SCAN–IT

The IAU Working Group for the

Preservation and Digitization of Photographic Plates

PDPP Newsletter No. 6 April 2013

Editorial

Heritage Data Still Need A Voice

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Despite the long gap since the last SCAN-IT Newsletter, things on the plate preservation front have by no means been idle. New projects are starting up, and some are in production mode, though funding restrictions or organizational changes have brought new problems to be tackled in other cases. Inevitably things move only rather slowly, so one might question whether a Newsletter with a greater frequency than (say) once per year is worth the effort. Members who were able to attend the IAU General Assembly last August in Beijing discussed the usefulness and the frequency of SCAN-IT, and came to the general conclusion that a high frequency was more desirable than a low one, but (frankly) the time and effort required to solicit contributions and to edit them appropriately is already as much as someone with a fairly full schedule of other commitments really wants to handle very often!

Yes, things have not been idle. The Chinese have gathered up most of the photographic observations from most Chinese observatories and placed them with considerable care and attention in a clean room of the former Observatory, and have acquired a substantial grant to commission and build a suitable digitizer. However, I was able to see for myself that storage problems from earlier years had caused damage of sufficient severity as to render some plates useless. The Russians have tackled their national heritage problem a little differently, as you can read below, and (again) I hope to see that project for myself later this year. *DASCH* at Harvard is now deep into production, *DAMIAN* in Brussels is operational (at least for scanning non-astronomical plates) and can produce images with stunning detail, and the world's only spectrum digitizing project at the DAO in Canada is placing its scanned spectra on-line at the CADC website. PARI's storage area for unwanted plate collections is now fully air-conditioned, and sorting and cataloguing are under way.

Recent problems that have raised rather ugly heads all stemmed from a wish by an organization (public or private) to (re)gain access to space that plates are occupying, and to request their removal. Often those requests have come with woefully inadequate lead-time to make full enquiries or follow up suggestions; people need to be found and contacted, materials have to be assessed, and ideas have to be debated and costed. While it may seem fully reasonable for a local council to give two months' notice to have a building vacated, finding a willing and suitable home for several tons of glass, all of which requires very careful packing and handling, can absorb at least all of that interval, as was found in Johannesburg, in Crayford and in Cambridge (UK), and in Australia just in the last few years. In order to forestall similar bolts from the blue (as was experienced at the University of Michigan), a committed group from North American observatories has been trying to develop a Policy (a.k.a. "Work Plan") that places the whole issue of heritage data on a firm *astrophysical* footing such that issues regarding the future of whatever plate store can be made rationally, sensibly and in a timely fashion. An application is being made to the AAS to establish a Working Group on Time-Domain Astronomy, to service both heritage data and modern data as astrophysical dependants.

However, undoubtedly one of the most reinvigorating moments for the PDPP happened just recently when the IAU General Secretary said that he doubted that the "old plates [that I described] are really part of modern astronomy". Not since its inception in 2000 has the PDPP sprung forward with such agility to defend itself! It was really heartwarming to discover how passionate our members are, and how deeply committed to the cause (even though frequently sharing that commitment with many other "modern" projects too).

The reports in this issue help to demonstrate to the outside world whether or not plates can be regarded as just historical artefacts. You and I know the answer, but we have now been tasked to show it convincingly. IAU Commission 5 (*Astronomical Data*, PDPP's host Commission) is to present a Case for the PDPP remaining within that Commission, and not be switched to Commission 41 (*History of Astronomy*). Happily, Dr. Bob Hanisch, President of Commission 5 and also Chair of the USA's VO movement, is strongly on our side, but the battle still has to be fought (and won). To that end, we started (re-started, actually) a bibliography of published papers that describe results which could not have been reached without access to historic data. Sergio Ilovaisky at Haute-Provence Observatory (France) has kindly agreed to manage the list, so please contact him (sergio.ilovaisky@oamp.fr) with literature references. We need to construct that dossier soon, so this request is somewhat urgent. Conference Proceedings qualify, even if not refereed. For instance, IAU S285 ("New Horizons in Time-Domain Astronomy", Oxford, 2011) held a number of workshops on specialist topics, one being the relevance and protection of heritage data for time-variability studies, and a full report of that workshop is included in the published Proceedings.

Once we get the PDPP firmly accepted in its rightful zone of "modern" astronomy within the IAU, it will be time for me to hand over the Chair to someone else. Editing the Newsletter should also become a more modern-looking operation, with on-line submissions in *html* rather than the somewhat steam-hammer methods that I use! Volunteers and nominations are welcome at any time.

UCAC – Final Release

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UCAC4, the Final Release of the USNO CCD Astrograph Catalog project, became public at the IAU GA in 2012. UCAC4 contains accurate positions of about 113 million stars to magnitude 16, supplemented by optical and 2MASS photometry. Proper motions are given for about 110 million stars, and were derived from CCD survey observations combined with old photographic plate data, like the Northern and Southern Proper Motion (NPM, SPM) programs and many others. Without those early programs there would not be any modern, deep, astrometric star catalog beyond the about 100,000 Hipparcos stars.

UCAC4 is served by the CDS, and can be obtained on DVD from USNO. See Zacharias et al. (2013), and `www.usno.navy.mil/usno/astrometry/optical-IR-prod` .

Reference

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Dramatic Spectrum Changes in V439 Cyg

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Though many centuries have passed since the Aristotelian concept of the cosmos was disproved, the idea that skies are unchanging is still strong in the subconscious. However, that is far from what astrophysical data show; while it may be true that most stars change very little on the time-scale of human history, many objects show drastic changes in their luminosity and spectra on a time-scale of a few decades. This is true of LBVs, and of other active stars whose nature is (to date) but poorly understood. For those cases, plate archives are extremely important resources for unveiling their physical nature.

V439 Cyg—an intriguing member of the Berkeley 87 young open cluster—seems to have changed its spectral type from late to early on time-scales of just a few years. Van Schewick (1941) reported it as a Mira variable, and it was included in the Merril & Burwell (1949) catalogue of Be stars. Perraud & Pelletier (1958) classified it as a carbon star, but it was reported by English et al. (1983) as having an early type spectrum, compatible with B0ep. We have checked, as far as possible, the historical records in order to exclude misidentifications, and in August 1989 we performed a complete low-dispersion spectroscopic survey of all the members of Berkeley 87 and field stars down to V=16 within a 16′ circle centred on V439 Cyg. No object with a spectrum similar to that of a C star was found, giving us confidence that the Perraud & Pelletier classification was not due to a misidentification (Polcaro et al, 1991).

The best proof of the spectral variability of V439 Cyg came from examining the original 18 IIa-O plates taken by Perraud and Pelletier from λ 4000–4900 Å in August 1958, using the GPO spectrometer on the OHP 40-cm telescope with Fehrenbach's double exposure technique. The good-quality spectrum of V439 Cyg that we recovered from those plates shows the Balmer lines in deep absorption and a very clear G-band, and other absorption features which we identified as CN, CH and C_2 bands (Polcaro et al., 1989). We therefore confirmed that the spectrum of V439 Cyg was of late type in 1958, though not exactly a C star.

Unfortunately we were unable to recover the 1944 Mount Wilson plate, but should stress that the Merrill & Burwell (1949) Survey was based on red objective-prism spectra with a cut-off shortward of λ 5600 Å, and that higher-resolution spectra in the Hα region were only taken in cases of dubious classification. The red 1944 Mount Wilson spectrum could not therefore be compared directly with the 1958 (blue) OHP one and the 1958 OHP one, so we can neither confirm nor reject a spectral change between 1944 and 1958. However, our later observations, while confirming its early-type nature, also showed that the λ 4400–4440 Åband and the Merrill–Sanford (MS) band near Hβ was much weaker in 1986 compared to 1982 *and then completely disappeared* (Polcaro & Norci, 1998). The actual nature of the object (maybe the smallest LBV, or a main-sequence Be star with unusually strong mass ejection episodes; see Turner, 2003) is thus still a mystery.

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The Digitized First Byurakan Survey: Now On-Line!

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Introduction

We report here on progress made on the *Digitized First Byurakan Survey* (DFBS) project, which was described as "work in progress" in SCAN-IT 2.

The Digitized First Byurakan Survey objective-prism plates have a scale of $1''.54$/pixel and cover a field of $\sim 4^\circ.1 \times 4^\circ.1$. The prism generates a dispersion of ~15 Å/pix at λ 3700 Å, 26 Å/pix at λ 4340 Å and 100 Å/pix at λ 6900 Å. To date it is the only photographic spectroscopic survey which has been digitized and made freely accessible to the astronomical community through the web.

Details of the DFBS project and its potential for further scientific use have been published in book form (E. Massaro, A. Mickaelian, R. Nesci, D. Weedman: 2008, *The Digitized First Byurakan Survey*, available upon request). A paper describing briefly the main characteristics of the DFBS was published by Mickaelian et al. in 2007 (A&A, 464, 1177).

Data Processing and Products

All the available plates at Byurakan Observatory were scanned, and astrometrically calibrated. Dedicated software ("bSpec"), developed in linux by the MIGG s.r.l. software group in collaboration with the "La Sapienza" University group, performs extraction and calibration of the spectral data automatically for a DFBS plate, based on the experience gained interactively with IRAF tasks. It also performs all the operations necessary to build the DFBS database. In the reduction procedure, the catalogue driven approach has been used for the finding algorithm: an object list in each plate area was downloaded from the 1996 USNO-A2 catalogue, with an upper magnitude bound of $B \leq 17$. Starting from the USNO coordinates, each spectrum is re-centered with a combination of two parameters: peak position and baricenter. For each image, a mean spectrum position angle is computed through the distribution of the whole set of objects, and adopted as the spectrum direction for all the spectra of the plate. To filter out noisy objects, a limit in brightness and ellipticity is imposed on the spectra used to compute the mean direction. The local background around each image is estimated using the median value of the pixel distribution in two strips (left and right side) parallel to the spectrum direction. The software then automatically performs the transformation from the scanner DN to intensity (in arbitrary units) for each plate, finds the "red head" of each spectrum, and extracts the spectrum by subtracting the local background; the abscissæof each extracted spectrum are adjusted such that pixel 20 is at the red head. bSpec is challenged when two spectra are too near in RA (a few pixels) or if they partially overlap; in such cases only one spectrum appears in the database, and will therefore not be reliable.

