate dimensions of the digitized files at 1600 dpi are: Schmidt plates (20x20 cm) 260 MB, 122 cm plates (9x12 cm) 70 MB, 182 cm plates (20x12 cm) 150 MB. We are for the moment saving the files to DVDs, but a dedicated system is planned in the near future to store and distribute the files via the Internet. Tests have been performed on 30 different types of plates, images and spectra, to determine the effective spatial resolution of the scanner. The result is 16 micron/px, which is sufficient for the plates used in imaging but not quite so for the spectroscopic material. Therefore the present digitizing activity is concentrated on images; at present, the total of scanned plates is about 750, among which all of the available M33 plates from all the telescopes, M31 and QSO plates. Then the Pleiades and NGC 7000 scanned by Milcho Tsvetkov (Bulgarian Academy of Science), while in Asiago in the frame of a collaboration with the Sofia Sky Archive Data Center. To evaluate the photometric capability of the digital files, in Paper I we examined with the IRAF-DAOPHOT package the Selected Area 57. A better check



**Fig. 1.** Examples of digital scans of a Campo Imperatore objective prism plate. The ordinates represent the sky subtracted intensities normalized to the maximum flux. The emissions of the Hydrogen Balmer lines are clearly detectable in the spectrum of the Mira type star.

was made on the plates of 3C 345. In Paper I we also checked the astrometric precision of the S67/92 digitized plates, using the coordinates of the SA 57 stars provided by USNO-A2.0 to check the equatorial coordinates. We have then extended the tests, with better astrometric programs, to other star fields; up to now, the tests have been limited to subfields of  $1500 \times 1500$  px, with approximately 150 USNO stars per field, finding a St. Dev. in both coordinates of about  $0''.35$ . **Activity in Torino:** systematic plate inspection and inventory is starting. In parallel, selected plates will be measured with a scanner available at OAtO (Microtek Artixscan 1100,  $1000 \times 2000$  dpi, optical density 3.9, 14-bit resolution). More than 300 plates obtained around 1990 with the REOSC and Morais telescopes have already been digitized using TOCAMM (an original SCORECORD measuring machine, automatized by OAtO and currently hosted by Cagliari Observatory), which has proved to be astrometrically stable at the 0.5 micron level (Lattanzi et al. 2001). This material will be used to assess the astrometric and photometric accuracy attainable with the in-house scanner.

**Activity in Rome University:** the Rome University team has taken up the task of digitization of the objec-

tive prism material, given their long-standing interest in these arguments (Cassatella and Viotti 1975).

The tests initially started on the Byurakan plates showed promises of a good scientific return; therefore a deeper analysis was performed on a plate taken with the Schmidt telescope of Campo Imperatore in order to check the accuracy of spectral classification with IRAF packages applied to spectra from plates. We extracted several spectra and made crosschecks on already classified objects, obtaining satisfactory results. Two final spectra are shown in Fig.1). A second scanner is therefore to be placed in Asiago Observatory, dedicated to the objective prism plates. To get an indication of the photometric results possible on short focal length telescopes, we scanned a plate of the 40/61/121 Schmidt camera of the Catania Observatory. We transformed the plate transparency into photographic density. Aperture photometry was then performed with IRAF/Apphot. A comparison of our instrumental photographic magnitudes with the GSC2 ones was plotted. The best fit linear relation has slope 0.85, close to the ideal value of 1.00 and the rms deviation is 0.14 mag. We confirm therefore that sufficiently accurate photometry can be done on the digitized images. As a re-

sult, a third scanner has been put in operation at Perugia University, to scan the large amount of Asiago S67/92 plates taken by P. Maffei for the search of variable stars.

**Activity at the Specola Vaticana:**

A scanner identical to those in Padova-Asiago has been installed in Castelgandolfo. About 300 Schmidt plates have been digitized. No reduction work has been done so far.

**Activity in Monte Porzio:** Rome Observatory has started the calibration work on a sample of plates from the archive of the Asiago 67/90 Schmidt telescope. Observations are carried out at the 60/90 Schmidt telescope of the Campo Imperatore Observatory. The aim is to produce an algorithm to linearize fluxes from the digitized plates, or to create a pipeline to directly modify the data files. A conversion to the standard Johnson filter set will also be attempted to homogenize actual measurements and data from the historical archive. It is our goal to produce a long term light curve of the variables found in the test plates. A system for data storage and distribution over the Internet (NAS: Network Attached Storage) has been implemented in Campo Imperatore. It accepts NFS, FTP and Windows protocols. The present capability is 540 GB, in configuration RAID5 without hot spare, and it can be expanded to 1 TB.

**Activity in Catania:** a scanner Epson 1680 Pro, A4 format, has been bought with a dedicated high quality PC. An electronic logbook of the plates is in compilation. By using an available AGFA 8-bit ARCUS II back-illuminated scanner, some tests have been made on the old (1910) plates of Halley's comet and on more recent plates obtained at the M.G. Fracastoro station with the same 33-cm objective. An attempt of scanning the ancient plates of the astrographic catalogue and of Carte du Ciel have given evidence of the strong damage they suffered by funguses and moulds.

The restoration of even a partial number of these old plates can give valuable scientific information. A collaboration has been undertaken with the Institute of Plant Pathology of Catania University.

#### 4. On-line Consultation

In the Asiago Observatory page (<http://www.pd.astro.it/Asiago/>), the digitized logbooks are available in PDF format. For the S67/92 telescope, an experimental on-line query page is active (see <http://dipastro.pd.astro.it/~asiago/>), yielding data from the main fields of the catalogue, a jpg preview of the plate and the form to request the FITS file via FTP.

*Acknowledgements.* We gratefully acknowledge the support of many collaborators: S. Mottola (DLR), V. Mezzalana, A. Migliorini and G. Umbriaco (Dept. of Astronomy, UPd), E. Massone (Observatory of Torino), Riccardo Benini e Marco De Mattia (students at Rome University La Sapienza), Fernando Pedichini and Fabrizio Bernardi (Observatory of Rome Monte Porzio) and Enrico Catinoto (Catania Observatory).

#### References

- Barbieri, C., Omizzolo, A., & Rampazzi, F. 2003, MSAIt 74, 430
- Cassatella, A. & Viotti, R. 1975, ASSL Vol. 54: Image Processing Techniques in Astronomy, 367
- Griffin R.E.M. (2001), Astronomy and Geophysics, Vol.42, p.225
- Lattanzi, M., Massone, G., Poma, A., & Uras, S. 2001, J2000, a fundamental epoch for origins of reference systems and astronomical models, Paris, edited by N. Capitaine, p.33
- USNO: <http://www.usno.navy.mil>
- Viotti R., Baratta G.B., Cassatella A., Polcaro V.F. 1993, MSAIt, 64, 701