SCAN–IT

The IAU Task Force for the

Preservation and Digitization of Photographic Plates

PDPP Newsletter No. 1

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Editorial

Elizabeth Griffin (Elizabeth.Griffin@hia.nrc.ca; remg@astro.ox.ac.uk)
Dominion Astrophysical Observatory, Victoria, BC, Canada

August 2000 was a milestone in the history of our science. No-one who attended the closing Assembly of the IAU in Manchester can have failed to appreciate that a matter of considerable moment was being debated – one that split the membership into opposing camps, and persuaded the IAU Executive Committee as a body to risk its neck by voting against what was being debated (and in so doing to receive a public rebuke for its stand).

What was being debated was a simple, earnest proposal that the astronomical community, aware that its historic archives of stored photographic data were swiftly becoming an endangered species, should encourage reasonable efforts to preserve the information in those data by transferring them to modern digital media. How it was that a debate over the proposed Resolution came about at all has been adequately aired (see IAU Bulletin 88, pp. 41–42, November 2000) and that is water under the bridge. Resolution B3, "Safeguarding the Information in Photographic Observations", was democratically voted in by the GA, and its implications are therefore matters that now concern the whole astronomical community.

The Resolution (reproduced here on page 32) calls for energy to bring about the transfer of the information in historic observations to a format which is readily accessible by everyone (i.e. digitally). It also recognizes the growing risk to the very existence of some, if not all, of those archives as a result of changing ideas, trends in modern instrumentation, and biases in education. To provide support for the main thrust of the Resolution, therefore, we created an international special-interest group to act both as advisory body and as watchdog – the *Task Force for the Preservation and Digitization of Photographic Plates (PDPP).* Coming into existence under IAU auspices, the TF is formally joined to Commission 5 ("Astronomical Data"), where it belongs rather naturally. It will seek Working Group status in the future, but that is something that can only be granted at a General Assembly, if the host Commission so proposes.

Membership of the PDPP is open to everyone involved in any way with what its title says, though with a heavy bias towards things astronomical. In particular we would like to represent every project, current or planned, concerning photographic-plate archives, be it designing their long-term protection, creating on-line catalogues of their contents, or scanning plates in order to preserve the information digitally, preferably in physically-meaningful units. Those actively engaged in such projects, whether full-time or casually, constitute the "core" membership of PDPP. "Ordinary" membership includes those who are interested in, and sympathetic to, what the group is trying to achieve; this would be the appropriate category for corporate members.

It is particularly important that the membership represent every astronomical observatory that has a plate store. Please raise this matter with your own observatory. My e-mail address is given above.

Even during its brief probationary existence so far, PDPP has been defending its objectives:

• We were alerted to the imminent destruction of a plate collection whose space was being requisitioned for other purposes, and we were instrumental in getting the imperilled plates moved elsewhere, at least temporarily, while a permanent solution is worked out.

• An enquiry about the recommended procedures for cleaning old plates prior to scanning them led to a discussion involving preservation experts.

• Efforts are being made to raise grants for the purpose of cataloguing archive contents.

• We hear that a large collection (nearly 2 tons) of 100 year-old solar spectrobolarimetric plates needs a new home because "the Smithsonian Museum feels it can no longer store them." That opens up a whole new can of worms....

While the responsibility for maintaining and preserving astronomy's historic records seems to have devolved upon a willing few, many of whom are – or, we very much hope, will be – associated with PDPP, we depend on the vigilance of the whole community in warning us of impending problems. We also want to share successes, if there be any, to encourage fellow-travellers. It is therefore important that the activities of PDPP have wide recognition, and to that end we will issue an occasional Newsletter. This, our first, endeavours to set out information about some of the relevant activities that have come to our attention. Given that we certainly have not been able to include a complete list of those activities, there is a pleasingly large amount to report, and we hope that by sharing the information we may inspire other observatories or groups to prepare on-line catalogues or to set about digitizing part, if not all, of their photographic collections. Provided it is done properly, the task has only to be done once!

Over Half a million ... and still counting

The Wide-Field Plate Database (WFPDB) (see page 20) contains descriptive information about wide-field photographic observations stored in numerous archives all over the world. It currently provides access to information (meta-data) for about 640,000 plates from 117 plate archives, i.e. about 30% of the estimated total of about 2 million plates.

Preparing on-line catalogues requires careful supervision, but is worth doing properly since it provides the only inside view of the enormous resource which we can in principle mine for research. Experience shows that one can enter records into a database at a rate of about 1,000 per week. Uniformity is also vital, and anyone commencing this important task is encouraged to apply to the WFPDB personnel for a cataloguing template, so that a final merger into a Master Catalogue can be carried out seamlessly.

On-Line Contents Catalogues are Essential!

PROJECT REPORTS

Scanning Activities at Asiago Observatory

Cesare Barbieri (barbieri@pd.astro.it, cesare.barbieri@unipd.it)
Department of Astronomy, University of Padova, Italy

1. Using funds from the University of Padova, I have allocated two external contracts:

(a) to set up a programme to service the Web with digitized log-books and digitized images; we had a first coordination meeting in Asiago recently, the work is proceeding in a very satisfactory way. A first query programme has been implemented on the available data base. At the end of this programme, a remote user can access the log-books, make a selection by object name or by coordinates, and have immediately a quick view (jpg format, 2000 × 2000 pixels). If he then wants the complete .fits file, he must explicitly apply via e-mail.

(b) to digitize the remaining log-books of the Asiago telescopes (those of the two Schmidts have been already done). This work is also proceeding well. Both projects should be completed by the end of September. A further contract will start in October to digitize the log-book of the Vatican Schmidt.

2. The digitization activity is being carried out both in Padova and in Asiago with the two Epson scanners (Expression 1640XL, size A3) we have available, and taking advantage of the acquisition software developed by S. Mottola at DLR Berlin. We have concentrated most of the activity on two Schmidt 67/92-cm fields, M 31 and M 33, and those are almost finished. Each file (resolution 1600 × 1600 dpi, 14 bit, positive image, FITS format) occupies 280 MB. Data are stored on (5 GB) DVDs; 11 DVDs have been already filled. 5 more DVDs have been filled with scanned plates from the Vatican Observatory. Several experiments, mostly using the stars of Selected Area 57, have been made to calibrate properly the image acquisition, and we feel we now have a good procedure for preserving photometric and astrometric integrity.

3. Experiments have been started to digitize spectra at the maximum optical resolution of the scanner, namely 3200 dpi. Using the comparison spectrum of a 4.2 Å/mm plate of Deneb on IIa-O emulsion, we were able to calibrate the effective spatial resolution of the scanner. We found a pixel size of 7.98 μ, and an effective resolution of 3 pixels, namely around 25 μ. That resolution should be adequate to cover most of the material taken with the 1.2-m and 1.8-m telescopes; however it could be insufficient for Schmidt objective-prism spectra (as some studies carried out by Corinne Rossi seem to indicate). Mr. Umbriaco has started a market survey to find higher-resolution scanners.

4. I have been invited to give a talk at the important meeting of Accademia dei Lincei in March 2003 (Rome), devoted to "100 years of Astronomy in Italy", where I will present our experiments and results not only on the recent plates but also on those of the Carte du Ciel available in Catania and Vatican.

It is truly important that any activity of preservation and restoration of old plates be done in a coordinated and strictly controlled way. I hear of very dangerous ideas freely thrown out in ministerial meetings of historians of science. It is very good to seek, and receive, advice from the international community.

Digital Access to Belgian Aero- and Astrophotographic Archives

Jean-Pierre De Cuyper (Jean-Pierre.DeCuyper@oma.be)
Royal Observatory of Belgium, Brussels, Belgium

This test-bed project, initiated and financed by the Belgian Federal Services for Scientific, Technical and Cultural Affairs (SSTC Project I2/AE/103), involves three Belgian institutes: The Royal Observatory, the National Geographic Institute, and the Royal Museum of Central Africa. The project aims to acquire, within the coming four years, the necessary know-how, hardware and software in order to preserve the historic scientific information contained in aero- and astro-photographic archives, both glass plates and film.

A digital catalogue is being generated in the form of an ODBC data base that is to be distributed on intranet and internet. Html files, ActiveX objects, C++ and Javascripting programming are used to create a user-friendly interface that allows easy searching and gives a straightforward overview of the available meta-data. In order to save the hand-written notes from previous measurements that are present on the glass side of part of the astrophotographs, systematic pre-scanning is being carried out at low resolution using commercial preprint flat-bed scanners in transmission mode, creating quick-look images for distribution on the Web. Those images are only for visual use, but will be used to redetermine the plate centres.

In order to make the photographic information scientifically exploitable again a high-resolution digitization technique will be used, taking into account the geometric errors of the photographic plate, i.e. the deviations from a perfect mapping of the sky or ground area onto the perfect image plane, have a clear hierarchy: global (whole plate), large scale (extending over cm range), local (mm to sub-mm) and emulsion structure (granularity noise). The origin of those errors can be mapping defects of the optics and larger-scale systematics due to centering errors of the lens system. It also can be effects from the mechanical and darkroom processes. Another source is inhomogeneous developing, rinsing and drying of the plates. All this can and will produce systematic and random errors of any correlation length (i.e. the emulsion shifts are correlated over mm or cm range). To determine these effects, reference stars or points are used. Some effects can also be calibrated by clever measuring setups at the telescope or camera (tilt of the image plane, position of the optical axes on the plate). Unfortunately these setup data are often not available. Those errors are in the 1–2 μ range, and the question is how regular they are, for calibration to $< 0.5\ \mu$. Therefore it is important how precisely the images of the reference stars or points can be measured (locally) on the emulsion. Depending on the granularity of the emulsion, that is possible down to a few tenths of a micrometer.