A magnitude calibration for each plate is made using objects in the central square degree of the plate; instrumental B and R are evaluated by integrating the spectrum between pixels 20–40 (R) and 55–90 (B). A polynomial fit of these magnitudes against their USNO-A2 ones yields a calibration curve; objects deviating more than two sigma are excluded from the relation. That curve is then used to compute the DFBS magnitude of all the objects in the plate; those brighter than 13 mag are usually overexposed in the DFBS so their magnitudes are not very meaningful, and neither are ones near the plate limit.

The best photometric information obtainable from DFBS spectra comes from integrating the spectra blue-ward and red-ward of the green sensitivity gap, yielding an instrumental "blue" and "red" magnitude: those spectral regions are very similar to the POSS O (4050Å) and E (6450Å) sensitivity ranges and can therefore be linked reliably to the B and R magnitudes given by POSS-based catalogues. A typical uncertainty is 0.2 mag in R and 0.3 mag in B; it is up to 2 times worse in V (near the sensitivity gap of the FBS emulsions) and in U (the UV edge of the FBS spectra), which are generally less well exposed. This photometry is useful for revealing cases of marked variability, e.g., when data from the FBS plates are compared to data taken at different epochs, and is therefore included in our DFBS database.

For each object the database contains the USNO-A2 identification, the RA and DEC of the red head, in plate pixels, B and R magnitudes from the USNO-A2 and from the DFBS, the local background, a quality estimate, the spectrum length (defined as the distance between the red border and the first pixel blue-ward below the sky level), and the extracted spectrum (141 pixels long). The quality markers are "OK" if not overlapped and has a good S/N ratio, "F" if faint but otherwise good, "NL" if there is overlap with another spectrum, and "U" for all other cases. However, that classification is not always reliable, and serves mainly for statistical purposes only; visual inspection is always recommended for studying individual objects.

The Web Interface

The DFBS database (v3.0) can be queried at `http://byurakan.phys.uniroma1.it/`. The user interface provides access to general information about the FBS and DFBS, an easy comparison of a spectroscopic DFBS plate with the corresponding direct plates from the DSS1 and DSS2, and access to the database and to (portions of) the digitized plates. It does not allow the user to run bSpec on a remote machine.

The user interface (the DFBS portal) presently offers the following operations:

a) *Sky coverage* brings up a rectangular RA and DEC map showing the position of each plate on the sky. Plates already processed are colour-coded. Basic data for each plate are brought up by clicking on the corresponding plate.

b) *Plate list* shows a list of the plates, and can sort it by different parameters (e.g. plate number, RA or DEC, emulsion type, observer) and download it.

c) *Explore* can display a portion of plate around a given central RA and DEC and compared it with the same portion of the DSS1 or DSS2 (blue, red, or IR); it can select interactively one or more spectra present in the database, collect them by saving them in a list, and download (ASCII) files to the guest computer.

d) *Get image* can select a portion of a plate (presently up to 1024×1024 pixels, i.e. about $26'.5 \times 26'.5$) and all the spectra of this portion present in the database. The spectra are downloaded as ASCII files, and the plate portion in FITS format.

e) *Get spectra* can download all the spectra in the database within a given distance from a selected central position. The query may be either interactive, in RA and DEC, or made by uploading an ASCII file containing one or more coordinates and a search radius (one per line). Objects may be selected by B, R or $B - R$. This option also displays an interactive table of the selected objects, allowing one to look at each object individually (in both 1-D and 2-D) for a quick evaluation of the data.

Re-Processing Kiev Observatory Plates for the Ukraine VO

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Kiev University Astronomical Observatory (AO KNU) commenced photographic observations in the late 19$^{\text{th}}$ century[1]. Parts of the archive were destroyed during the two world wars, but what survived includes about 20,000 images on glass and film of various sizes from over over 40 instruments, both in Kiev itself and other observing stations, and from observing expeditions. Several attempts to catalogue the collection have been made since 1990. The main problem has been the lack of dedicated manpower for such an exacting task. The solution to the problem was somewhat unusual: batches of plates were being assessed by the Observatory Museum for their historic value only, but after considerable persuasion an astrometry department was assigned to evaluate their scientific quality too. The plates have a double value, not only as sources of scientific data about celestial objects but also providing unique information about methods of observing, tools and equipment, expeditions, and the scientific topics pursued at the Observatory.

The Main Astronomical Observatory of the National Academy of Sciences of Ukraine (MAO NAS) was already ahead in its own archiving, and colleagues were able to assist with the AO KNU work. Once the systematic cataloguing of AO KNU plates was completed, the plates were classified according to certain parameters (observing programme, equipment, methods, observing dates, emulsion, etc.). The observations are now being integrated into the UkrVO digital archive [2,3]. In parallel, we are exploring how to re-process these historic observations, with special emphasis on solar-system bodies (planets, asteroids, comets). Because of the long time-span of the collection (1898–2002), involving different equipment, emulsion types and observing methods, it is important to assess the precision of the data in the collection, and to determine the scanner and software errors and limitations. In general, flatbed scanners can incorporate errors up to 0.5 pixel in position and 0.15 mag in photometry.

Research carried out by the MAO into scanner techniques has helped reduce instrumental errors, thereby significantly improving the output. The proposed processing software for treating the scanned images now reduces random instrumental errors to 0.035 pixels and 0.015 mag when scanning with both the 1200-dpi scanner Microtek ScanMaker 9800 XL TMA and the Epson Expression 10000XL.

Below are some sample results. As a test to evaluate the astrometric precision of plates from the AO KNU Merz-Repsold astrograph (D = 0.2 m, F = 4.3 m) we selected a plate of the star field in the neighborhood of radio source ISRS 1807 698, taken in 1990. The plate was digitized with the Microtek ScanMaker 9800 XL TMA scanner. Stellar images were delivered as FITS files, and were reduced with linux/midas/romafot software at the MAO. In Figure 1 the top two panels show the raw differences between the measured and the Catalogue coordinates for RA and Dec of stars in the TYCHO-2 Catalogue, while the bottom two panels show the corrected differences. Note that for a telescope with a scale M = $48''$/mm, when scanning with a spatial resolution of 1200 dpi the scan scale is approximately 1 PCL = $1''.043$. The precision of equatorial coordinates for stars in TYCHO-2 is close to $\sigma_{\alpha,\delta} = 0''.06$.

Plates of the Pleiades obtained in 1988 with the same instrument were used to evaluate photometric accuracy by examining ones of different exposure times. The uncertainty that was determined by comparing long and short exposures of the same images amounted to 0.17 mag; the contrast (γ) for the emulsion in question was determined as $\gamma = 0.80$, and the limiting

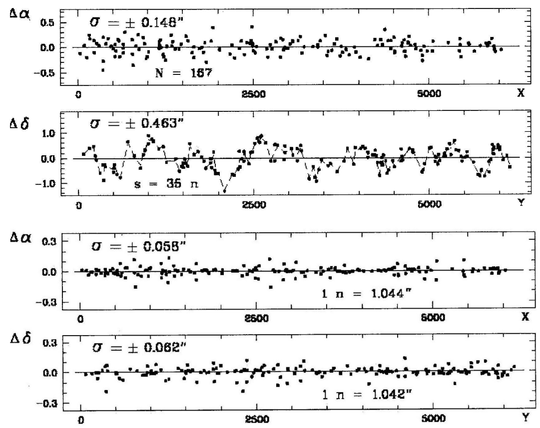

Figure 1: Upper pair: raw errors relative to the TYCHO-2 Catalogue. Lower pair: after re-processing.

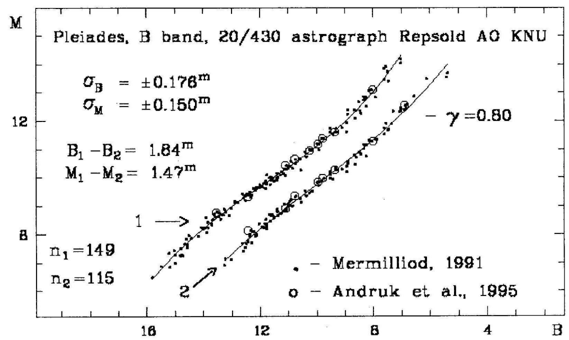

Figure 2: Characteristic curves for the V band.

magnitudes for long and short exposures were 16 and 13 mag, respectively. The relationship between actual magnitude and the amount of corresponding brightening in the emulsion is described by a "characteristic curve". Two representative curves for long and short exposures made in Johnson B-band are presented in Figure 2. The differences between the γ values of the curves reveal a photometric difference between measured and catalogue values of Johnson V and $B-V$ that was related to the actual rectangular coordinates (X, Y).

A plate exposed at Abastumani Observatory in 1941 was scanned with the Epson Expression 10000XL at orientations of 0° and 90°, with a resolution of 1200 dpi ($3''.25$ per pixel), and reduced with the same software. Positional (X, Y) and photometric measurements were recorded by the the scanner. and the corresponding means in equatorial coordinates and magnitudes were compared to those in TYCHO-2. Various optical aberrations that also affected the outlying images on the plate were modelled and corrected. The complete programme included searching for, marking and restoring over-exposed images, excluding noise above a certain limit, and dealing with blended images. The results showed that the astrometric precision that was attained depends on the direction of the scan (Figure 3).

Because of the long interval (~50 years) between taking this image and the epoch of the magnitudes of the sampled stars in the reference catalogue, it was necessary to investigate whether a magnitude-related component was present in the photometric errors that were thereby determined. We therefore determined those errors separately for different magnitude bands (Table 1), and selected Tycho $B = 11$ mag as the optimal one to use (see Figure 4).

