Reports from the Sub-Sections of the Working Group

a): Sky Surveys and Patrols

In common astronomical terminology, *Sky Surveys* refer to observational programmes which aim at the *one-time recording* of a (significant) part of the sky, by (deep) direct or spectral exposures in different wavebands. The famous Palomar Observatory Sky Survey (POSS I) which covered the sky between declinations $+90°$ and $-30°$ is a typical example of this kind of work, although nowadays the term 'Sky Survey' is also used for radio-, IR-, X-ray and γ-ray programmes. Sky surveys are powerful tools when searching for particular types of astronomical objects, selected by morphological, colour or spectral criteria.

Sky Patrols are special surveys, which aim at covering a large part of the sky at *regular and frequent intervals*, in order to provide a continuous record of the sky and to document changes. Here, the long-term Harvard and Sonneberg Patrols first come to mind, each of which has produced several hundreds of thousands of photographic recordings. Because of the need to cover very large areas in a short time, patrols have been less deep than surveys, but have also led to innumerable discoveries, in particular of time-variable objects, such as minor planets, comets and variable stars. Sky Patrols also allow the investigation of objects retrospectively, for instance to learn how the luminosity of a recently discovered quasar has changed during the past century.

Sky surveys and patrols have eternal value, because we can never repeat an astronomical observation under completely identical circumstances: the epoch will always be different. By doing this kind of research, we pass on to future generations of astronomers an immense treasure of data, of which certain parts are bound to become very useful some day. However, we of course do not know which parts and for this reason, it is desirable that the data are as 'clean' as possible and they must in any case be extremely well documented and, wherever feasible, well calibrated.

It is exactly this unique mission of sky surveys and patrols that renders that type of work so valuable. To some it may appear rather monotonous, but experience shows that not only do the involved astronomers reap a bountiful harvest of discoveries now, they also do a great service to all our successors in the near and distant future. Just think about some of the labour-intensive surveys/patrols of the past, for instance the great Bonner Durchmusterung of the 19th century, which now provides an excellent check on various astrometrical measurements, or, to go further back in time, the careful record of historical supernovae and novae, collected over centuries by visual sky patrols in ancient China.

Clearly, it is our moral duty and in our own interest to continue such a tradition and to ensure that this kind of long-term work will not be forgotten amidst the natural enthusiasm for spectacular observations of one-time astronomical events and peculiar, individual objects. It must be admitted, however, and I think that it is quite understandable, that many younger astronomers are rather reluctant to embark upon this type of project at an early point in their careers!

We have at this moment arrived at a new crossroads in the development and execution of sky surveys and patrols. On the one hand, we master the art of producing the deepest possible sky surveys, witness the efforts in the USA and Japan

in the north, and in Australia and Chile in the south. The progress is impressively demonstrated when comparing the first Palomar Survey (POSS I) with its successor, POSS II, now being produced. On the other hand, it is sad to record that recently the Harvard patrol was discontinued and that most probably also the Sonneberg patrol will soon be stopped, after many decades of continuous action. In both cases the decision seems at least partly to have been caused by the opinion of the respective funding authorities that the ever sparser funds may be better used than to support operations with well-tested, but no longer very modern equipment at less-than-optimal sites.

But this should not lead us to believe that sky patrols are no longer needed! On the contrary, I am convinced that the time has now come to reconsider this basic area of observational astronomy, in terms of instrumentation and strategy.

Enter the quantum efficient, but still rather small CCDs. How and when will they take over after the photographic plates which have been the unsurpassed detectors during more than 100 years of astronomical sky surveys and patrols? I have attempted to give a partial answer in a recent article (ESO Messenger, **65**, 45; September 1991), which was based on a talk given at the October 1990 meeting of the former IAU WG on Photography and to which the reader is referred for more details.

Briefly, I do not think that the time has come yet to equip the large Schmidt telescopes with CCDs. Even the biggest CCDs are still so small that a change would rob the Schmidt telescopes of their unsurpassed ability to produce high resolution imaging over a very wide field — and hence their usefulness for deep surveys.

However, I could imagine that it would now be reasonable to consider a rebirth of sky patrols, based on mosaics of large CCDs in medium-size, e.g. 2 m telescopes, since for this type of work, a somewhat lower angular resolution seems acceptable. Such 'patrol telescopes' would be fully dedicated to sky patrols in order to be efficient and reach the faintest possible limiting magnitudes. Two telescopes at the best possible sites, one in the North and one in the South, could patrol the entire sky down to the quite faint magnitudes, say once per month. This would secure a lasting record of the sky and, if powerful on-line reduction facilities are also set up, at the same time provide unequalled opportunities for discovery of 'interesting' objects some of which would then be further observed with larger telescopes, including those of the new generation of giants, the Keck, the ESO VLT, the Japanese 8-m, and possibly others.

I note in this connection the recent surge of interest in search programmes for Near-Earth Objects, as demonstrated by various new undertakings like the — for some time very active and successful — Spacewatch facility in the USA, the recent San Juan Capistrano Workshop sponsored by NASA, the Workshop NEO-91 in Saint Petersburg (formerly Leningrad) in Russia, the creation of IAU and NASA Working Groups on NEOs, and the plans for a dedicated European NEO search facility.