So we are facing a bandwidth of error contributions from the micrometer to the sub-micrometer range on the plate. These can only be calibrated successfully if they are measured precisely on the plate to a factor 10 better than their size, as one cannot measure 2μ errors with a measuring accuracy of the same order because the unknowns in the calibration model will be statistically meaningless. Thus, regardless what type of plates one is measuring, this is the essential condition. Hence, in order to get the full information content from the plate, the measuring machine must have an absolute positioning accuracy of at least $0.5\ \mu$ over the whole measuring area. This implies that a 0.1μ-class positioning table is needed.

The aim of this project is to construct a scanner using an XY airbearing table with an open frame structure and laser interferometer steering, in a temperature (± 0.1 K) and humidity

(±1% RH) stabilised clean room, giving sub-micrometer absolute positioning accuracy of the photographic plate with respect to the fixed telecentric objective and digital camera unit.

The technique of first making an analogue copy on roll film, allowing unattended, uninterrupted scanning, will be studied in detail, as will the photochemical treatment of fungi and deteriorations, in order to determine the future applicability of those scans in view of the introduced geometric and radiometric deformations.

Digitization of Archive Plates at Cambridge

R. W. Argyle (rwa@ast.cam.ac.uk)
Astronomy Survey Unit, Institute of Astronomy, Cambridge, UK

During the three year period beginning May 1, 1999 a large number of Carte du Ciel astrographic plates have been scanned on the APM at the Institute of Astronomy, Cambridge (UK).

The digitization of the plates is in response to several requests from European colleagues who are doing work which requires accurate proper motions. The typical error of a derived star position is about $0''.2$–$0''.3$ and the average baseline is about 90 years. Fresneau et al. (2001) have also shown that the triple images on the CdC plates allow significant opportunities for the detection of flare stars.

The respective projects are as follows:

Plates	Zones (CdC)	No.	Project
Bordeaux CdC	+11 to +18	528	Bordeaux M2000 catalogue Ducourant et al. (in preparation)
Sydney CdC	–52 to –64	358	Dynamics of Stars near the Southern Coalsack. Fresneau et al. (AJ 2002, submitted)
Brussels astrograph		40	Fresneau et al. (AJ 2001, **121**, 517)
Bordeaux astrograph		18	Flare stars in the Pleiades
Total		944	

It is expected that another 200 plates from Sydney will be measured on the APM during the latter half of 2002. Enquiries will also be made about the location of, and possibility for measuring on APM, the Algiers CdC plates (+4 to –2).

Digitizing Photographic Plates and Data Archiving at the David Dunlap Observatory

C.T. (Tom) Bolton (bolton@astro.utoronto.ca)
David Dunlap Observatory, Richmond Hill, Ontario, Canada

Digitizing Photographic Plates

The David Dunlap Observatory acquired a PDS 1010A microdensitometer in 1976. The original version was controlled by a PDP-8/e computer. The operation of this instrument as a regional facility was supported until 1991 by an Infrastructure Grant from the National Sciences and Engineering Research Council of Canada. During that period the PDS was used on average more than 12 hours per day, by astronomers throughout Canada plus a few from international institutions. It was also used by the local medical research community. In 1988–89 we upgraded the machine by writing a new control programme in C++, replacing the A/D converter with a faster model, building a new electronic interface, and replacing the PDP-8/e computer with an 80286 PC and a multi-density 9-track tape drive.

The PDS continued to be used regularly by internal users for several years after we lost our Infrastructure Grant, but its use gradually declined owing to the installation of a CCD detector on the spectrographs on our 1.88-m telescope, and the illness of the two main users of the instrument. As a result, it sat idle from about 1995 onwards.

Last year I began work to reactivate the machine. The computer was replaced with a one-year-old Dell PC with a 600 MHz Pentium III processor. I initially considered using a Linux operating system, but after a few months it became clear that this was not possible without rebuilding the electronic interface. Since we lacked the resources to do that, I chose to use Windows 98 and to run the scan control software in a DOS window. My assistant, Dr. Mel Blake, and I encountered only minor problems converting the scan control software to run in a 32-bit environment. Unfortunately, some of the problems proved to be huge time consumers because of poor documentation of the programme and our inexperience as C++ programmers.

During the testing of the microdensitometer we encountered several problems. First we discovered that one of the linear encoder lamps was burned out, and we did not have a replacement. Since we had no information on who made the encoders, I attempted to track down the descendant of Photometric Data Systems. I was able to trace PDS from its origins through multiple acquisitions and relocations to the present rights holders, The Newport Corporation in Irvine, California, by using the World Wide Web. Unfortunately, when we contacted them, they no longer had anyone working for them that remembered the instrument.

Through the *PDPP* network I was put in touch with Mick Bridgeland at Cambridge University. He knew that the encoders were made by Heidenhain and he even provided me with parts numbers and the telephone number of the local Heidenhain office (Thanks, Mick). A technician at the local Heidenhain office had one good encoder lamp stuck away in a bin (lucky us) but he was remarkably unforthcoming about technical requirement for replacing the lamps if another one burned out. Since the lamps are glued into a ceramic block, replacing a bad one is not completely trivial. We have enough of the ceramic blocks and electrical leads to replace the lamps. The lamps appear to be more or less standard 6 volt, 4 watt lamps. However, we are uncertain whether there are any special requirements on the filaments and their alignment and how rigorous those requirements may be, and Heidenhain has not yet offered an answer.

We also encountered two other problems. First, one of the servo control boards that locks one axis in place while a scan is run on the other axis, plus our only replacement, were unstable. Secondly, there is some interaction between the speeds on the X and Y axis, such that when a scan pattern X (fast)—Y(slow)—X(fast) is ordered, the result is X(fast)—Y(slow)—X(slow). We're still tracing the source of this problem.

I am still hoping we will be fully operational by the end of 2002. We will be using the PDS to scan plates for my research programme and Bob Garrison's spectral classification plates. The latter will be part of the data used to study nearby stars. This is a NASA funded programme in which Bob is collaboration with Richard Gray, Chris Corbally, and others. We have no plans to scan the entire DDO photographic archive (but see below), but we will scan as many of the binary and variable star spectra as funding and time allow.

Archive of Digitized Photographic Plates

We have an archive of several hundred 9-track tapes of PDS scans, reduced spectra and images that accumulated between 1976–1995. The archive contains scan data of more than 50% of the spectrograms obtained with the Cassegrain grating spectrograph on our 1.88-m telescope. The tapes are all written in the original PDS tape format. None has been transferred to another medium. Fortunately, we have a working multi-density 9-track tape drive attached to a PC. Mel Blake has written a tape-reading routine that is able to skip over bad data and pick up later files. He has also written a routine to convert the PDS formatted files to FITS files. This summer we started to read the archive tapes, convert their format, and rewrite the data on hard disk and CD-ROMs. This process has been remarkably successful considering the age of the tapes. On average, we've been able to read more than 90% of the files on a tape.

More than 20 years ago we began creating an electronic log of our photographic spectra. The log is 100% complete for the Cassegrain grating spectrograph (1969–1990), and about 30% complete for the prism spectrograph (1935–1969). Neither of these logs is available on line, but they are accessible by knowledgeable internal users. We hope that we will eventually have the resources to complete these logs and make them accessible on line. Ultimately, we would like to add to this log the measured radial velocities, which are currently entered in a card catalogue, and notes about which spectra have been digitized.

Archive of CCD Spectra

The Observatory has maintained an electronic log-book of CCD spectra and a data archive of the raw spectra since we obtained a CCD detector in 1990. The electronic log-books are created from the FITS headers and are available publicly at `ddo.astro.utoronto.ca/ddohome/`. Click on 'Operations' to see the sites for the log-book databases. Unfortunately, these databases are not yet searchable. Internal users have access to searchable versions; they also have access to the data archive which is stored on hard disks in two different geographic locations. External queries about DDO data should be directed through me or the Observatory's Associate Director, Slavek Rucinski (rucinski@astro.utoronto.ca). Access to the data may be conditional on the permission of the original investigator.

The Spectroscopic Virtual Observatory

Frank Younger (yg100@victoria.tc.ca)
Chairman, World Spectra Heritage, 585 Aurora Way, Victoria, BC, Canada

The Spectroscopic Virtual Observatory, a laboratory for digitizing astronomical spectrograms, is being hosted by the Dominion Astrophysical Observatory in Victoria, BC. The project has been planned by the IAU Working Group for Spectroscopic Data Archives, which was founded in 1992 with two objectives: (1) to encourage and stimulate the creation of meaningful archives of spectroscopic observations, and (2) to work out a solution for the large numbers of spectrograms in the world before events overtook their possible rescue.

The World Plate Store, first announced in 1997, was intended to create a lasting home for world archives of astronomical spectrograms, and to scan selected ones. However, it proved difficult to find an appropriate location for this considerable amount of storage. Accordingly, the emphasis of the project was modified to concentrate on the digitizing activity, borrowing relevant sections of plate archives and returning them after scanning those spectrograms of interest. Our request for accommodation to create the scanning laboratory at the DAO was accepted, with the proviso that we raise all the operating funds ourselves. The DAO is also offering the use of its own PDS scanner when not otherwise required.