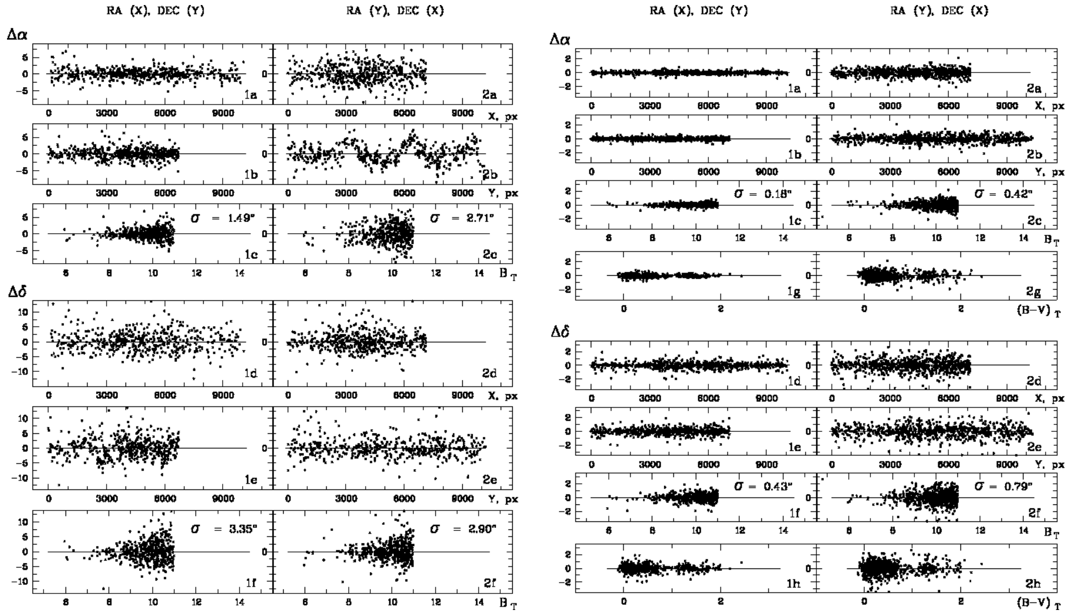

Figure 3: Dependence of astrometric precision upon direction of scan. Set 2: after 90° rotation compared to set 1. Left panels: raw measuring errors in α and δ; right panels: after correction for instrumental errors. Panels g, h show the dependence on colour.

Table 1: Measuring errors corresponding to different magnitude limits in Tycho B_T. For set 2 the plate was rotated through 90° compared to set 1.

	Set 1			Set 2		
B_T	σ_α	σ_δ	n	σ_α	σ_δ	n
<9 m	±0.183	±0.194	94	±0.282	±0.325	100
<10	0.169	0.326	266	0.314	0.608	283
<11	0.180	0.430	588	0.420	0.789	685
<12	0.303	0.570	980	0.801	1.375	1301
<13	0.403	0.795	1077	0.911	1.569	1461

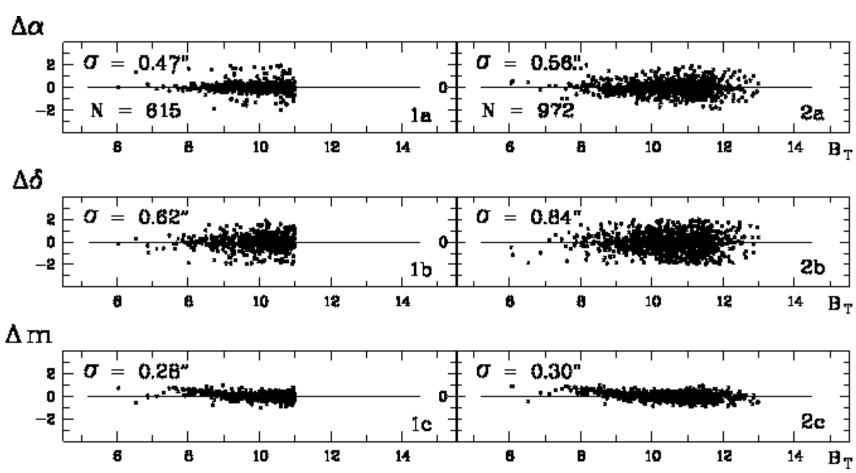

Figure 4: Dependence of astrometric precision upon direction of scan, for $B_T < 11.5$.

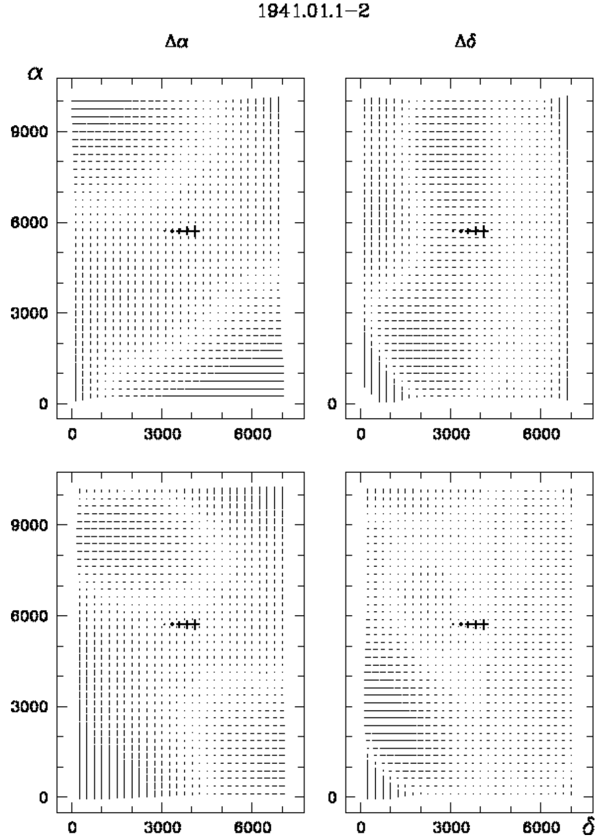

Figure 5: Dependence of astrometric precision, in pixels, upon direction of scan.

Telescope aberrations were determined as the difference between the measured coordinates α, δ and the tangential ones calculated from both polynomial and linear models. It was found they they also depended upon the direction in which the scanning was done (Figure 5).

The exploratory research that was conducted showed that modern re-processing of photographic images requires an individual approach for almost every series of observations depending on its characteristics, in order for the data to be generally compatible. The results described above still require confirmation with larger samples and different methods.

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Preserving Astronomy's N. American Archived Records

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Much of astronomy's archival material is at risk. A Workshop to develop a Plan for preserving astronomy's archived records was held on 2012 April 18–19 at the offices of the American Institute of Physics, College Park, MD, USA. The charge was to develop an Action Plan for preserving material which has scientific value and/or historical interest. The Plan's overarching objective is to preserve heritage observational material on behalf of the astronomical (or wider) community in a scientifically-meaningful form in order to enable the production of new science.

The 39 who attended represented 26 USA institutions (including the AAS, The AIP and the VAO), 2 Canadian ones and 3 overseas ones. The Workshop format was round-table discussion, with one break-out session. Discussions probed the nature and content of what constituted "archived records", their present and future locations, associated risks, and the responsibilities of owners or guardians, and prioritized the immediate tasks (making information on *content* visible, assessing risks and defining optimal digitizing procedures). In order to promulgate and activate a Plan it was agreed to propose a new AAS working group ("Time Domain Astronomy Working Group", WGTDA) as its organizational body, and to draft a proposal to that effect to the AAS. Background information was documented by the 2007 PARI Workshop and the 2008 Plate Census (Osborn & Robbins 2008).

From both plenary and breakout discussions, the Workshop identified the prime materials in question (photographic plates, essential metadata, papers, instrument manuals, some applicable software, calibration information, plus non-photographic records such as magnetic tapes and readers, strip-charts, punched tape and cards and supporting documentation) and prioritized associated urgency according to factors such as information density, any publications based on the material, and upon the condition and rate of deterioration. It also urged the specification of preservation standards and schemes for archiving all relevant materials, and the development of criteria for digitization. It further agreed that orphaned (displaced) materials must be recalled and returned, regardless of their sources of origin.

The Plan would be widely disseminated to observatories, relevant educational and archiving institutions. In the first instance it would be limited in scope to North American heritage, though it was recognized that most of what was discussed had relevance worldwide. It would also be cognizant of any parallel developments elsewhere.

Other issues (the structure of proposed AAS Working Group, possible sources of funding, etc.) will be decided by the WG in due course. In the meantime, it is important that everyone concerned about these issues take steps to promote awareness of the true situation facing astronomy's observational heritage.

A full report of the Workshop can be consulted on the website of WGPAH, the AAS *Working Group on the Preservation of Astronomical Heritage*:
`http://aas.org/files/wgpah_april_2012_workshop_report.pdf` .

Status of the Astronomical Photographic Data Archive

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The Astronomical Photographic Data Archive (APDA) is located in the Pisgah Astronomical Research Institute (PARI), which occupies a 200-acre site 15 km northwest of Brevard, North Carolina, U.S.A. in the half-million acre Pisgah National Forest (Figure 1).

Figure 1: The 200 acre Pisgah Astronomical Research Institute, 0.5 km from the PARI 26-m East radio telescope and looking towards the PARI West 26-m radio telescope.

Now in its 14th year, PARI provides space, infrastructure, and Internet access. The first floor of the Research Building (Figure 2, left) is dedicated to the APD¡A, with additional lab and office space on the second floor. Figure 2 (right) shows one of the APDA plate vaults.

Figure 2: *Left:* The Research Building, east entrance. The lower level is the home of the APDA. Behind are the West PARI 26-m radio telescope, and the PARI 4.6-m Internet-accessible radio telescope ("Smiley"). Renovation of the Research Building, completed in 2012, was supported by an NSF ARI grant. *Right:* One room of the APDA Plate Vault.