However, the NEO search techniques may not be optimally suited for full-sky patrols and there is of course always the critical question about how the enormous amounts of recorded data will be archived. This is a major problem in all current CCD work. But even if NEO facilities may be too special for sky patrols, it will clearly be very useful to establish close links with this community and to see how the various observational needs can best be taken care of.

The above thoughts are provisional only and serve to call attention to what I perceive as a compelling need for action. There may be different ways to proceed, and this theme will undoubtedly be further discussed within the WG on Wide-Field

Imaging.

In the meantime, I would be interested in receiving opinions from all interested persons, especially from the WG members. Are we ready to consider restarting regular sky patrols by means of wide-field, dedicated CCD telescopes? If so, which kind of telescope? What kind of CCD and in which configuration? To which limiting magnitude? Are there any groups or observatories who would like to embark upon such a project, or at least to carry through an first appraisal of the technical and organisational problems?

I look forward to your reactions!

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b): **Photographic Techniques**

1 Introduction

I am very pleased to find that the interests of the astronomical photographic community have been incorporated into the Wide-Field Imaging Working Group. While the remit of 'Wide-Field Imaging' does not completely embrace all of photographic astronomy, this Group covers all the most active areas and is broad enough to include most applications of photography in our science. More important, the Group provides a potentially lively and conspicuous forum for those of us who believe that photography has something unique to offer the astronomical community. It is up to us to display our wares and exchange ideas.

So why should we persist with photography in the age of the CCD? It turns out that there are many reasons. The photographic emulsion is a detector with a DQE of a few percent over sensitive areas that are measured in large fractions of a square metre. This sensitive surface has astonishing uniformity and is covered with pixels that are small compared with those of most CCDs. Not only is this remarkable detector readily available, but it is relatively inexpensive and most existing telescopes are equipped to use it without modification. As well as being a rich source of scientific discovery, both serendipitous and statistical, the photographic plate is an excellent storage medium. Almost incidental to its scientific rôle, photography is able to produce pictures that are exciting to look at, a characteristic that other solid state detectors have yet to match.

Given these properties, it is not surprising that photography is extensively used for wide-field survey purposes, and a detailed discussion of its problems and potential compared to CCDs has been given by West (1991). A broader view of the future of astronomical photography and the reasons for its present state has been presented by Malin (1988).

2 New Activities

It was reported by Ken Russell (UKST) at the 'Digitised Optical Sky Surveys' meeting in mid 1991 that experiments with Tech Pan film based material in the UK Schmidt had proved very promising, at least from the image quality point of view, though this improvement is not obvious from simple inspection of the original films. It is evident that Tech Pan has considerably better spatial resolution and finer grain than the widely-used IIIa emulsions. These improvements come at almost no extra cost in exposure time and the contrast is about the same as IIIa-F. The initial tests imply that in good seeing, IIIa emulsions in the UK Schmidt are probably undersampling the image, and that the DQE of the film-based material must be considerably higher than the similarly sensitised IIIa-F.

The possibility of using this improved film-based material for Schmidt surveys (e.g. see the article by Phillipps and Parker in this newsletter – Ed.) immediately raises some interesting questions, some of which I hope the Working Group will be able to address. These are concerned with its spectral sensitivity and with the mechanical problems of using a film-based product.

The astronomical community acquired a new passband with the introduction of the IIIa-J emulsion 20 years ago. Though this emulsion revolutionised astronomical photography, an unwanted side-effect was that the long established B and V

passbands languished, with only the older, relatively coarse-grained emulsions being available in the O and D sensitizings on which the B and V passbands were based. Tech Pan offers yet another passband, strongly peaked around 656nm, reflecting its origins as a solar flare patrol film. The Working Group must consider if the improved imaging properties of Tech Pan justify asking the manufacturer to make O, D or F sensitizings with Tech Pan-like imaging properties.

The second problem concerns the use of a film-based material at the strongly-curved focal plane of the large Schmidts. Persuading film to comply with this surface introduces non-uniform deformations which may not recover fully in the way that glass does, with obvious consequences for astrometry. Tests are planned to assess the seriousness of this problem.

One of the things that digitisation of images makes possible is the ability to combine many plates of the same field with consequent improvements in the signal-to-noise ratio. This is especially valuable where many plates of the same field already exist, as is often the case with Schmidt surveys. Similar image addition of large areas can be done more quickly in the darkroom, but the photometric information is lost in the output. Tests are about to be conducted which are intended to compare photographic and digital addition of identical plates. It may be possible to take advantage of the speed of the photographic approach and then recover the photometric information by digitising the final combined photographic image.

These activities underline the value of a group that brings together workers in all these areas. No doubt recipients of this Newsletter will have their own views on topics to be discussed and I would be delighted to hear from them.

References

[1] West, R.M., 1991. *ESO Messenger*, Issue **65**, September 1991, 45-50.

[2] Malin, D.F., 1988. In *'Astrophotography', Proc. IAU Photographic WG meeting Jena 1987*, pp. 2-20, ed. S. Marx, Springer-Verlag, Heidelberg.