The task of fund-raising is even less straightforward than it might be because the SVO manager-elect, Elizabeth Griffin, is not a native of North America. We therefore set up a not-for-profit charitable foundation, called the World Spectra Heritage, in order to manage the fund-raising sufficient to employ SVO staff (about 5 are envisioned) to operate the laboratory. Funds are also required to equip SVO with suitable scanners, computers and general office equipment, for transportation of plates and for project promotion.

The pilot project for SVO has recently been funded (see page 24), and we are now concentrating on Phase II: scanning equipment. In response to an appeal in the AAS Newsletter, we have been offered three scanners – two PDS instruments (one from Lund Observatory, Sweden, and one from NOAO), and the modified Joyce-Loebl scanner from Cambridge Observatories in the UK. (Incidentally, the fact that several respondents to our appeal regretted that they were unable to help as the instrument in question had recently been thrown away serves to highlight the urgency of this matter.) Two instruments are gifts; one is a loan. We are now in the process of designing state-of-the-art upgrades to all three machines, with appropriate software. The scanning will partly be carried out in restricted "spectroscopic" mode, and partly in "image" mode; in the latter mode, which is particularly suitable for large numbers of small-format spectra, the required regions will be extracted in software.

Plate calibration is of course a matter of highest relevance. As far as possible we will use calibration exposures, but where those are not of adequate quality, or were not included (as on some exposures made for radial-velocity measurements) we will have to determine a calibration curve for the emulsion batch in question via stellar exposures. Boot-strapping must only be regarded as a second best, but it should certainly be better than nothing.

Efforts to interest potential private donors, foundations and industry in our laboratory are continuing. A Press Conference held at the DAO recently was followed by a public lecture, radio and TV interviews.

Royal Observatory Edinburgh – Plate Library Holdings and Digitization Programmes

Clive Davenhall (acd@roe.ac.uk) & Sue Tritton (sbt@roe.ac.uk)
Royal Observatory Edinburgh, Blackford Hill, Edinburgh, UK

The Wide-Field Astronomy Unit (WFAU), of the Institute for Astronomy of the University of Edinburgh and located at the Royal Observatory Edinburgh, operates the Plate Library and SuperCOSMOS – a fast, automatic microdensitometer.

The Plate Library is the permanent archive for ∼18,000 exposures taken with the UK Schmidt Telescope (UKST) located at the AAO in Australia. Nearly 7,000 exposures were taken for the various major southern sky surveys (see the description on page 26), of which 3,391 were accepted as master survey plates. The other 11,000 exposures were taken for individual research programmes. All these exposures are publicly available, on request, for personal examination or for digitization. The UKST plate catalogue can be searched on-line (see `www.roe.ac.uk/ukstu/`) and a form is available to request that a plate be digitized. The Plate Library also holds copies, variously on glass, film or paper, of all the major sky atlases made from the sky surveys taken with the Palomar, ESO and UK Schmidt Telescopes. Visitors are welcome.

The exposures were taken on glass plates (or film), 356×356 mm square and covering an area of sky $6\overset{\circ}{.}5 \times 6\overset{\circ}{.}5$. All the surveys were constructed using the same standard field centres, set 5° apart; 894 exposures are required to cover the whole southern sky. The original 3,391 exposures accepted for the southern sky surveys have all been digitized by SuperCOSMOS (see below). However, several of the rejected survey plates are also of high quality and can provide additional information for most areas of sky. In addition, many of the non-survey plates have been exposed on standard survey field centres (or on special non-standard centres). These plates can be particularly useful in providing additional colour information, or for studying time-varying phenomena including finding pre-discovery images of asteroids and proper motion studies.

The Photolabs at ROE have produced sky atlases (on glass or film) from some of the surveys, and copies are still available. In addition, film copies from specially selected original plates have been made into different teaching packages. Details are available on the Web.

SuperCOSMOS is a fast microdensitometer designed specifically to scan automatically and digitize plates taken by the large Schmidt telescopes. It is systematically digitizing the surveys made with the UK, ESO and Palomar Schmidt Telescopes. The SuperCOSMOS Sky Survey (SSS) of the southern hemisphere is now complete. It contains data on 894 fields from Dec = –90° to $+2\overset{\circ}{.}5$ and includes three colours: B_J, R and I (constructed from the three main UKST surveys) and a second epoch in red (from the POSS-I E and ESO-R surveys). In addition, 'short-red' exposures of fields in the Milky Way (approximately $|b| < 10°$) and Magellanic Clouds (contemporaneous with the infra-red exposures) and an Hα Survey of the same area have been digitized and are available on-line.

The SSS includes both simple pixel images of the digitized plates and catalogues of objects detected in these images. The survey is public and can be accessed on-line via the Web.

Several digitizations of the large Schmidt surveys have been carried out elsewhere. However, the reasons which make the SSS particularly useful include:

- The pixel size is 10 micron (0.7 arcsec), smaller than that used in some other digitization programmes.
- The object catalogues extend roughly to the plate limit.
- The pixel images and object catalogues are well-integrated and can, if required, be retrieved as a single FITS file for analysis in tools like GAIA (see page 23).
- Colours, proper motion and variability information are included for the first time in public digitized surveys.

Scanning of glass copies of selected POSS-II B_J and R plates has now commenced and it is hoped to complete the northern sky by 2004. The possibility of scanning the POSS-II I and/or POSS-I E plates to provide additional colour and proper motion information in the north depends on funding and demand.

For further information on the surveys and for more general information on the WFAU see `www.roe.ac.uk/wfau/`.

The Harvard Plate Collection

Alison Doane (adoane@cfa.harvard.edu)
Curator of Astronomical Photographs, Harvard College Observatory, MA, USA

In Spring 2001 the Harvard-Smithsonian Center for Astrophysics organized a team to investigate the possibility of digitizing Harvard's behemoth plate collection. Professor Josh Grindlay, Dr. Leonid Berdnikov, Doug Mink and Alison Doane formed a team to study commercially-produced flat-bed scanners, investigate sources of grant money, and grapple with the feasibility of various photometric methods. We scanned several plates from one of our deepest plate series, taken on the 16-inch Metcalf doublet. The first scans were done on a $50,000 Creoscitex scanner, and later scans were done on a $5,000 UMAX PowerLook 3000 scanner. Doug Mink studied the scans and, with a few changes to his world coordinate system software tools, was able to apply accurate coordinates and link them to several existing on-line star catalogues. From a comparison of the two scanners, we decided on the UMAX scanner because of its affordability, speed and comparable photometric accuracy. With 400,000 plates to scan, time was a critical element in our decision-making. As the UMAX scanner performs a single pass, we are able to do a single grey scale scan in approximately 10 minutes.

We received a small grant for a Summer 2002 pilot project, and purchased a Mac and the UMAX scanner. We then brought in Dr. Leonid Berdnikov from Sternberg Institute, Moscow, to begin work on photometry. Dr. Berdnikov experimented using IRAF, SExtractor, several different WCS tools and also programmed his own photometry routine. He scanned and obtained photometric results from 65 plates of M 44.

We plan to have Dr. Berdnikov combine elements of SExtractor with portions of his own photometry program, which allows for more accurate results in crowded fields. Since eventual use of the digitized Plate Stacks data should not be confined only to high latitude fields, or exclude the crowded regions of the galactic plane and the LMC/SMC, it is important to develop techniques for photometry of digitized plate images of crowded fields.

We also must search for funding within both the library and scientific communities. This may be our largest challenge. We hope to apply for a grant within the Harvard University library system for the year 2003, but we will need many more such grants to allow for the labour, multiple scanners, and storage of data involved in scanning 400,000 glass negatives. Ultimately, we hope to have enough interesting science gleaned from our early projects to get the scientific community interested in funding our digitizing. We believe that making our vast quantity of photographic data available to modern techniques of study will rejuvenate this venerable collection and will present new options for scientific inquiry.

Plate Digitization at the Maria Mitchell Observatory

Vladimir Strelnitski (vladimir@altair.mmo.org)
Maria Mitchell Observatory, Nantucket, MA, USA

In March 2001 the Maria Mitchell Observatory (MMO) started a complete digitization of its archive of about 8,000 photographic plates obtained with the MMO 7.5-inch Cooke/Clark refractor between about 1915–1990. A commercially available scanner, AgfaScan T5000, is used for this project. Three image files (about 700 MB in total) are burned on a CD for every (8 × 10 inch) plate – the overview scan of the whole plate with a resolution of 840 ppi, and two high-resolution (2,500 ppi) scans of the western and eastern halves of the plate (with some overlap). The higher resolution corresponds to about 10 microns on the plate. As of September, 2002, 90% of the plates have been scanned.

The MMO plates have a field of view of about 10°, and are especially numerous for Sgr, Sct, and Cyg. The catalogue of the plates is available on our Web site, `www.mmo.org`. The image files in TIFF format are available on CDs upon request.