The APDA commenced in 2007, and has grown to include a rebuilt PDS operating in astrometric mode, 39 collections, renovated heating, humidity control, and air conditioning and environment controls, plus a 500-kw UPS and backup generator system.

APDA also possesses two high precision plate scanners, GAMMA I and GAMMA II that were built for NASA and the Space Telescope Science Institute. The scanners were used by a team of scientists under the leadership of the late Dr. Barry Lasker to develop the Guide Star Catalog and Digitized Sky Survey projects that guide and direct the Hubble Space Telescope.

GAMMA II has been rebuilt as an astrometric measuring engine. It uses the same laser interferometer positioning system and original illumination optics, and offers a variety of apertures from 12μ to 48μ square, circular, and slit. The light transmitted through a plate is detected by a photomultiplier tube and converted to a digital signal with a 15-bit A/D converter. The Astrometric Measuring Instrument (AMI) has been rebuilt as a strictly classic astrometric measuring machine. We started this project to help begin to meet some of the needs expressed by visiting astronomers who requested this capability. The AMI is capable of doing small postage stamp size images of reference stars and target objects for astrometric measuring purposes. The 4mm $\times$ 4mm image shown in Figure 3 (left) was created with a raster scan consisting of 10-μ steps and 12-μ aperture.

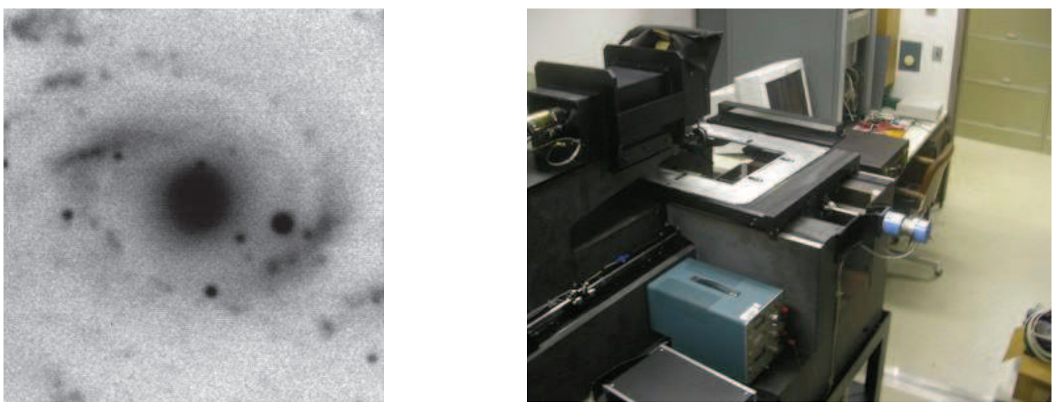

Figure 3: *Left:* The field digitized with AMI containing NGC 2207, IC2163 and SN 1975a, found on plate #1466 taken on 19 January 1975 with the KPNO 4-m telescope. *Right:* The former GAMMA machine. Note the C section on the left side of the image. The C section will carry the camera and lens. The platen is shown with a plate in place; it moves horizontally perpendicular to the motion of the C section.

Currently the 39 photographic plate collections located in APDA total about 220,000 photographic plates and films. Tables 1–6 (see Annexe) list the major collections and the names of specific surveys in APDA. The goal is to make APDA a resource harnessed by present and future generations of astronomers, bringing 20$^{\mathrm{th}}$ century analog astronomy into the 21$^{\mathrm{st}}$ century digital world through digitization projects. The APDA staff look forward to serving the astronomical community as a vital archival resource for future research projects.

APDA continues to receive national public recognition. In November 2011, PBS broadcast a QUEST 'Continuing Science Education' programme describing the APDA and its importance to the astronomical community and the general public. QUEST is a multimedia science and environment series created by KQED; San Francisco. QUEST reaches approximately 36 million viewers and listeners. EMC, a global leader in data storage systems and cloud computing, produced a video which is is distributing worldwide. A production crew from EMC-TV, the television division of EMC Corporation, visited PARI last fall to tape a video about PARI, APDA and EMC Corporation's support of the PARI mission. The video may be viewed at the EMC website `http://www.emc.com/emc-plus/index.htm` (see "EMC TV, The Human Face of Astronomy").

Additionally, Physics Today published a note about the APDA and astronomical photographic data archiving (PT, March 2009, **62**, 26) and Mercury Magazine (published by the ASP) published a more extensive article about PARI and APDA (Mercury, Winter 2009, **38**, 24).

For the first time in 2011 the NASA Marshall Space Flight Center Annual Fireball conference was held at PARI rather than in Huntsville. Participants at the workshop came from around the world and deemed the Harvard Photographic Meteor Program collection to be a significant source of meteor data directly impacting their research, but in need of analysis. With the proper amount of resources, we can meet their needs.

EMC Corporation donated more than $2.4M of data storage equipment specifically for APDA use, and includes networked storage system and software that can store more than 200 TB of research data, with an additional 200 TB for mirror storage. ERC Broadband also donated several multiprocessor computers, including a 20 processor SGI Altix 3000 which is available to APDA.

The environment conditions have been greatly improved by renovating the Research Building:.

• Climate control
• New HVAC systems installed in 2012
• Temperature controlled to 21 $\pm 1^{\circ}$C
• Humidity controlled to 40 $\pm$ 5%
• Electrical power service
• Stable line conditioning using dedicated UPS for computer systems and research instruments
• Electrical backup system with a 500-kw UPS and a 500-kw diesel backup generator
• Concrete steel-reinforced walls and flooring, and solid granite floor foundation
• Secure site facility with single gated vehicle entrance.

Local geological conditions include:

• Seismically stable area in western NC with zero probability of an earthquake >6.0 within 50 years and within a 50-km radius (according to the U.S. Geological Survey Seismic Hazard Mapping Project)
• At an elevation of 914 m, so not in a high-risk flood zone.

A firm foundation has been set for the Astronomical Photographic Data Archive, allowing for expansion in space and capabilities. Astronomers are encouraged to visit, to contribute suggestions, and to use the facility.

Contents of APDA, March 2013

1. Direct Plates

20	USNO: Flagstaff (61″-telescope)
321	CTIO: 4-m telescope plates
513	Henize 3″× 4″ plates (1960s)
2,000	Miscellaneous slides, plates and negatives
1,123	Halley 1985–96 Positive Film Copies from 84 observatories
8,300	Maria Mitchell Observatory, 1915–1995 (complete collection)
55	Harvard All-Sky Survey 1898–1903
35,000	Harvard Meteor Survey at White Sands Proving Ground, 52° FOV (molded films)
8,000	Harvard Prairie Network: Meteorite Project 1963–1974 (fixed cameras)
300	Central Michigan University
650	Dyer Observatory (Vanderbilt University)
160	Las Campanas Observatory (Chile)
10	Mount Stromlo (Australia)
200	Lick Observatory
96	Hale Observatories (Palomar and Mt. Wilson)
24,000	USNO: Double Stars, Solar System, & Miscellaneous objects
150	David Dunlap Observatory (University of Toronto)

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2. Spectroscopic Plates

153	Skylab – UV spectra (complete collection)
22	Burrell-Schmidt plates taken in Michigan
385	Henize Southern Survey - Hα 16° × 16°
120	McDonald Observatory: coudé spectra
3,500	CTIO (Curtis Schmidt Telescope) – Nancy Houk Southern Survey
350	MCT (Montreal–Cambridge–Tololo)) Survey
20,000	Warner & Swasey Observatory), 1941–1994
350	CTIO (Curtis Schmidt Telescope), infrared Survey – McConnell
22,000	University of Michigan: 472 objects (stars, novae, comets, etc), 1911–1970s
550	Miscellaneous spectra from other observatories
21	Canada-France-Hawaii 3.6-m Telescope
109	Grober Schmidlspiegel (Germany)
21	Observatorio Astrofisico Nacional (Tonantzintla, Mexico)

Continued . . .

3. Astrometric Plates

1,328	Minor Planet Survey: U. of Texas 8″ × 10′
180	USNO (Washington) Minor planets, 1904–1909
4,000	USNO: Twin Astrograph
58,940	USNO: parallax plates
5,340	USNO: AGK2, Hamburg, Black Birch. Lick

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4. Film Copies

300	Mars: 1939, 1941, 1960s, and more
300	Miscellaneous: 8″ × 10″, from McDonald Observatory
1,872	POSS-I

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5. Low-Resolution Spectroscopic Surveys

A-Stars Survey 1.8-deg prism	HK Survey 4° prism
He Survey UV filters	High Luminosity Survey
IR Survey 4° prism	Red Survey 4° prism
OB Survey 4° prism	QSO Survey 1.8° prism
SGP Survey 1.8° prism	LS1-VI Luminous Stars Survey 1.8° prism
All-Sky Survey 4° prism	Blue Survey 10° prism
AntiCenter Survey 4° prism	Weak Metallicity Survey 4° prism
6-Degree Survey, 6° prism	Low-Z Survey 4° prism
NGP Survey 1.8° prism	Parallax Survey (non-USNO) Direct images
SGH Survey, 2° or 6° prisms	Henize H-alpha Southern Survey 4° prism
UV-Survey 1.8° prism	Taurus 6-Degree Survey, 6° prism

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6. Specific Fields or Objects

Coma Berenices Cluster	Virgo Cluster
Hercules Field	LS1-VI Luminious Stars
SMC	LMC
Ursa Major	Barnard's Star
Coma Berenices Cluster	Various Comets
H & χ Perseus	Hyades
ILF 1-3 Fields (Clusters)	IRC Fields
Kinman Field	LF1-10 Stellar Luminosity Function (Regions)
Peculiar Galaxies	Messier Objects
Monoceros Fields	Orion
Pleiades	Variable Star Fields 1–10

Novæ: Cep 71, Cyg 75, Del 67, Herculis (esp. Her 60, Her 63), Per 74, Scuti & Vul 68

Update on DASCH at Harvard

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Harvard's plate digitization program, named Digital Access to a Sky Century @ Harvard (DASCH), has progressed through several mile markers within the last two years. Originally we scanned plates of intended targets like M44, 3C 273, Baade's Window and the LMC. These were our "Development Fields" in which we developed and tested the DASCH photometry pipeline software. Then, in May 2012, we initiated the development of our "Production Scanning," where we began scanning systematically all the Harvard plates in Galactic Coordinates, beginning at the North Galactic Pole (NGP) and progressing toward the galactic plane. This method of organizing our digitization has the decided advantage of producing science immediately; had we scanned an entire series of plates from one telescope and moved to the next telescope, light-curves across our 100-year time span would not have been available until DASCH was completed. In April 2013 we will have our first public data release (DR1); this will be image data as well as photometric and astrometric data of a 15° region around the NGP from 1887–1989.