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c): Digitization techniques

The past 10–15 years have seen considerable advances in the large-scale digitisation of photographic plates, which previously could only be digitised in very small parts or measured very tediously (and subjectively) by eye. It is good to see that there are now several groups around the world (or at least very soon will be) with the capability of systematically digitising the photographic sky survey material. Also, we can now realistically anticipate the availability of large amounts of this digitised material, as evidenced by the plan of the STScI to distribute the scans obtained under the Space Telescope Guide Star programme as well as the plans of the APS and COSMOS machine groups to release their catalogues of the Northern and Southern sky respectively.

With these large digitisation programmes, we are now at last gaining access to quantities of data hitherto undreamed of. Detailed studies of Galactic structure have been made possible, as have quantitative studies of the large-scale structure of the Universe from (for the first time) purely objective measurements of the distribution of galaxies and clusters. The second epoch sky surveys now well underway will allow other far-reaching studies to take place, such as the kinematics of the Galaxy and the halo system of star clusters and satellite dwarf galaxies, studies of the faint end of the stellar luminosity function and searches for brown dwarfs.

Some groups have demonstrated the possibility of digitally co-adding photographic plates, and we now see the very real promise of pushing photographic Schmidt material to magnitudes as faint as B$\sim$ 25 (see the article by Hawkins in this Newsletter). Experiments with the use of fine-grain film on wide-field telescopes has shown that we have not yet reached the limit attainable with photographic material and provides further scope for new sky surveys based on these emulsions. Obviously, while we continue to use photographic materials for sky surveys, we continue to require digitisation devices and we must strive towards as accurate extraction of the information contained on the photographs as possible.

Digitisation of the photographic sky survey material is at the present time a very active field (as witnessed by the very important contributions presented at the 1991 conference in Edinburgh on 'Digitised Optical Sky Surveys'). Even if in the coming years the photographic medium is superceded by the use of CCDs for undertaking sky surveys, there is still a considerable wealth of information in the 1st and 2nd epoch sky surveys which must be extracted and made available as a legacy for future generations of astronomers.

I would like to hear the views of readers of this Newsletter. The questions I would like to raise are:- what should be digitised? do we only need to digitise the whole sky in a single passband for a single epoch, and only require multi-epoch, multi-colour scans for a small representative area? or should we digitise the entire sky survey material? should we digitise the objective-prism plates? should we digitise all of the good quality plates from all of the major Schmidt Telescope archives? Please, let me hear your views!!

Obviously, the enormity of an undertaking for bulk digitisation will mean that it is not practical for any single group to take the entire task upon itself. Local scientific interests of each group may drive them to scan a subset with a particular scientific

goal in mind. I hope that we can set up some form of (informal) coordination of the digitisation activities. At the very least there should be exchange of information on scanning plans, and this has already been instituted through the meetings of the 'DOSS' community which will continue under the wider Working Group.

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d): Archival and Retrieval of Wide-Field Data

As organizer of the IAU WGWFI's sub-section, 'Archival and Retrieval of Wide-Field Data', I am writing this first newsletter piece to ask our membership for their views on the programs of the sub-section. I regard our challenge as the identification of areas in which IAU-sponsored communication or even collaboration will advance our work, while simultaneously avoiding those topics in which formal structure will contribute little (and may actually inhibit) to good work at individual sites.

One may usefully regard our archival concerns as being motivated by two rather distinct types of data,

1. wide-field pixel data, and

2. catalog data.

At the last Digitised Optical Sky Surveys workshop (Edinburgh, 1991), we heard about a number of programs, both pilot projects and fully developed ones, addressing various aspects of each area.

The active approaches to the matter of wide-field pixel data involve full-plate scans, cutouts of identified images, and image compression on full-plate scans. It seems that each addresses a specific need and will be used by some investigators in the next several years. As the field matures, we may reasonably expect to need to exchange data in these formats; and this raises the issues of standardization. Regrettably, my expectation is that we already have one file format per data type per institution. Perhaps the situation is already too advanced to do much standardization, but if there is sufficient interest, the topic should be explored. As far as I can tell, the only common practice at present is a loose adhesion to FITS (without much thought about the keywords) as an exchange medium.

The storage of catalog data is an area where we are likely to see rapid progress in the next few years. Presently, small catalogs (10^5 to 10^6 objects) are well supported with powerful access tools, e.g. the SIMBAD facility, while larger ones (10^7 objects) are supported in accessible but less convenient ways with catalog-specific tools and structures. However, the situation is less clear for the larger catalogs (10^8 to 10^9 objects) which are currently under development at several institutions. How are we going to store them? to access them? to distribute them? Several promising ideas in various stages of development were reported at the DOSS workshop. At the minimum, we should use our facilities to give these efforts an appropriate level of informal visibility.

Comments on these topics before the end of February will be especially useful in preparing for the first meeting of the WGWFI's organizing committee in April, 1992. My E-mail addresses are scivax::Lasker (SPAN), lasker@stsci.edu (internet), and lasker@stsci (Bitnet/Earn).

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