In order to check whether digitization with this scanner entails any serious loss of information, we carried out photometric measurements of several scanned plates containing the open cluster M25. This study, performed by the MMO/REU student Kristina Barkume, showed that the simplest visual photometry of standard stars from this cluster is equally precise for estimates on the plates directly and on their digitized images (BAAS **33**, n.4, p. 1322, 2001, abstract 10.13). Previously, it was demonstrated in another MMO/REU project (BAAS **30**, n4, p. 1266, 2000, abstract 11.11) that visual photometry of stars on photographic plates is not less precise than other methods, such as microphotometry or numerical reduction of digitized images. We conclude that digitization with the AgfaScan T5000 provides a copy of the original plate without appreciable loss of photometric information.

PPARC and the ex-RGO Plate Archive

Colin Vincent (colin.vincent@pparc.ac.uk)
Head of Astronomy Ground-Based Facilities Group, PPARC, Swindon, UK

On the closure of the Royal Greenwich Observatory (RGO), Cambridge, a new home was needed for the historical archive of photographic plates and associated material which had been held there. The glass plates derive from a wide range of telescopes, both within the UK – such as those at Herstmonceux (the previous home of the RGO) – and overseas, and range in date from the early years of the twentieth century to the early 1970s. In all there are around 165,000 plates, plus glass spectra, observers' notebooks and a number of separately-boxed collections of large-format plates from eclipse expeditions.

The plates were contained in acid-resistant envelopes and cartons within the RGO and were packed within large wooden crates for transport to their new, temporary home, at a commercial storage facility in London. The size of the collection and its peculiar storage needs meant that other possible hosts were less than enthusistic about taking on the rôle of curation. The store in London specialises in retention of collections of art and antiquities – largely deriving from the over-spill from private collections. The plates remain packed in their crates (over 100 of them) and stored in a temperature and humidity controlled room. Access is limited, and withdrawal of plates can only be made with the assistance of storage facility staff.

A full inventory of the glass plates was undertaken shortly after they were deposited, such that we are able to locate plates using their unique numbers. However, we do not have the ability to locate plates on the basis of a query consisting purely of a source; for instance, we cannot locate all images of Betelguese or M82, etc.

We do offer access to the archive by written request to PPARC, but cannot guarantee to meet requests. In order to ensure that the plates are handled properly and not damaged, we offer this through the laboratories at the Cambridge Astronomical Survey Unit or the Wide Field Astronomy Unit at Edinburgh, both of which have facilities for scanning or copying plates. Other locations are only considered if they can demonstrate that they have the ability to handle the plates appropriately. There is no charge for this service when a small number of plates is required, but we reserve the right to charge for more complex requirements.

We are interested in finding a longer-term, more scientifically appropriate, home for the collection, but this must be able to provide similar storage conditions to those currently available. We do not have the resources to pay for the creation of a new facility or, more importantly perhaps, to staff it. Similarly, we would consider alternative arrangements for a sub-set of the collection (e.g. the spectra, the solar observations, the Carte du Ciel plates) if assurance can be given that they are to be cared for.

Wanted ...

A suitable home or homes for 100+ crates of historic astronomical observations, containing about 165,000 glass plates, spectrograms, solar-eclipse observations, and observers' notebooks. The consignment can be split into sections relating to different disciplines. Those interested are invited to contact colin.vincent@pparc.ac.uk

Plate Archiving and Scanning in Italy: a National Perspective

Regina Coluzzi (regina.coluzzi@coma.mporzio.astro.it) and Elizabeth Griffin
Monte Porzio Observatory, Rome, Italy, and Oxford, UK

14 representatives from 10 Italian observatories and astronomical institutes met in Rome in January 2001 to discuss the situation regarding Italy's heritage of photographic observations, and to see whether agreement could be reached concerning the preservation of those data and transfers of their information onto digital media.

Delegates reviewed briefly the essential pre-requisites (Contents Catalogues), digitizing equipment and media for data storage and dissemination, and mentioned present-day situations (technical and financial) that were perceived as global obstacles tending to discourage astronomers from achieving the desired preservation and digitization of those observations. Dr. Griffin outlined the current situation worldwide, mentioning the achievement of IAU Resolution B3 in August 2000 in which the IAU formally commends efforts to preserve and digitize photographic observations (see page 32), but emphasizing the urgency of these projects inasmuch as both the necessary equipment and the essential expertise are ageing and are not being replaced.

The quantity and quality of plates stored at Italian observatories or institutes were reviewed (see below), with mention of associated programmes of research and projected future uses of those data, and of extant digitizing equipment. Delegates hoped to to design a solution that could be commended to colleagues and institutes throughout Italy. Sources of possible funding should take account of the historic, cultural and educational aspects of such a project as well as those specific to astronomy. Delegates also saw a demonstration of a high-speed scanner developed by the High-Energy Physics Group for identifying and measuring trajectories of particles within multi-layered photographic emulsions, and discussed possible astronomical applications.

Plate Stores in Italy – a Summary

Extracted from a full inventory compiled by Regina Coluzzi

Observatory	Direct	Objective Prism	Spectra	Others/Notes
Asiago (Padova)	43,226	2621	23,608	
Catania	2230			5000
Loiano (Bologna)	15,000			some film
Collurania (Teramo)	2000			
Torino	9000			
Trieste	300			some film
Arcetri (Firenzi)				13,000 Solar Patrol
Vatican	8500	1500		
Brera-Merate (Milano)	362		2786	
Campo Imperatore (Roma)	1000	1000		1,000,000 Solar Patrol (film)

Preservation and Digitization of Photographic Plates at Sonneberg Observatory

Peter Kroll (pk@stw.tu-ilmenau.de) and Tam Bräuer (tam@stw.tu-ilmenau.de)
Sonneberg Observatory, Sonneberg, Germany

Preservation

The Sonneberg collection of some 275,000 glass plates and sheet film is largely in a good condition. The material is stored in boxes at a temperature of 15–25° C and a relative humidity of 40–60%. Several thousand plates are affected by brown discoloration and the so-called "silver mirror" caused by insufficient fixing and rinsing; in most cases the latter could be successfully removed. During the last four years about 120,000 plates have been checked manually for correct labelling, cleaned (e.g. removal of finger prints of careless users) and repacked in new boxes, each containing up to 20 plates separated by sheets of chemically neutral paper.

Lohrmann Observatory (Dresden, Germany) has proposed that some 1,500 of its plates and sheet films (mostly multiple exposures of asteroids) be transferred to the Sonneberg collection.

Scanning Activities

The plate scanner DIA was in use until mid-2001, when the electronics of the 10-year-old CCD camera failed. So far about 6000 plates have been scanned. The fast scanner HISS is still under reconstruction to improve the data depth (from 8 to 12 bit) and the automatic data-processing pipeline, but is expected to be working again by the end of 2002. The data storage facilities have been expanded by a CD-ROM-writer robot, which can handle up to 50 CDs.

Image Processing

Since the beginning of 2001, in collaboration with the Technische Universität, Ilmenau, we have operated an investigation of the image restoration of scanned plates. Peter Hiltner (Sonneberg) and Rico Nestler (Ilmenau) are trying to adapt the pixon method to very noisy and heavily distorted images near the edges of plates. The results are very promising. The pixon method almost completely removes the astigmatism and grain noise in the images, and results in an improvement in astrometry of about a factor of four, and in photometry of a factor of two to three. Also, fainter stars re-appear close to bright stars and nebulae. The results of this work will be presented at the ADASS conference in October in Baltimore.

Scientific Output

During the last two years, the archive was used by about 20 investigators mostly for deriving light-curves of regularly varying stars such as eclipsing binaries and pulsating stars, and O-C curves. Of particular interest was the long-term behaviour of the solar-like star EK Dra, for which a slow decline of about $0^{m}.08$ over 35 years could be detected (Froehlich H.-E. et al., A&A **391**, 659, 2002). Another surprising result is from Richter and Kroll (presented at the DLR workshop "Planetenbildung: Das Sonnensystem und extrasolare Planeten" in February 2002). They studied HD 209458 (= V376 Peg), the first star in which a transit of an extrasolar planet was detected. The transit light-curve could not be measured on account of the minuteness of the amplitude ($0^{m}.017$), but they detected a variability of $0^{m}.3$ over decades in the G0 V star.

Search for Long-Period Variable Stars on the Carte du Ciel Plates

Fabrice Lamareille, Jonathan Thievin, Emmanuel Davoust (davoust@ast.obs-mip.fr)
Observatoire Midi-Pyrénées, Toulouse, France

This is a progress report on a project to do science with our collection of photographic plates. We have about 10,000 plates covering the Toulouse zone (+4° to +11°) of the Carte du Ciel, taken in the period 1891–1961 (`webast.ast.obs-mip.fr/patrimoine/cdc_e.html`). Over a hundred fields of this zone have been photographed more than 10 times in the course of time. This should allow us to find variable stars with very long periods, of the order of 50 to 100 years, if such stars exist.

The scanner is an AGFA SNAPSCAN 1236S, whose performances at 600 dpi have been carefully investigated by using photographic plates with sensitometric spots. The performance is satisfactory, provided that the plate is placed in the middle of the scanning area.

The first steps are to determine the scale and the conversion law from equatorial coordinates to pixel coordinates of each plate, and to measure the total density of the stars and of the nearby sky background. That is done with MIDAS procedures.