Production scanning has required an uptick in the data entry of our telescope logbooks, which we have accomplished using a combination of students, Harvard volunteers, and the faithful help of volunteers at the American Museum of Natural History. Once our metadata of a particular region is complete, our software engineer, Ed Los, generates binned lists of plates working around the NGP. We locate those plates, barcode them, look for historical writing on the glass side of the plate, photograph the plate and jacket at high resolution, and clean all the plates except those reserved for historical reasons.

DASCH has been using barcodes in its procedures since 2006, but in 2012 we incorporated a barcoding system to track plates from the moment that they are chosen for digitization all the way through the scanning process. This is necessary owing to the immensity of Harvard's collection and is in keeping with our mission to scan all plates of any particular region. The system thus enables us to identify conditions on each plate that might affect our photometry and astrometry: emulsion colour, filter, multiple exposures, use of the "Pickering wedge", and conservation or development problems. We also identify portions of the collection that we are not yet scanning, like grating and objective prism plates. This issue of SCAN-IT provides a complete write up by David Sliski, DASCH Curatorial Assistant, about the development of our barcoding, photography, and upcoming plans for copying plate jackets.

Plate cleaning is critical for DASCH because dirt and ink on the glass can mimic stars and introduce problems in our automated astrometry and photometry. Under consult from Harvard's Weissman Preservation Center, we have made changes to our method of hand-cleaning plates. Ten years ago, we were cleaning the glass side of our plates using a non-ammonia window cleaner diluted 50/50 with tap water. We placed this fluid in the centre of the glass side, with the emulsion facing down on mat-board covered with paper. Then we scraped gently using a single edge razor blade to loosen hardened Indian ink, and rubbed the glass with industrial grade paper towel to both clean and dry the glass. In 2007 we introduced palm-sized scrub brushes and microfibre cloths into the cleaning process. In the hands of a cautious, conservation-minded person, the scrub brush accelerated the removal of ink and the microfibre cloth, owing to its bulk, dried the glass faster than paper. However, both tools have the capacity to bring moisture near the edge of the plate where it could contact the emulsion on the other side; the brush can flick fluid, expanding the intended area of moistening, and the cloths can be less absorbent than paper, leading a novice plate cleaner to pull fluid toward the vulnerable edges of the plate.

Whenever the edges of a photographic emulsion are moistened, the risk of delamination, or emulsion peeling, is introduced.

The photographic conservators at Weissman Preservation Center recently recommended that we hand-clean with a 50/50 solution of 190 proof ethanol and distilled water, and gave two reasons: it is a more effective cleaner, and it is safer to use near photographic emulsions. Ethanol is superior as a solvent and the diluted solution enables us to remove dirt on the plate with less physical effort; this has allowed us to dispense with the use of scrub brushes. More importantly, ethanol's evaporative qualities make it safer as a solvent for conservation use. If one accidentally exposes the plate edge to our ethanol solution, it will dry rapidly, minimizing the risk of weakening the bond between emulsion and glass on the other side of the plate. To reduce the risks involved in breathing ethanol vapour, we are using carbon filter hoods at each cleaning station. We continue to place the plates to be cleaned emulsion-side down on a cushioned surface like a rubber mat or mat-board, but cover that surface with paper that can be changed often, thus offering successive plate emulsions a dry surface on which to rest.

Labour is a fundamental need in DASCH digitization. To increase our throughput, we have employed students for the summers of 2011 and 2012; they have provided a great energy resource for the varied layers of work in the DASCH pipeline. Our undergraduates are able to operate the scanner, photograph plate markings, and barcode, and with care we are able to teach them how to clean the glass side of the plates. Our overall pace of progress marching through digitization has been encouraging. From 2006–2010 we scanned a total of 12,067 plates; during that time period we focused on plate processing and on increasing the accuracy of our results with increasingly sophisticated software. In 2011 we scanned 7,602 plates and in 2012 we had a marked increase in production, scanning 22,403 for the year. As of January 2013, the DASCH team had scanned a total of 42,072 plates, from which the DASCH automated analysis software has generated 2.5 billion magnitude estimates. By our best estimate, we have hauled more than 16 tons of precious glass up and down the spiral staircase of the Harvard Plate Stacks. And we just keep singing:

"16 tons, and what d'you get?
Another day older and deeper in [~~debt~~] data"!

Proper Jackets Preserve Plates!

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A common issue facing astronomical glass plate collections is the deterioration of the jackets which house the plates. Most often, plates are not stored in a climate-controlled environment, but instead reside on shelves or in wooden boxes. As a result of sitting in a wooden box, which is acidic in nature, or the fact that many jackets were produced with acidic paper, there is a chance that a harmful interaction with the plate emulsion will occur.

For example, in our plate collection an old and degrading jacket registered a pH of 3.6, which is akin to orange juice. A new jacket that was ordered to re-house the plate registered a pH of 7.8 – well within the specified range of 7.0 to 9.5 ± 0.2 in the ISO standard 18905:2007. In addition, after decades of sitting on a shelf, jackets can discolour and slowly disintegrate. This degradation poses three threats to the integrity of the plate.

First, if the paper that the jacket is made from is acidic in nature or was sitting in a wooden box, it may react with the emulsion of the plate. Such reactions may cause the plate to yellow, to fade, or even cause the emulsion to detach from the glass. This may cause a change in the background, which in turn can alter the data once digitized. For this reason alone, it is imperative that the storage conditions of the plates be addressed as soon as possible. Secondly, if the adhesive used to seal the jacket is in contact with the emulsion, it can leave marks that harm, damage, or even destroy the emulsion. This is why it is important that the emulsion face away from the seals on the jackets. Thirdly, if the jacket degrades to the point where it is disintegrating, it can leave the emulsion exposed to dust and dirt. When that occurs there is a higher chance that the emulsion will become scratched and therefore loose potentially important data.

Replacement jackets should meet certain standards. They should be made of acid-free, lignin-free, non-buffered paper board of a neutral pH that meets the International Standards Organization 18902:2007 and 18916:2007 standards. One should also ensure that jackets pass the Photographic Activity Test. New jackets which meet those standards can be purchased from companies such as University Products and Light Impressions Direct. Since few people have the funds to re-jacket their entire collection, a lower-cost alternative is to add a thin sheet of buffered tissue between the emulsion side of the plate and the jacket.

In addition to protecting the plate, the jacket presents the plate's defining information. In Harvard's case, the plate series and number, class, center coordinates, exposure time, and the date the image was taken are typically recorded. Given how long it would take to transcribe the information from the old jacket and transfer it onto a new jacket by hand, I decided to search for an alternative. I discovered that Harvard Library's Weissman Preservation Center had been faced with similar challenges with other plate collections at Harvard. In 2008, after investigating many copying or scanning options, their solution was to use an Epson Stylus CX6000 Multifunction Ink Jet printer to copy the old jacket information onto a new archival enclosure. For their purpose, they did not want to have any scanned files as part of the process, so they used the printer as a copier, printing directly onto the new enclosure. At the time of their testing, the Epson was the only printer with a direct paper-feed configuration. That was important, as bulky enclosures tended to jam it. The printer was set to draft mode to reduce ink usage. Although that diminished the overall print quality, it was satisfactory for their purposes. Another benefit of that particular printer was the stability of the ink when exposed to light, moisture, and direct water.

A drawback of many ink-jet printers is that they use a combination of colours to create black. That, combined with the fact that inkjet printer ink "expires" after a certain time, made us rethink our re-jacketing strategy. In order to speed up the process, create a higher quality print and introduce fewer user-interface issues, I explored the possibility of using a multifunction laser printer. New multifunction laser printers have a flat-bed scanner, feed-through scanner, fax, email, and sometimes store files on an on-board hard drive. Additionally, some units can scan and print on both sides, usually referred to as "duplexing."

Recognizing improvements in technology during the past five years, I approached various printer companies to solicit tests to ensure that laser printers could handle the heavy paper weight (i.e., thick, 100-lb stock) of our new enclosures. This is an issue for most printers as the paper is generally too thick to make a 180-degree turn. Some printers have a feed-through option which allows the jacket to pass straight through the printer. For that reason several printer companies, including Epson, Fujitsu, and Scansource, did not respond to requests about printing on thick media, stating that it was "outside their specified range." Dell attempted to comply but found a problem with their printers and ‘will fix the problem shortly’. Canon, Brother, and HP all took on the project and submitted results.

Working with a representative at each of the latter three companies, we found that each was able to produce results for the text on the jacket. Each was also able to reproduce the barcodes which we had placed on the jacket, in such a way as to be readable by a barcode scanner. What separated the companies was their ability to detect pencil writing, produce colour prints, and perform duplex printing.

The Canon MF8380 CDWI, a colour, duplexing, multifunction laser printer, did the best job. It was able to accomplish a high-quality duplex print in both colour and black and white. It was also the best at picking up faint pencil handwriting and at printing the most accurate, highest contrast reproductions. The Harvard team was impressed with the quality of both its colour and its black-and-white prints.