The main difficulty is to obtain an accurate intensity calibration of the plates, which of course do not have sensitometric spots. We selected from the SIMBAD database all stars which were included in one of four catalogues (HD, GSC, Hipparchos, SAO), excluding all those listed as a variable of one kind or another, and extracted about 150–200 stars per field which we used to determine the calibration curve of each plate. The calibration law is obtained by fitting a polynomial of order 2 in the log of opacitance to the nominal magnitude of the calibration stars. A quadratic (rather than linear) law takes into account the saturation effect on bright stars.

A detailed study of the dispersion in magnitude about the calibration curve shows an important effect with distance. The magnitude difference (nominal – measured) varies linearly with distance, with a negative slope. For fainter stars, the variation is quadratic (the difference becomes positive again toward the edge, as a result of coma). There is also a colour effect, with a negative magnitude-dependent slope in (B–V). We were therefore not able to use plates from neighbouring fields to get more data on a given star by this reduction method. (Recall that neighbouring fields overlap by one quarter of a field).

If one looks for variable stars in a given field without attempting to determine magnitudes in the (UBV) system, the accuracy of the present method is reasonably good. The field ($17^{h}56$, $+5°$), for which 29 long-exposure plates are available, was calibrated with 187 stars (although not all 187 stars were measurable on a given plate); the measured photographic magnitudes have a mean standard deviation of $0^{m}.15$. Only 7 stars have a standard deviation larger than $\pm 0^{m}.30$; they are probably variable.

We are now considering ways of improving the accuracy of the calibration curve, e.g. by adjusting a gaussian to the images of the stars, or by treating separately the different images of a given star on the plate – rather than taking the sum of the densities of all exposures on the plate, in the case of multiple exposures.

The UDAPAC Project: Uccle Direct Astronomical Plate Archive Centre

http://udapac.oma.be

Jean-Pierre De Cuyper (Jean-Pierre.DeCuyper@oma.be) & René Hudec (rhudec@asu.cas.cz)
Royal Observatory Brussels, Belgium, and Ondrejov Observatory, Czec Republic

16 astronomers from 9 different European countries met in March 2000 at the Royal Observatory of Belgium, Brussels (ROB) and agreed to attempt to create, within a time-frame of 5 years, a digital archive, in scientifically meaningful form, based on observations selected from some half a million direct photographic plates currently stored in Europe – about 25% of astronomy's total heritage of direct photographic observations. The main goal of UDAPAC is to create a unique resource for scientific research that exploits the long time-base of these archives, by gathering the collections into a suitable environment and re-processing a wide selection of particularly time-sensitive observations. The ROB has offered the use of a large semi-basement storage area for this project.

To create such a database requires a well-organized effort and substantial, but not exorbitantly high, resources. The gradual but steady loss of ageing expertise in the particular techniques implies a degree of urgency.

The locations, counts and contents of most of the relevant photographic archives are already documented in the Catalogue of Wide-Field Plate Archives (see page 20). That facility is an essential first step in locating the plates needed for a given task, e.g. for multiscale analyses of specific targets. A few observatories (particularly ESO) did not routinely request observers to return their plates, and consequently many ESO plates, at least, remain widely dispersed though no longer actively in use.

The key stepping-stones towards realizing the aims of UDAPAC include:

(a) Creating an appropriate environment for the plates,
(b) providing new plate envelopes where required,
(c) completing the WFPA list for Europe, with checks on whether collections are still active,
(d) issuing a worldwide request for plates in personal collections to be returned,
(e) testing the performance of commercial scanners as compared to purpose-built ones,
(f) identifying a small sub-set of research projects that can be executed relatively quickly from new scans of old plates, in order to demonstrate convincingly the soundness of the project and thence attract funding to establish it firmly,
(g) selecting archive software,
(h) fund-raising.

A Core Team was established to coordinate the strategies and follow up the agreed action commitments and schedule. More information about UDAPAC can be found at `udapac.oma.be`.

StarScan Measuring Machine of the U.S. Naval Observatory

Sean Urban (seu@pyxis.usno.navy.mil)
U.S. Naval Observatory, Washington, DC, USA

The StarScan measuring machine, located at the Washington, DC site of USNO, is designed for high-precision astrometry. Over the last few years it has been upgraded with a Pulnix TM1300 CCD camera and a Schneider Xenoplan telecentric lens. The machine itself is constructed from 5 tons of granite. Plates up to 24 × 24 cm are measured in a series of overlapping footprints mapped onto the CCD; locations of the stages holding the plate are read by Heidenhain encoders. Plates near the 24 × 24 cm limit take about 1 hour to measure in two orientations. Machine calibrations to date yield errors of 0.2–0.3 μ, which includes errors from the camera mapping, straightness of the stages, and the air bearings.

StarScan is currently being used to measure the AGK2 plates photographed in Germany between 1928–1930. The 2000 AGK2 plates cover the entire Northern Hemisphere down to –5° in a two-fold, corner-in-centre overlap pattern. Each plate has two exposures of different duration; the magnitude range is about $5^{\rm m}$–$12^{\rm m}.5$. Currently about 70% of the AGK2 plates have been measured; it is expected that the entire set will be measured by early 2003. The final positional accuracy of the resulting reductions is expected to be about 70 mas. Our plans are to combine these positions with those from the USNO CCD Astrograph (currently observing from USNO Flagstaff) to obtain proper motions of about 1 mas/year.

Plate Scanning at the U.S. Naval Observatory

Dave Monet (dgm@nofs.navy.mil)
U.S. Naval Observatory, Flagstaff, Arizona, USA

The US Naval Observatory is pleased to announce the public release of the USNO-B1.0 catalogue in September 2002. This catalogue contains positions, proper motions, magnitudes, and star/galaxy separators for 1,045,913,669 objects, based on 3,648,832,040 individual measures. It is nominally 2-epoch and 3-colour in the North (emulsions O,E,J,F,N) and 1– or 2–epoch 3-colour (J,F,F,N) in the South. It will be served first at `www.nofs.navy.mil` and then at various national data centres. Given its 80 GByte size and the expectation for updates (or fixes) on an annual basis, the mechanism for the distribution of individual copies is not yet understood. Note that `www.nofs.navy.mil` already serves all the pixels upon which this catalogue is based (and a lot more), but pixel access is slow owing to storage on DLT. A DVD version of the 13 TByte pixel database is scheduled for 2003. A paper giving an overview of the USNO-B catalogue is being prepared for submission to the Astronomical Journal shortly, and will be posted on astro-ph after acceptance.

PMM now stands idle.

Plate Scanning at Valencia University Observatory

Alvaro Lopez (Alvaro.Lopez@uv.es)
Valencia University Observatory, Spain

1. Digitizing a big plate can be performed as a mosaic of small partially-overlapped plate fields imaged with a small CCD camera, storing each field as a normal or compressed image and saving X,Y central position of each field. In this way a plate of about 20×20 cm can be read as 10×10 small fields each 2×2 cm in a few minutes, and can be reconstructed easily.

2. Alternatively, a method similar to the previous one is to "read" each field and store it as a matrix of signals. Each line of the field image can be compressed and stored in several ways. The final volume of the plate files is smaller than in case 1 but the computer digitizing time is longer.

3. An identification algorithm of stellar and other shape images, similar to a normal automatic measuring process, can be applied. In that way X,Y co-ordinates, radius and other parameters (shape, central intensity, etc.) of each "object" are stored. The plate file is much smaller, but we loose information about the plate content, and plate reading time increases substantially. Objects common to overlapping images provide a robust fitting of the full plate.

Cases 1 to 3 have been investigated at Valencia Observatory with an automated ASCORECORD machine; we have obtained good results.

4. A wide-field CCD camera (astronomical or professional grade) can be used to obtain either a full or a central image of the plate. Our trials have been carried out with a back-illumination system and a CCD AP10 camera from Apogee, Inc. (2048×2048 pixels, each 14 μ) connected to a PC computer. As the CCD sensor is 28×28 mm, a plate 20 cms wide can be imaged with a resolution of 100 μ per pixel. Better resolutions (50 μ, 25 μ) can be obtained over smaller plate fields, yielding several images per plate.

5. Standard scanners provide a poor spatial stability, although they can provide a good representation of plate contents. Asteroid plate scanned images give a fitting mean error of about $4''$, whereas microscope measuring usually gives standard errors of $1''$–$2''$. Scanning with high resolution creates large images that are difficult to manage with our software (VisualBasic). We do not have experience with professional scanners that may be the easiest systems for plate digitizing.

At this moments we are involved with CCD images of asteroids obtained with the AP10 at the telescope focus, but our plate-measuring systems are ready for use. Please let me know your opinions and comments on these or similar measuring processes that we can apply to archived plates.

We offer our experience and collaboration to any group interested in our work.

Wide-Field Plate Database at Sofia Sky Archive Data Center

http://www.skyarchive.org/SSADC, http://www.skyarchive.org/

Milcho Tsvektov (tsvetkov@skyarchive.org)
Institute of Astronomy, Bulgarian Academy of Sciences, Sofia, Bulgaria

The Wide-Field Plate Database (WFPDB) is a project of the IAU Working Group on Sky Surveys, hosted by Commission 9. The project is developed at Sofia Sky Archive Data Center (SSADC), situated in the campus of the Center of Physics of the Bulgarian Academy of Sciences and operating in the frame of the Space Research Institute in collaboration with the Institute of Astronomy. The WFPDB, started in 1991, is developed in three main directions: preparing a catalogue of existing professional wide-field plate archives (CWFPA), managing a database of the general plate index catalogue (WFPDB), and digitizing plates with a precise microdensitometer (PDS 1010) and professional flat-bed scanners.