The Brother MFC-8710DW is a black-and-white multifunction laser printer. The scanner was able to pick up faint pencil marks and reproduce them in monochrome printing; however, it could not print in duplex mode. The Brother MFW-9910CDW produced similar results for black-and-white printing compared to the MFC-8710DW. The 9910CDW has both colour printing and duplexing capabilities, though they were not tested.

The HP LaserJet Enterprise 500 MFP M525, which is a colour, duplexing, multifunction laser printer, produced mediocre results. While the printer was able to handle the heavy paper and print in duplex mode, the scans did not achieve high contrast. That in turn led to poor print quality. Further attempts to adjust the scan quality were not made, though it is likely that the scan quality could be improved by changing the settings.

The last stage of our procedure was to ensure that the toner used was of archival quality and would not cause the jacket to deteriorate over time. For that I sought the advice of Brenda Bernier and Elena Bulat, two photograph conservators at the Weissman Preservation Center at Harvard. We tested two black-and-white prints and two colour prints from the Canon printer.

To test the water fastness of the toner, a piece of white paper was inserted into each of the four jackets. The jackets were submerged in water for 30 minutes, followed by air drying. The envelopes printed in colour were dried between cotton blotters with a large Plexiglas plank on top so that the envelopes would dry in close contact with the blotter.

No bleeding was noticed on any of the four envelopes. The white paper inserts did not change colour, indicating that the toner would be unlikely to transfer to the emulsion if the plate was exposed to high humidity or water. The two colour envelopes left some minor coloration on the blotter during drying under weight, but the inscriptions were fully legible. We also tested the pH of the jackets after printing, and they registered a 6.8. While just inside the ISO standards, the photographic conservators felt it was OK to move forward with further testing.

In light of the above, and considering also that the cost of the Canon is similar to that of the Brother and much less than that of the HP, the Harvard team decided to choose the Canon MF8380 CDWI multifunction color laser printer. A new model, Canon MF8580 CDWI has just been produced, and we will order that version and test it more thoroughly.

Preservation and Digitization of Photographic Plates in China

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About 30,000 photographic plates were taken during the 20th century by five Chinese Astronomical Observatories: Shanghai (SHAO), Purple Mountain (PMO), Beijing (BAO), Yunnan (YNAO) and Shanxi (CSAO). The SHAO plates, which date from early 1900, cover the longest time-base; the 40-cm refractor at Zô-Sè (the SHAO field station) took its first plate in 1901, and is one of a few telescopes in the world to observe Halley's comet in both 1910 and 1986.

The observing programmes featured in China's plate archive include asteroids, comets, binary stars, variable stars, star clusters, nebulæ(etc.). Because of slow speeds of digitizing machines (like PDS) in former years, only parts of many plates have previously been digitized, and some plates were not digitized at all.

With support from the Chinese Academy of Sciences, all the plates from the five observatories were assembled in a plate archive at Zô-Sè in 2008. The archive is in a semi-basement beneath the observing room of the 40-cm refractor, and has air conditioning and humidity controls. The temperature is maintained at $18° \pm 2°$C, and relative humidity at $50 \pm 5\%$.

A special project supported by the Chinese Ministry of Science & Technology commenced in mid-2012, with the aim of digitizing all those plates in five years. The principal investigators are Zhang-Hong Tang and Jian-Hai Zhao. The principal tasks of the project are as follows:

(1) The Zô-Sè plate archive needs further renovation, particularly for increased ventilation to create more comfortable working conditions. A small enclosure for a digitizing machine should be set up so that its own temperature and humidity can be well controlled.

(2) In the past, the only information sent to the Wide Field Plates Data Base (WFPDB) concerned the plates taken with 60/90-cm Schmidt telescope at Xing Long, the BAO field station, and with the 40-cm refractor at Zô-Sè. A complete database of information for all existing plates in China will soon be finished, and will be submitted to the Chinese VO database for ingestion. Original log-book records and envelopes of all the plates will be scanned by commercial scanners and linked to the corresponding entries in the database.

(3) A new digitizing machine will be developed that has high enough precision for astrometry and photometry, and is acceptably fast. Dedicated image processing software will be developed once the machine is operational.

(4) Before digitizing plates, different cleaning solutions and methods will be tested in order to tackle the various conditions which they present.

(5) When all the plates have been digitized and the images reduced, the end products will be ingested into the China-VO database.

To complete all these tasks thoroughly, international cooperation can be important. We welcome astronomers who have expertise in plate digitizing, cleaning, image reduction and database management to visit Shanghai and share their experiences.

Acknowledgements. The authors are grateful to Professors Wenjing Jin, Bao-An Yao and Chen Li, and Drs. Shu-He Wang and Ya-Qing Mao, for their contributions and suggestions.

Status of Digital Data Archiving at OHP

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As told in the previous issue of this newsletter, archiving of science-ready high-resolution échelle digital spectra from the ELODIE and SOPHIE instruments makes it possible for these data to be available to the astronomical community through a web interface. This is now a continuing joint effort between Philippe Prugniel (Lyon) and myself, with contributions from Caroline Soubiran (Bordeaux).

The ELODIE Archive

This Archive (`http://atlas.obs-hp.fr/elodie/`), containing 35,535 spectra, all public, continues to see world-wide active use. 69 papers making total or partial use of the Archive were published between 2005 and 2012. A further 74 papers making use of the ELODIE Library (Prugniel and Soubiran 2001) appeared between 2002 and 2012. The Library features a selected set of 1962 ELODIE spectra for 1388 stars which have been reduced to the rest-frame, and are available in two resolutions: R = 42000, normalized to the pseudo-continuum, and R = 10000, calibrated in physical flux to outside the atmosphere.

The SOPHIE Archive

As of early March 2013, this Archive (`http://atlas.obs-hp.fr/sophie/`) contained more than 65,000 spectra for 4800 distinct targets. Almost 30,000 spectra (for 2240 targets) are fully public, and more than 23,000 spectra (for 2644 targets) are available with the exact time of observation masked (for a 5-year period), while nearly 12,000 spectra (for 978 targets) are under the standard 1-year proprietary period. The spectral types represented are O(0.2%), B(1.7%), A(4.5%), F(20.6%), G(42%), K(24%) and M(7%).

Two distinct fibre trains in the spectrograph yield different spectral resolutions, depending on whether an exit slit is used: High-Resolution (R =7 5000, HR) or High-Efficiency (R = 40000, HE). At the present time, about 13% of the spectra were observed in HE mode, mainly for the fainter stars (V = 12–16 mag). A large fraction of the HR data are part of the key-programme of extra-solar planet searches. The Archive can be queried by designation or sky coordinates, with additional constraints on signal-to-noise ratio, date, resolution or exposure time.

The spectra can be downloaded as 's1d' FITS files in wavelength space where the 39 échelle orders have been reconnected and re-sampled in 0.01 Å bins. If necessary, data can also be downloaded as 'e2ds' 4077×39 images in pixel space, where the original sampling is conserved and for which the relevant flat, blaze and wavelength files are made available separately. Work remains to be done on the imperfect blaze and continuum corrections.

SOPHIE Radial velocities

The main feature of SOPHIE is its capability to yield precise radial velocities. The information derived from numerical cross-correlation (CCF) of the spectra with one of several digital masks (F0, G2, K0, K5, M4 and M5) has been available since late 2011. That information includes the radial velocity (referred to the barycenter of the Solar System) plus the depth and width of the CCF dip, as well as bisector span. CCF profiles for more than 63,000 spectra and can be downloaded in FITS format.

The Future: The spectrograph has undergone recent improvements to increase the accuracy of the radial velocities (now 2–3 m/s) largely through the use of octagonal-section fibres which fully scramble the image on the $3''$ arc entrance aperture to mask any dependence on image quality. Further improvements have also been made on the telescope systems to reduce time lost between exposures. The new improved SOPHIE, called SOPHIE+, is expected to remain operational for at least another 7 years, and the Archive will be upgraded to gain another 4 TB of RAID5 storage to accommodate future data.

The Hewitt Camera Archive

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The Hewitt Camera Archive is a collection of about 11,000 photographic plates in the custody of the Crayford Manor House Astronomical Society at Crayford, in Kent [1]. The plates were taken between 1965 and 1990 using two Schmidt Cameras designed by Joseph Hewitt of the Royal Radar Establishment at Malvern, England. The cameras were originally intended for following launches of the *Blue Streak* ballistic missile, but following the cancellation of that project they were then deployed for tracking artificial satellites. One of the cameras was moved to Siding Spring, Australia and, from 1982 onwards, nearly 4000 plates were taken with it; the remaining 7000 or so plates being taken from various sites in the UK. After the relocation of the Royal Greenwich Observatory from Herstmonceux to Cambridge in 1990 all the plates (including the Australian ones) were placed under the custody of the Crayford Manor House Society by the British Astronomical Association, along with a manual Zeiss Plate Measuring Machine.

The original purpose of the plates was to image man-made satellites, therefore each image was untracked and was usually chopped (to allow the satellite's speed to be estimated). Each exposure is circular of diameter 10 cm, which represents 10 degrees of sky. Since certain times of night and certain times of year are more favourable than others for satellite work, the distribution of plates across the celestial sphere is not uniform. On average, a given star in the northern hemisphere will appear on about 30 plates, and in the southern, on about 16 plates. Stars near the poles are generally better represented than those near the celestial equator. Typically, the plates reach around magnitude 10, but on some magnitude 13 has been reached, though on others the limit may only be magnitude 8. The Society has created a computerised index to all the plates, so plates showing a particular star or a particular satellite can be readily identified [2].

Members of the Society have previously investigated a number of variable stars in the archive and have submitted a number of reports to interested astronomers, both amateur and professional. Occasionally, these reports have led to, or substantiated, other research which has then produce a paper in a professional journal where the Society is duly recognised.