The current version (4.0) of the CWFPA (www.skyarchive.org/data/description40.pdf) contains descriptive information for wide-field photographic observations stored in 345 archives around the world. The total number of observations, made since the end of the 19^{th} century by the help of more then 200 telescopes, is over 2 million. More than half are in Western and Central Europe, and of those nearly 40% can be found in Russia and the FSU republics. The CWFPA can be accessed on-line at www.skyarchive.org/data/catalog40.pdf. Version 4.1 of the Catalogue is now in progress, and will be published for the IAU GA in 2003.

Currently the WFPDB provides access to the information for about 640,000 plates from 117 plate archives, i.e. about 30% of the estimated total number. The WFPDB team is continuing to enlarge the database as information is submitted or recovered. The WFPDB can be accessed and queried from draco.skyarchive.org/search_ test/. Search and samples are possible by equatorial coordinates and date (UT), as well as by instrument and observational parameters such as instrument type and aperture, plate scale and size, object/field designation, method of observation, emulsion, filter type or exposure time. Retrieval of additional meta-data such as plate quality and availability, notes or observer are also possible.

The larger part of the observations is not yet available in digital form. Plate scanning (the objective of the SSADC) has been under way since early 2000 when the PDS-1010, kindly donated by ESO, became operational. Now we are concentrating on the plate collections from observatories in Germany and in Southern and South-East Europe. Recently the hardware and software have been upgraded. Further equipment donations, including portable flat-bed professional scanners, are expected in near future thanks to to the generosity of the Alexander von Humboldt Foundation and German Research Council (DFG). With those donations the WFPDB will be on its way to realizing its main objective, namely to digitize plates on site upon request. In these endeavours we are benefiting from collaborations with observatory groups in Bamberg, Potsdam, Brussels, Konkoly, Bordeaux, Bucharest, Belgrade, Kiev, Crimea and Odessa, and the astronomical data centres in Strasbourg and Moscow.

In a pilot project, which involved a collaboration with colleagues in Bamberg, we are processing the wide-field plate surveys from the Boyden station (South Africa), Mount John (New Zealand) and San Miguel (Argentina), using about 30,000 plates from the period 1963–1971 now stored at Bamberg Observatory.

MISCELLANIA

Cleaning Dry Photographic Plates

Alison Doane (adoane@cfa.harvard.edu)
Curator of Astronomical Photographs, Harvard College Observatory, MA, USA

Before beginning our digitizing project (see page 11), the Harvard Plate Stacks were visited by the renowned photographic conservator, Paul Messier. Paul gave us a general description of the cleaning of glass negatives which I shall outline here:

1. Begin by cleaning the glass side using dry materials only. Place the plate emulsion face down on a blotter or mat board. Using a soft cotton cloth or cotton wool, dry-clean the glass.

2. If that is not sufficient, move forward to an aqueous cleaning. Start with 91% isopropyl alcohol, and if necessary for stubborn dirt or ink, try 70% isopropyl alcohol, and if that is still insufficient, use ammonium hydroxide 1% in water (like glass cleaner). Put a small amount of one of these liquids onto the cloth or cotton wool and apply to the centre of the plate, glass side only. Clean as necessary, but stay away from the edges of the plate. It is imperative to keep the emulsion dry, as an emulsion is weakest along its perimeter, where it begins to thin, craze or pull away from the glass.

3. Using a soft brush, brush away cotton debris.

4. Flip the plate over and clean the emulsion using soft brushes and gentle, compressed air.

5. Paul Messier felt that it was most important to get into the mind-set of avoiding cleaning where possible. The least interference, the better for long-term preservation.

Our plates are old and dirty and require considerable cleaning. We are using 70% alcohol with cotton wool pads, and I have found it helpful to use coarse paper towels to wipe off the alcohol as soon as possible, thus avoiding dry streaks of dirt across the plate. We have not been able to embrace the notion of avoiding cleaning. Since we are concerned that our photometry programme could be influenced by dirt, we are wet-cleaning the glass side of every plate we scan. I also purchased a 115 volt Gast pump, model number DOA-P172-AA, and use it to blow dust and dirt off of the emulsion. It is far superior to "canned air" because the pressure is adjustable, and can be set on a gentle enough pressure to be kind to old plates. It also has a filter to capture moisture before it is blown onto the emulsion. Canned air, in my opinion, is too forceful, can have moisture in it, and sometimes sprays air that is too cold. I also have resorted to cleaning some ink off the glass side by scraping gently with single-edge razor blades.

On-Line Contents Catalogues are Essential!

It is argued that because so few people request access to historic plates there must therefore be little intrinsic value in those historic data. In fact, very few archives have an on-line contents catalogue, so how can anyone ask to access data that are "hidden"?

CURSA – Manipulating Astronomical Catalogues

Clive Davenhall (acd@roe.ac.uk)
Royal Observatory Edinburgh, Blackford Hill, Edinburgh, UK

CURSA is a package for manipulating astronomical catalogues and similar tabular datasets. It includes features for browsing or examining catalogues, selecting subsets from a catalogue according to various criteria, calculating new quantities from the columns in a catalogue, pairing two catalogues (to find objects with similar coordinates), converting catalogue coordinates between some celestial coordinate systems, plotting finding charts, sorting catalogues, copying catalogues, and photometric calibration. Catalogues can be examined, subsets selected and new columns computed with the easy-to-use catalogue browser `xcatview` which is driven from a graphical user interface. Other functions are provided by executing commands from the Unix shell. Various types of selection are available, including finding objects which satisfy an arbitrary algebraic expression (with the column names as variables), lie inside a range, rectangle, circle or polygon, or simply every nth object. CURSA can access catalogues in several different formats, including the FITS tables and Tab-Separated Table (TST) formats. It can also perform simple remote searches, via the Internet, of various catalogues, including the HST Guide Star Catalog, the USNO PMM and the SuperCOSMOS Sky Survey (SSS). CURSA is available for the Compaq Alpha/Tru64, Sun/Solaris and PC/Linux versions of Unix. It is documented in

SUN/190: *CURSA – Catalogue and Table Manipulation Applications.*

There is a 'home page' giving further information at `www.starlink.rl.ac.uk/cursa/`. CURSA is developed by the Starlink Project in the UK (see `star-www.rl.ac.uk/`). It can be obtained from the Starlink Software Store at `www.starlink.rl.ac.uk/cgi-store/storetop`, together with its documentation.

Plates need Protection!

• *Extensive flooding in the Czec Republic recently affected about 200,000 plates and films. The material is archaeological, but the risk, the damage, the loss and the recovery procedures now needed are astronomical. If the scientific information is on computer disks, it simple to store the digital data in low-risk sites, and back-up copies can be widely distributed.*

• *A small astronomical plate collection was almost thrown away this year because the space it occupied was needed for other purposes. It was the modern astronomers who were content to let the plates go; it was the historians of science who rescued them.*

GAIA – Graphical Astronomy and Image Analysis Tool

Peter Draper (p.w.draper@durham.ac.uk) & Clive Davenhall (acd@roe.ac.uk)
Durham University, UK, and Royal Observatory Edinburgh, UK

GAIA (Graphical Astronomy and Image Analysis) is an interactive display and analysis tool for direct, two-dimensional astronomical images. It includes a comprehensive suite of facilities for displaying and manipulating images (pan, zoom, manipulate the colour table, *etc*). It also has extensive facilities for the astronomical analysis of images, including astrometric calibration, automatic object detection (that is, generating a catalogue of the objects present in an image) and aperture, optimal and surface photometry. GAIA can access images in most of the data formats common in astronomy, and is suitable for use with the two-dimensional images generated by digitizing direct, two-dimensional photographs. GAIA can also retrieve copies of remote images and catalogue overlays via the Internet. In particular, it can extract images from the DSS and SuperCOSMOS Sky Survey (SSS) archives of digitized Schmidt plates. GAIA is available for the Compaq Alpha/Tru64, Sun/Solaris and PC/Linux versions of Unix. It is documented in

SUN/214: *GAIA – Graphical Astronomy and Image Analysis Tool*,

SC/17: *The GAIA Cookbook*.

There is a 'home page' giving further information at `www.starlink.rl.ac.uk/gaia/`. GAIA is a customisation and enhancement of the *SkyCat* image display tool developed by Allan Brighton and colleagues as part of the ESO VLT project. It is developed by the Starlink Project in the UK (see `star-www.rl.ac.uk/`). Copies of GAIA, together with its documentation, can be obtained from the Starlink Software Store at `www.starlink.rl.ac.uk/cgi-store/storetop`.

Digitization is going to get harder!

"The fact that several respondents to our appeal regretted that they were unable to help as the instrument in question [a PDS] had recently been thrown away serves to highlight the urgency of this matter" (see page 9).

On-line Contents Catalogues are Essential!

If an Internet mail-order firm does not publish a catalogue or any information at all about its products, how many customers will it get?

The Need for Contents Catalogues

Elizabeth Griffin (Elizabeth.Griffin@hia.nrc.ca)
Dominion Astrophysical Observatory, Victoria, BC, Canada

Everyone who becomes involved with archiving data must at some stage find a way of communicating to potential users in an efficient, succinct yet comprehensive manner what those archives contain. Astronomy's photographic archives are particularly badly off in that respect; although the observing log-books can be produced, and many also have hand-written card-files, nothing can be interrogated on-line. There are no FITS files whose headers can be skimmed for the necessary meta-data. The levels of information in the card-index cards are not uniform; some give the date, instrument and log-book number of each exposure, whilst others record new exposures merely as tally marks.

The entries in the card-index catalogues that I have seen are arranged in order of Right Ascension. That is certainly better than having them arranged in chronological order, as in a log-book, and for the purposes of seeking out all the plates of specific stars the cards can be extremely useful, though examining them inevitably entails a personal visit to the archive. However, for seeking out spectrograms of (say) early-type stars in the far UV, neither the log-books nor a card-index catalogue is going to point quickly to more than a small fraction of the total amount of relevant material.

In many respects an archive is like a lending library. An archive without a Contents Catalogue is like a library that has no catalogue of authors or subjects – merely a list of the dates when the books were published. You won't get far looking for specific books in the latter kind of library, and as a result few people will waste their time trying. It is therefore small wonder that photographic plates are deemed "unwanted" by many astronomers on the grounds that there are so few requests to borrow plates. *Which* plates can they want??

My personal experience of seeking out specific plates in archives is limited, but serves to illustrate the point. A few years ago I attempted to follow up the past eclipses of a bright binary which undergoes dramatic chromospheric eclipses every 10.5 years. The literature on the subject was informative, and I located and borrowed several hundred spectrograms, from Mount Wilson, the DAO, the University of Michigan and Stockholm Observatory, carrying them in my hand-luggage to the UK or to the DAO in order to digitize them. The wear and tear on the researcher was much as might be expected, and I felt I got off reasonably lightly with only a fractured arm – a hazard of winter roads in Sweden, not of carrying glass in bulk.

My next task, however, will be harder. Instead of looking out plates of a given object, I need to examine all archived spectrograms of hot stars (i.e. earlier than ∼mid-F) shortward of $\lambda\,3300$ Å. The research in question is the pilot project of the SVO (see page 9), and involves an examination of the evidence of terrestrial ozone from historic stellar spectra which show the O_3 Huggins bands – broad features a few Å wide in the near UV between $\sim\lambda\,3300$ Å and the atmospheric cut-off. The hope of retrieving very accurate and precise concentrations of ozone from early stellar spectroscopy may be slim, but the prospect of unearthing any information at all about the natural history of telluric ozone is of enormous importance for climate and atmospheric modelling. There is no other resource in the universe which can in principle provide atmospheric scientists with these fascinating snippets of recent earth history.

So where do I start? If only we had on-line catalogues of the contents of the most likely archives, I could tell at a glance whether the useable sample will be a few tens of plates or a few thousand. The literature hints faintly at where to begin; studies of Be II will automatically have recorded ozone bands, and some pioneering studies of stellar spectra in the far UV have published inviting-looking wavelength lists. But inevitably I will make many fruitless visits, and inevitably I shall feel more than a year older after 12 months of searching in this rather puerile fashion.

Sooner or later, and possibly sooner if the ozone project turns up valuable evidence, the astronomical world is going to have to bite the bullet and get its log-books keyed in. As with digitizing the plates themselves, it is a task which has only to be done once, and it can be done by intelligent but unskilled clerical assistants working under appropriate supervision. Various experiences estimate a rate of 1,000 log-book entries per week. The funds required for these tasks are relatively modest, and the sources which may be approached are not necessarily limited to those concerned with astronomical research; organizations that offer small grants for archiving, for the history of science, for cultural preservation, etc., are worth investigating. Compared to the cost of even a small telescope or space mission the resources needed are minuscule, yet in terms of value for money they can scarcely be bettered.

I am not alone in feeling this lack so keenly. Milcho Tsvetkov's team, working for the benefit of world astronomy by cataloguing details of all the direct-image archives in the world (page 20), has experience enough of the difficulties occasioned by the lack of Contents Catalogues.

Some groups have already made excellent progress in this direction (see pages 4, 8, 10 and 12), proving that the task is not the 10-headed dragon that others fear. Should we organize a joint onslaught through the PDPP, or will individuals take the matter up independently with their own observatories?

Everyone's saying it...

The world's collection of photographic images represents the costly output from over a century of devotion and skill. They are already nominally in the public domain, but as a universal resource they are seriously under-exploited. The main reasons are

(a) lack of information in digital form about the plates, and
(b) lack of digital versions of the observations.

(Extracted from `udapac.oma.be/ fido.ovid.html`*, section II (Scientific Rationale), point 2.3).*

...and some are already doing it

Several contributors – see pages 4, 8, 10 and 12 – are able to report that they have already organized Contents Catalogues of their log-books or plate archives. Maria Mitchell Observatory should also be singled out as a shining example of a small observatory which has settled down to digitize its entire collection of historic plates. If they can, then ...

Large Schmidt Surveys and Digitization Programmes

Clive Davenhall (acd@roe.ac.uk), Nigel Hambly (nch@roe.ac.uk)
& Sue Tritton (sbt@roe.ac.uk)
Royal Observatory, Edinburgh, UK

This note summarises the major sky surveys conducted with the large Schmidt telescopes, and the digitization programmes performed on those surveys. A 'major survey' is one covering an area of more than 1000 sq. degrees. Starting in 1948 the Palomar Schmidt in the northern hemisphere and subsequently the UK and ESO Schmidts in the south have been systematically photographing the sky. Table 1 (mostly from M.V. Zombeck, 1990, *Handbook of Space Astronomy and Astrophysics*, 2nd edition, Cambridge University Press, p. 115) summarises the properties of the Palomar, UK and ESO Schmidt Telescopes. The ESO Schmidt was de-commissioned in 1998. The Palomar Schmidt has been re-fitted for use in the NASA NEAT asteroid discovery programme and the UK Schmidt is now mostly used for wide-field spectroscopy, though it can still take photographs. All three have conducted several major surveys, which are summarised in Tables 2–4. Further details are available at `www.roe.ac.uk/ukstu/`

Several fast microdensitometers capable of scanning the large photographic plates produced by Schmidt telescopes are, or have been, in operation (see Table 5). Apart from the STScI group machines, which are modified commercial PDS microdensitometers, the machines are purpose-built, and consequently their positional and photometric accuracy, useful dynamic range, pixel size, etc., are all different. All the machines are conducting systematic programmes to scan the Schmidt surveys and generate catalogues of the objects imaged on the Schmidt plates (see Table 6). The digitized surveys, except those prepared by MAMA, are publicly available.

We anticipate that updates to this note, giving details of the surveys and digitization programmes as they progress, will appear in future issues of *SCAN-IT*. We have assembled the tables from the published literature and Web sites, and though we have attempted to ensure that they are accurate, it is possible that they contain errors or omissions. Any corrections, additions or comments are most welcome.

Table 1: Details of the Palomar, UK and ESO Schmidt Telescopes

	Palomar	UK	ESO
Clear aperature (cm)	126	124	100
Mirror diameter (cm)	183	183	162
Focal length (m)	3.1	3.1	3.0
Plate size (cm)	35.6 x 35.6	35.6 x 35.6	30 x 30
Plate size (degrees)	6.4 x 6.4	6.4 x 6.4	5.5 x 5.5
Plate scale (arcsec/mm)	67.14	67.12	67.45
In operation	1948	1973	1972
Latitude	33° 21′ N	31° 16′ S	29° 15′ S
Longitude	116° 52′ W	149° 04′ E	70° 44′ W
Elevation (m)	1706	1145	2347

Table 2: Major surveys undertaken with the large Schmidt telescopes

Survey	Epoch	Emulsion and filter	Band	Depth	Dec zones	No. of fields	Atlas
Northern hemisphere:							
POSS–I O	1950–58	103aO (no filter)	O	21.0	$\delta \geq -30°$	935	G,P
POSS–I E	1950–58	103aE+2444	E	20.0	$\delta \geq -30°$	935	G,P
POSS–I I	1975–79	IVN+WR88a	I	19.0	$\delta > 0°$; $\|b\| < 10°$	80	P
Whiteoak Ext.	$\sim$ 1960	103aE+2444	E	20.0	$-36° \geq \delta \geq -42°$	100	P
POSS–II B	1985–02	IIIaJ+GG385	B_J	22.5	$\delta \geq 0°$	894	G,F
POSS–II R	1986–99	IIIaF+RG610	R	20.8	$\delta \geq 0°$	894	G,F
POSS–II I	1989–01	IVN+RG9	I	19.5	$\delta \geq 0°$	894	F
Southern hemisphere:							
ESO–B	1973–78	IIaO+GG385	B	21	$\delta \leq -20°$	606	G,F
ESO–R	1978–90	IIIaF+RG630	R	22	$\delta \leq -20°$	606	G,F
SERC–J	1974–87	IIIaJ+GG395	B_J	23	$\delta \leq -20°$	606	G,F
SERC–EJ	1979–95	IIIaJ+GG395	B_J	23	$0° \geq \delta \geq -15°$	288	G,F
SERC–I/SR	1978–85	⌈ IVN+RG715	I	19	$\delta \leq 0°$; $\|b\| \leq 10°$; MC	163	F
		⌊ IIIaF/098+RG630	R				
SERC–I	1978–02	IVN+RG715	I	19	$\delta \leq 0°$; $\|b\| \geq 10°$	731	
AAO–R	1984–01	IIIaF/4415+OG590	R	22	$\delta \leq -20°$	606	
SERC–ER	1984–01	IIIaF/4415+OG590	R	22	$0° \geq \delta \geq -15°$	288	G,F
UKST Hα/SR	1997–02	⌈ 4415+Hα	Hα	20	$\delta \leq 0°$; $\|b\| \leq 10°$; MC	273	
		⌊ 4415+OG590	R				

Notes:

References and notes for the surveys are given in Table 3. The approximate wavebands for the various emulsion and filter combinations are given in Table 4.