The majority of the plates (some 7000) are glass and each weighs 458 gm and measures 210mm $\times$ 150mm $\times$ 6mm. The remaining plates (approximately 4000) are plastic of a similar size but much thinner and weighing correspondingly much less. A more complete description of the Archive, together with the use of the index and the Zeiss, is given by Howarth (1992).

Recent developments

For some years the Society occupied rooms in a building owned by the local Council. However, early in 2012 it was advised by the Council that it would have to re-locate to alternative premises as the building was being closed. Consequently, it moved to new premises at Sutton-at-Hone (a few miles south of Crayford) and was given permission to house the Archive there. The Archive was moved in mid-August 2012 and can remain there for as long as the Society use the facilities there, which for the foreseeable future, will be indefinitely. The move was no mean feat given that the entire Archive weighs around three tonnes. However, the new location is not ideal as the Archive is no longer readily accessible.

Ideally, what is required is for the entire Archive to be scanned, but for scientific-quality results that needs to be done with a specialised scanner. Flatbed scanners can only show a picture of a plate, not a hi-fi digital record of it. Standard methods of illuminating a negative or a film are quite inappropriate for quantitative scientific use, and scatter light into a range of pixels around each one as they scan, thus reducing the dynamic range and (more importantly) seriously degrading the photometry, since a photographic emulsion has a non-linear response to light.

Any advice on appropriate and cost-effective digitisation techniques and equipment would be very much appreciated, and should be sent to the author at the following e-mail address: roger.pickard@sky.com.

Acknowledgement. I am grateful to Clive Davenhall for his assistance in preparing this report.

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[1]http://www.crayfordmanorastro.com/
[2]http://cmhas.wikispaces.com/HewittCameraArchive

More Plates on the Move

Brian Mason (USNO; brian.mason@usno.navy.mil) reports that:

To date, PARI has made 4 plate pickups at the US Naval Observatory in Washington, picking up a total of 68,303 plates. We anticipate that the transfer of the remainder of the USNO plate collection can be completed in two more pickups.

Electronic Catalogues of Yerkes Observatory Plates

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An overview of the photographic plate collection of Yerkes Observatory was given in SCAN-IT #5 (p. 18). Since then, work has been underway to prepare electronically-readable catalogues of the various plate series. Priority has been given to the wide-field direct plates. The catalogues are presently Excel spreadsheets. As a catalogue is completed, it is posted on the Yerkes Observatory web page (`http://astro.uchicago.edu/yerkes/plates/plates.html`), from where it can be downloaded, searched or sorted.

Each catalogue includes a brief overview of the characteristics of the plate series: telescope used, range of dates of the exposures, plate scale, etc. Information listed for each plate includes the plate number, date and time of exposure, object (if given), right ascension and declination of the plate center, exposure time and physical size of the plate.

Catalogues of the following plate series have been completed and versions of the spreadsheets are now available on the web page:

(1) 3850 "Barnard" plates, taken in 1897–1934 (mostly by E.E. Barnard) with the Bruce Telescope. Most cover a $12^o \times 12^o$ field with limiting magnitudes to about $m_{pg} = 16$.
(2) 1425 plates of comets and comet fields taken in 1893–1924 with the Bruce Telescope. These cover the same sky area as the Barnard plates, but many have trailed star images as the guiding was on the moving comet.
(3) Copies of 144 of the best plates taken by Barnard while at Lick Observatory in 1889–1895. Reproductions of many of these plates are in *Lick Publications, XI*.
(4) 1590 Yerkes Patrol Camera plates taken in 1916–1934. These cover a 20^o field.
(5) 2900 "Ross" plates taken in 1924–1929 by F.E. Ross and others with the Bruce Telescope. They have a $12^o \times 12^o$ field and a limiting magnitude of $\sim m_{pg} = 16$, and were taken as a second epoch for the Barnard plate regions.
(6) 850 plates taken in 1967–1997 with the Yerkes 41-inch reflector, and cover a field of $\sim 1^o$. Many are of globular clusters.
(7) 2900 plates taken in 1950–1962 with the Cook 10-in wide-field camera at McDonald Observatory. Most cover a $6^o \times 8^o$ field to $\sim m_{pg} = 16$.
(8) 900 plates taken in 1940–1978 with the University of Illinois 4-in Ross-Fecker camera. Most cover a $20^o \times 16^o$ field and about half reach to $m_{pg} = 16$.
(9) 550 plates taken in 1937–1947 with the Dearborn Observatory 10-in red camera. Most cover a $12^o \times 12^o$ field and about half are low-dispersion objective prism spectra.

Catalogues for the following Yerkes series are in preparation:

(11) FRy-series: 60 early plates taken by Ritchey with the 40-inch refractor in 1900–1904.
(12) F-Series: 750 40-in plates of star clusters and nebulæ, taken in 1900–1949.
(13) FP-series: 440 40-in plates of planets, taken in 1905–1928.
(14) O-series: 450 40-in plates of star fields, variable stars, M42 and novæ taken in 1905–1925.
(15) PN-series: 65 plates taken with the MW 60-in by Barnard in 1911 and 20 by Ross in 1931.
(16) TV- and 10H-series: 550 plates taken in 1936–1949 with the Bruce Telescope for photographic photometry.
(17) S-Series: 60 plates of star fields taken in 1904–1907 by Sullivan with a 6-inch lens.

For further information about the Yerkes plate collection, please write to the Observatory at 373 W. Geneva Street, Williams Bay, WI 53191, USA., or send email to W. Osborn.

COSMOS Fast Microdensitometer Preserved

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The COSMOS fast microdensitometer which pioneered the automatic digitisation of large Schmidt plates during the 1970s and 80s has been transferred from the Royal Observatory Edinburgh (ROE), where it was operated, to the National Museums Scotland, also in Edinburgh, where it will be preserved for posterity.

The development of techniques for the automatic extraction of information from Schmidt plates at the ROE did not start with COSMOS. Rather, it goes back to 1959, when a group under P.B. Fellgett fitted 'digitisers' to an IRIS photometer. The success of those early experiments led to the development of the fast scanning machine GALAXY (General Automatic Luminosity And XY), which became operational in 1967. GALAXY could record approximate image positions at a rate of 10,000 per hour, or measure precise positions at a rate of 900 per hour. It made possible programmes that required the automatic measurement of large numbers of images.

GALAXY was largely used for photometric programmes, measuring plates taken with 16/24″ Schmidt telescopes in Edinburgh or Monte Porzio Catone, Italy. A copy of GALAXY was subsequently built and installed at the Royal Greenwich Observatory, then at Herstmonceux in Sussex, where it was largely used for astrometry.

GALAXY was intended for use with relatively small Schmidt telescopes, and hence was only designed to analyse circular stellar images. During the 1970s the 48″ UK Schmidt telescope became operational. Plates from this more powerful instrument contain a mixture of galaxy and star images. To analyse such plates the COSMOS (Coordinates, Sizes, Magnitudes, Orientations and Shapes) measuring machine was developed, which could analyse elliptical as well as circular images. COSMOS cannibalised components from the original GALAXY as insufficient funds were available to build a completely new machine. In addition to being able to process elliptical images, COSMOS also embraced some significant improvements, such as faster scanning.

COSMOS operated from 1975 until 1993, when it was replaced by SuperCOSMOS, itself now decommissioned. During its nearly two decades of operation COSMOS undertook numerous individual research programmes and conducted several large surveys, most notably the COSMOS/UKST Catalogue of the Southern Sky, which included all UK Schmidt fields south of the equator and having an absolute Galactic latitude greater than 10°.

Following its retirement COSMOS was stored in an outbuilding, pending a decision on its final disposition. In 2012/13 National Museums Scotland accepted a significant portion of COSMOS into the National Collections, where is joins a major collection of obsolete material from ROE. This collection includes the Schmidt camera which took the early plates scanned by GALAXY. COSMOS is particularly valuable as an historical artefact because it contains much of the original GALAXY, and it is gratifying that it is now being properly preserved and curated.

Acknowledgements
I am grateful to Tacye Phillipson, Peredur Williams and Nigel Hambly for their comments.

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The Lick Observatory Historical Collections Project

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`http://collections.ucolick.org/archives_on_line/` has completed a preliminary catalogue of the complete collection of about 2,000 holograph observing and reduction books from the late-nineteenth to the mid-twentieth centuries. The books contain many records pertaining to plates in the observatory's large archive. The catalogue may be searched on line at `http://collections.ucolick.org/archives_on_line/search_ms.html`. Enquiries should be sent to `collections@ucolick.org`.

About 80 books (less than 5% of the collection) have been scanned and may be downloaded. We hope to add to that number gradually, eventually making all the most historically, scientifically, and æsthetically interesting volumes available.

Special thanks are due Project volunteers Andy Macica and Paul Bricmont for their work on the catalogue.

The NAROO Project
(New Astrometric Reduction of Old Observations)

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A Workshop organized by IMCCE at Paris Observatory on 2012 June 20–22 brought together 40 participants from 10 countries. The purpose of the workshop was to discuss the use of old data (especially photographic plates) in scientific research. The main interest was in astrometric observations of solar-system objects, since those bodies are moving relatively rapidly, and the quality of the dynamical models depends on data which have to be spread over a long interval of time. Old observations are still used for modelling the dynamics of solar-system objects, but the old positions as published at the time the plates were taken are not accurate enough for use with modern data and need a new measurement and a new reduction. The new reference star catalogue and the future arrival of the Gaia astrometric catalogue will make the reduction of old photographic plates possible with the accuracy of today: we will be able to observe in the past!

Several techniques for plate digitizing and methods of plate reduction were presented. Inventories of plate archives were also shown, and scientific results obtained using historic data were included.. The Workshop agreed to continue to collaborate on this topic. Its website is `http://www.imcce.fr/hosted_sites/naroo` . The Proceedings will be available soon, and may be requested by sending an email to arlot@imcce.fr.