The POSS–II I survey was completed with 34 UKST plates (see Table 3).

'MC' = Magellanic Clouds.

Entries under 'Dec zones' refer to the field centre.

An entry under 'Atlas' indicates that an atlas has been published from the survey; the codes indicate the medium used: G = glass, F = film, P = paper.

Table 3: References and notes for the major surveys

NORTH

POSS–I O, POSS–I E J.M. Lund & R.S. Dixon, 1973, PASP **85**, 230–240.

R.L. Minkowski & G.O. Abell, 1963, in *Basic Astronomical Data, Stars and Stellar Systems*, ed. K.AA. Strand (Univ. Chicago Press), **3**, 481–487.

POSS–I I J.G. Hoessel, J.H. Elias, R.A. Wade & J.P. Huchra, 1979, PASP, **91**, 41–45.

Whiteoak Ext. J.B. Bolton, M.E. Clarke & R.D. Ekers, 1965, *Aust. J. Phys*, **18**, 627–633.

See also J.M. Lund & R.S.Dixon, 1973, *op. cit.*

A southern extension to the POSS–I E survey. The filters used in the two surveys, though nominally the same, actually differed slightly.

POSS–II B, POSS–II R, POSS–II I I.N. Reid *et al.*, 1991, PASP, **103**, 661–674.

The POSS–II I survey was completed with 34 UKST plates, 9 of which were common to SERC–I. The UKST plates used the same emulsion (IVN) as the Palomar plates, but a slightly different filter (RG715). The POSS–II B survey included 1 UKST plate.

SOUTH

ESO–B R.M. West & H.-E. Schuster, 1982, A&AS, **49**, 577–589.

ESO–R R.M. West, 1984, in *IAU Coll. 78: Astronomy with Schmidt-Type Telescopes*, ed. M. Capaccioli (Reidel, Dordrecht), 13–24.

SERC–J R.D. Cannon, 1984, *loc. cit.*, 25–35.

SERC–I/SR M. Hartley & J.A. Dawe, 1981, *Proc. Astron. Soc. Australia*, **4**, 251–254.

Includes 163 matched infra-red ('I') and short-red ('SR') exposures of the Milky Way ($|b| \leq 10°$) and the Magellanic Clouds. Corresponding exposures were taken within a few weeks of each other.

AAO–R, SERC–EJ, SERC–R, SERC–I D.H. Morgan, S.B. Tritton, A. Savage, M. Hartley & R.D. Cannon, 1991, in *Digitised Optical Sky Surveys*, eds. H.T. MacGillivray & E.B. Thomson, *ASS. Libr*, **174**, 11–22.

UKST Hα/SR S. Phillipps & Q.A. Parker, 1998, *Astron. Geophys*, **39**, 10–13.

Q.A. Parker, S. Phillipps & D.H. Morgan, 1999, in *New Perspectives on the Interstellar Medium*, eds. A.R. Taylor, T.L. Landecker, & G. Joncas, *ASP Conf. Ser*, **168**, 126–137.

Q.A. Parker & S. Phillipps, 2001, in *The New Era of Wide Field Astronomy*, eds. R.G. Clowes, A. Adamson, G. Bromage, *ASP Conf. Ser*, **232**, 38–43.

Contains matched Hα and short-red ('SR') exposures, but the corresponding exposures are not contemporaneous; they could be some years apart. The 273 fields include 233 in the southern Galactic plane and 40 in and around the Magellanic Clouds.

Table 4: The approximate wave-bands and colours of the various emulsion and filter combinations used in the surveys

Emulsion and filter	Wave-band (Å)	Colour	Band
103aO (no filter)	3500 - 5000	blue	O
IIaO+GG385	3850 - 5000	blue	B
IIIaJ+GG385	3850 - 5400	blue	B_J
IIIaJ+GG395	3950 - 5400	blue	B_J
IIIaF+OG590	5900 - 6900	red	R
4415+OG590	5900 - 6900	red	R
IIIaF+RG610	6100 - 6900	red	R
103aE+2444	6200 - 6700	red	E
IIIaF+RG630	6300 - 6900	red	R
098+RG630	6300 - 6900	red	R
4415+Hα	6555 - 6625	Hα	
IVN+RG715	7150 - 9000	infra-red	I
IVN+RG9	7300 - 9000	infra-red	I
IVN+WR88a	7700 - 9000	infra-red	I

Notes:
'Band' gives the approximate equivalent Johnson band. 'O' and 'E' are not Johnson bands, but are the usual band names given to the corresponding emulsion and filter combinations. B_J differs from the B band in that its long-wavelength limit is 5400 Å rather than 5000 Å and hence includes the [O III] line at 5007 Å

Table 5: Current and previous fast microdensitometers

SuperCOSMOS (WFAU, IfA, Edinburgh–ROE, UK)

Information:	`http://www.roe.ac.uk/cosmos/scosmos.html`
Survey data:	`http://www-wfau.roe.ac.uk/sss`
Catalogue:	SuperCOSMOS Sky Survey (SSS)
Images available?	yes

COSMOS (defunct) (ROE, UK)

Survey data:	`http://xweb.nrl.navy.mil/www_rsearch/RS_form.html`
Catalogue:	ROE/NRL COSMOS UKST Southern Sky Object Catalog
Images available?	no

APM (IoA, Cambridge, UK)

Information:	`http://www.ast.cam.ac.uk/~mike/casu/apm/apm.html`
Survey data:	`http://www.ast.cam.ac.uk/~mike/apmcat/`
Catalogue:	APM Sky Catalogues
Images available?	no

APS (Minnesota, USA)

Information:	`http://aps.umn.edu/About/aps.html`
Survey data:	`http://aps.umn.edu/`
Catalogue:	APS Catalog
Images available?	yes

STScI: modified PDS microdensitometers (STScI, Baltimore, USA)

Information:	`http://www-gsss.stsci.edu/gsc/GSChome.htm`
Survey data:	`http://www-gsss.stsci.edu/gsc/GSChome.htm`
Catalogue:	HST Guide Star Catalog (GSC) I and II
Images available?	yes (the Digitized Sky Survey, DSS)

MAMA (INSU/CNRS, Paris, France)

Information:	`dsmama.obspm.fr/`

PMM (USNO, Flagstaff, USA)

Information:	`www.nofs.navy.mil/projects/pmm/index.html`
Survey data:	`www.nofs.navy.mil/data/FchPix/`
Catalogue:	USNO-A and USNO-B
Images available?	yes

Table 6: Status of Survey scanning by each fast microdensitometer

Machine	SuperCOS	COSMOS	APM	APS	STScI		PMM
Catalogue	SSS	ROE/NRL Southern	APM	APS	GSC I / DSS	GSC II / DSS	USNO–A USNO–B
Survey							
POSS–I O			done[1]	done[1]		done	done
POSS–I E	prog		done[1]	done[1]		done	done
POSS–I I							
Whiteoak Ext.							done
POSS–II B	prog					done	done
POSS–II R	prog					done	done
POSS–II I	plan					done	done
ESO–B							
ESO–R	done						done
SERC–J	done	done[1]	done[1]		done	done	done
SERC–EJ	done	done[1]	done[1]		done	done	done
SERC–I/SR	done					done	done
SERC–I	done					done	done
AAO–R	done		done			done	done
SERC–ER	done					done	done
UKST Hα	prog						

[1] $|b| > 20^\circ$ only.

Notes:
'plan' = scanning is planned but not yet started; 'prog' = scanning is in progress; blank = the survey is not being scanned. In some cases additional, more specialised, digital surveys, not included in this note, have also been prepared

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IAU Resolution B3, 2000

Safeguarding the Information in Photographic Observations

The International Astronomical Union,

Consequent upon

its Recommendation 13C (1991) of the XXIst General Assembly to create accessible archives of the large quantities of observational material collected during the 20^{th} Century and currently stored on photographic plates,

Recognising

that unless urgent action is taken this unique historical record of astronomical phenomena will be lost to future generations of astronomers,

Considering

the important efforts made by the Working Groups on (i) Sky Surveys, (ii) Carte du Ciel plates and (iii) Spectroscopic Data Archives, as well as by the centre for European plates recently launched at the Royal Observatory of Belgium, in locating and cataloguing plates, in defining the tools needed to safeguard them, and in negotiating the means to preserve their recorded information in digital form in the public domain,

Realising

that the cataloguing, storage and safeguarding of the photographic plates is an important aspect for the implementation of the possible future digitization process needed for selective media transfer of high quality data,

Recommends

the transfer of the historic observations onto modern media by digital techniques, which will provide worldwide access to the data so as to benefit astronomical research in a way that is well matched to the tools of the researcher in the future.

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ON-LINE CONTENTS CATALOGUES ARE ESSENTIAL!