Scanning projects are now in progress in the USA, China, Russia and Belgium. In France, we will build in Paris a centre for digitizing and analyzing plates, for both scientific and patrimonial purposes, using a high-accuracy sub-micrometric scanner.

“Schülerlabor Küstner” and the Bonn Plate Archive

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The Present Situation at Observatorium Hoher List

Observatorium Hoher List, the observatory of the Argelander-Institut für Astronomie, is located in the countryside 85 km south of Bonn; it was built between 1952–1954. In 1966 the double refractor (D=0.3m; f=5.1m/ D=0.4m; f=5.1 m) was moved to Hoher List and a new (D=1.0m, f=14m) Cassegrain telescope was installed. At that time the Cassegrain telescope was the largest optical telescope of the Federal Republic of Germany. Up to 2000, numerous scientific papers could demonstrate the active rûle of the observatory in the scientific community. However, since members of the Argelander-Institute are now more absorbed in projects that do not require optical observations, and especially because the telescopes of Hoher List are old fashioned and wanting renovation, the need of an on-site optical observatory has become less necessary. Hoher List Observatory was therefore closed in July 2012.

The Future of the Plates at Hoher List

Owing to the uncertain future of buildings and equipment at Hoher List, the plates are to be taken to the Argelander-Institut in Bonn. The collection consists of
- 9.000 plates from the (D=0.4m; f=1.3m) Schmidt telescope (taken between 1956–2000)
- 5000 plates of the (D=0.3m; f=1.5m) Astrograph taken between 1925–2000
- Spectra from the 1-m Cassegrain telescope, and
- Plates from other telescopes, and ‘orphan’ plates from various observatories.

For the next seven years, the plates will be stored in two rooms of the Argelander-Institut. A test of a possible scientific and didactic use of these observations has been started (Hapke 2007, Aretz 2009, Günther 2009, Enders-Brehm 2011). During the coming years small scientific projects based on those plates will be performed. The plate collection will also be organized and its future discussed.

Plates Taken by K.F. Küstner in Bonn

Bonn already possesses an archive of the plates from its double refractor, which was moved to Hoher List in 1966. The most valuable are 600 plates taken by K.F. Küstner (1856–1936), taken in Bonn between 1899–1922. Since Küstner took extreme care to attain high-quality observations, this collection is an optimal resource of first-epoch observations for proper motion studies (e.g. Odenkirchen et al. 1997, and references). As an indication of the quality of the plates: those taken by Küstner reach limiting magnitudes deeper than the corresponding plates from the Yerkes refractor! Although several scientific papers using old plates from Bonn have already been published, there are still first-epoch plates of some open clusters for which a new proper motion study is surely worthwhile. The accuracy of proper motions using Küstners plates reach values less than 1 mas/year, which is better than the proper motions from the Hipparcos satellite. The first-epoch observations have limiting magnitudes of 15 to 16.

”Schülerlabor Küstner” – a project to motivate young students

Recently, each year about 15 students of secondary schools ask for a practical course of two to three weeks in the Argelander-Institute. The provision of suitable tasks led to the founding of the ”Schülerlabor Küstner”. The general idea is to define small projects where young people may work with original astronomical data that have not used before by anyone. If possible, the results should be also useable for the scientific community. The basis of this Schülerlabor are the photographic plates from Hoher List and from Küstner'a Bonn plates. Another example is the collection of Lac OB1 association plates taken with the astrograph. There are over 100 plates of one field around the association Lac OB1, but which have scarcely been analysed until now. The determination of light curves of variable stars is an interesting didactic project for students. Since the plates were taken around 1970, these observations may be also valuable for the detection of period modulations in variable stars. As long as the Hoher List plates are available, they can be supplemented by more recent CCD observations. However, the most promising projects are those related to the plates of Küstner. For instance, we have selected about ten open clusters for which no or only moderate accurate proper motions are available. However, we now face the problem of extracting the magnitudes and positions of the stars.

Astrometry with commercial flatbed scanners

There is no doubt that the best method for scanning photographic plates is a professional measuring engine reaching positional accuracies of better than 1μ. However, such a machine seems to be out of reach for the Argelander Institute. We therefore decided at the start of the Schülerlabor Küstner to investigate commercial flatbed scanners. Vicente et al. (2007) have carried pout extensive tests to investigate the astrometric accuracy of inexpensive flatbed scanners. On the basis of their pioneering results we are following a strategy that uses flatbed scanners for a first analysis of the plates. Our next steps are:

- Learning about the astrometric and photometric precision which may be reached with different plates,
- Visualising possible scientific uses, and defining projects as testbeds for larger campaigns, and
- Finding a future storage place for the plates.

We outline here our first results from an investigation of the open cluster NGC 654. The cluster is very well separated from field stars, and we were also able to determine an absolute proper motion of the cluster.

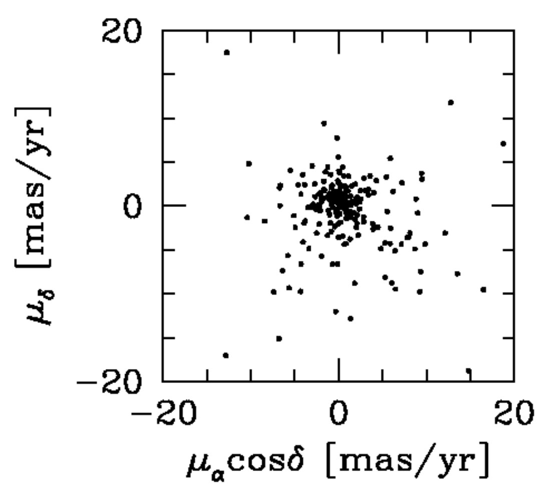

Figure 1: The Vector-Point-Plot diagram of the proper motions measured for stars of the open cluster NGC 654. Each point gives the proper motion of one star. The concentration near the centre of the diagram shows stars having the same proper motion; those ones are the most probable cluster members.

The results of Vicente (2007) have shown that for an inexpensive flatbed scanner there are large differences between the accuracy of the X and Y coordinates. We would also expect magnitude effects when using not professional measuring engines. We therefore scanned each plate in four orientations and used only the more accurate X-coordinate measurements. Bearing in mind that a fourfold measurement of each plate would be unacceptable for a larger scan project, we were able to reduce the error of such a measurement within a limit of squares of 3×3 cm to $< 2\mu$. Combining the data of three plates from Küstner in 1915 and 1916 with recent CCD observations from Hoher List Observatory we obtained proper motions of the order of 1 mas/year.

Acknowledgements

We thank the staff of Hoher List observatory (Mr. and Mrs. Polder, Mr. Saxler, Mrs. Schmitt, Mr. and Mrs. Willems) for their continuous support in preserving the plates. Schülerlabor Küstner is a school-project within the framework of Physikwerkstatt Rheinland. Financial support of the ZdI (NRW-Project "Zukunft durch Innovation") is gratefully acknowledged. I thank Drs. Tsvetkov and Tsvetkova for stimulating discussions.

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Digitizing Spectra at the DAO

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A noble start has been made towards digitizing the 110,000 photographic spectra of the DAO's plate archive. A dedicated, upgraded PDS is kept busy most of the day, and a second similar machine is being upgraded to match. The files of scanned spectra are calibrated in both wavelength and relative intensity via a semi-automatic pipeline, giving 1-D spectra in units of linear relative intensity that are then uploaded to the CADC website in FITS format. The hand-written observing log-books are also being keyed in. Both the log-books and the current catalogue of scanned plates can be queried at the DAO Science Archive:

`http://www.cadc.hia.nrc.gc.ca/dao/pa.html` .

We can also negotiate the digitizing of any non-DAO plates that you send to us. The website gives the relevant contact information.

Obituary: Herbert Loebl

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Dr Herbert Loebl died on 28 January 2013 at the age of 89. He was one of the co-founders of Joyce, Loebl & Co. who designed and manufactured the eponymous microdensitometers that were common in astronomical observatories and university departments in the 1960s and 70s.

Herbert Loebl was born in Bamberg on 18 April 1923 to a family of Jewish extraction and in 1938, aged 15, he was sent to Britain, where he was later joined by his immediate family. He was interned during the war, but afterwards took a degree in Electrical Engineering at King's College, Newcastle (now the University of Newcastle).

In 1951 he co-founded Joyce, Loebl & Co. with Captain Robert Joyce, who he had met as a fellow-student at King's. Initially the firm had capital of £200 and premises underneath a railway arch. It produced a variety of precision scientific instruments, including optical microdensitometers. The firm thrived and soon had hundreds of employees and was exporting worldwide. In 1960 it was sold to an American buyer, but Loebl remained as Chairman for many years. Currently there are four companies in the Newcastle area descended from Joyce, Loebl and numerous other related businesses.

Later in life Loebl returned to Newcastle University to gain an MSc and PhD. He was also a strong supporter of the University's Business School. He funded the founding of, and was then actively involved in the Herbert Loebl Export Academy within the school, with a remit promote exports. Dr Loebl was awarded an OBE in 1973 and was the recipient of numerous other awards.

A more detailed obituary was published in the *Daily Telegraph* for 5 February 2013:
`http://www.telegraph.co.uk/news/obituaries/9848478/Herbert-Loebl.html`.

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ACTION REQUIRED!

In order to justify its existence as an IAU Working Group that has an undeniable potential for modern science, PDPP needs to assemble a bibliography of recent publications that describe results which could *only* have been obtained by accessing heritage data. Sergio Ilovaisky (sergio.ilovaisky@oamp.fr) has kindly offered to manage the list, so please send your contributions to him right away. "Recent" means dating from the years when plates were no longer the routine detector.

When we prepare the Case as to why PDPP should remain in IAU Commission 5 (Astronomical Data and Division B) and not be sent to History (Commission 41 and Division C), we will need to be able to point to as long a list as possible of publications that justify the value of past data for modern science. The future of the PDPP is therefore in *your* hands!

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