THE SECOND PALOMAR SKY SURVEY

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1. INTRODUCTION

The Carte du Ciel was the first photographic survey of the entire sky, extending to 15th magnitude in the blue "photographic" passband. The first Palomar sky survey followed in this tradition, covering the sky north of $\delta = -30°$ to a limiting magnitude of $\simeq 20$ in both blue and visual/red wavelength ranges, while the Whiteoak extension added the fields to declination $-42°$ in the latter color. In the thirty years that have elapsed since the completion of the original survey there have been substantial improvements in emulsions and sesitization techniques, as well as an increase in the wavelength range accessible to photography. These techniques have been ably exploited by the UK Schmidt telescope, and a cursory comparison between anv UKST IIIaJ plate and an original POSS 103a-O photograph highlights the considerably improved depth and resolution of the southern survey. We have, therefore, embarked on a second Palomar survey, POSS 2, in an effort to redress the balance. This paper outlines the progress made to date and go on to describe some of the scientific programs that are planned.

2. POSS 2 - THE STORY SO FAR

Undertaking the new survey demanded the renovation of many of the facilities associated with the 48-inch Schmidt. Preparations started in 1980, but most work had to await the delivery of the new corrector in early 1984. The darkrooms and hypersensitizing equipment were modernized, which effectively entailed completely reconstructing much of the Schmidt building. The original equipment was designed for baking plates, rather than dealing with the hydrogen soaking or, for IVN plates, $AgNO_3$ sensitizing that modern emulsions require. In addition the telescope itself was given a complete overhaul and, most important, the new achromatic corrector fitted, allowing the survey to

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be extended to infrared wavelengths. Although simply described, these modifications involved a substantial investment of time and effort by the Palomar mountain staff.

Plate-taking for the new survey started in mid-1986, interspersed with periods of engineering work on the telescope. There are, in fact, three surveys underway - in the blue with IIIaJ emulsion coupled with a GG385 filter; in the red with IIIaF and RG610; and in the photographic infrared with IVN and RG9. The last of these has only recently been started. To date we have accumulated 89 J and 52 F plates of acceptable quality.

Apart from the considerably improved sensitivity and resolution, a major difference between POSS 1 and POSS 2 is that, following the example of the SRC/ESO surveys, the new survey will be taken on field centres separated by 5 degrees, rather than the 6 degrees of the old survey. This increases the number of northern hemisphere fields to 894, including 72 in the 0 degree declination zone. The new survey only extends to $\delta = 0°$. There have also been several what might be called environmental changes since the 1950s. First, despite the considerable cooperation of San Diego and the other surrounding cities, there is the slow deterioration of the night-sky at Palomar; second, the proliferation of artificial satellites passing over North America; and, finally, the considerable increase in the number of light aircraft in southern California. These last have been responsible for the rejection of more than 30 plates.

The merits of the new survey can be seen clearly in comparing some of the most recent plates with their counterparts in POSS 1 (see figure 1, which shows the spiral galaxy UGC 6144). Calibrating these exposures using CCD frames taken on the Palomar 60-inch telescope, the limiting magnitude for detecting stellar images is typically 22.5 in J and F and $\simeq$19 at I.

3. SCIENTIFIC EXPLOITATION OF POSS 2

One of the most important functions served by the Southern UK Schmidt survey has been the provision of finding lists of candidates for follow-up investigation with large telescopes. Such studies fall into two categories - searches for very rare objects, which are then subjected to detailed scrutiny; or statistical investigations of the average properties of a particular class of object. Obviously the construction of fast, accurate plate-scanning machines has greatly eased the logistical problems involved in undertaking such surveys. With the advent of very large telescopes in both terrestial hemispheres and Space Telescope, the importance of this preliminary sifting of the data increases. One of the prime selling points of the large reflectors is their ability to study very faint objects. It is important, therefore, to locate interesting objects worth studying.

Besides providing an encyclopaedic reference for many scientific projects, the plate material acquired for the new survey will, by itself, form the basis for numerous investigations. Amongst the most exciting is the large scale proper motion survey that the thirty-year baseline between POSS 1 and POSS 2 makes possible. Luyten's work in

the 1960s demonstrated the power of such large-scale surveys in probing galactic structure.

Another subject which Schmidt surveys - either northern or southern - should help illuminate is the frequency, indeed the existence, of sub-stellar-mass brown dwarfs. These low mass objects evolve along evolutionary tracks that, at a given luminosity, lie at considerably lower temperatures (hence redder (R-I) colors) than the hydrogen-burning main sequence (D'Antona and Mazzitelli, 1985). The lower the mass, the larger the offset - but even the most massive ($0.07M_\odot$) scarcely exceed an effective temperature of 2800K, or an $(R-I)_C$ color of ≃2.15. This, then, points the way towards identifying these objects - combining IVN and IIIaF plates - and Hawkins (1986) has already started such an investigation with the UK Schmidt.

Predicting the number of brown dwarfs one expects to find in such a survey is essentially not possible, since the rate of evolution in luminosity depends critically on the mass, and the number of observable objects depends strongly on the shape of the mass function and the local star formation history. Star formation theory makes no firm predictions - rather, the observational limits obtained will constrain the theory.

Besides studies of our own Galaxy, the new Palomar survey will be well suited to searches for low surface brightness galaxies, which are being found with increasing frequency, and to examining the outer structure of elliptical and SO galaxies. The latter subject has received considerable attention since the discovery of shell or ripple-like features around what otherwise appear to be "normal" ellipticals (Malin and Carter, 1980). The improved sensitivity of POSS 2 will allow a more detailed survey of northern hemisphere galaxies.

Finally, one of the major achievements springing from POSS 1 was the Abell catalogue of galaxy clusters, which has formed the starting point for many studies of galaxy and cluster evolution. The additional depth of the new survey will permit the detection of higher redshift clusters and the extension of such studies to earlier epochs.

4. FUTURE DEVELOPMENTS

While the J, F and N surveys will clearly form the major preoccupation of the 48-inch Schmidt observations for the next few years, we can look ahead to two developments which may lead to other, perhaps more limited, surveys. The first is the purchase of a low-resolution objective prism for the Palomar Schmidt, well-suited to the identification of emission-line objects such as quasars and HII galaxies. Second, Kodak is currently developing new, finer-grain emulsions. Tests of one such emulsion show that it has significantly better signal-to-noise (at sky) than IIIa emulsions, although it has similar sensitivity, and should provide more accurate observations of low surface brightness objects. Further experiments with different hypering methods are underway at several observatories, and we can expect even higher quality plate material to become available in future years.

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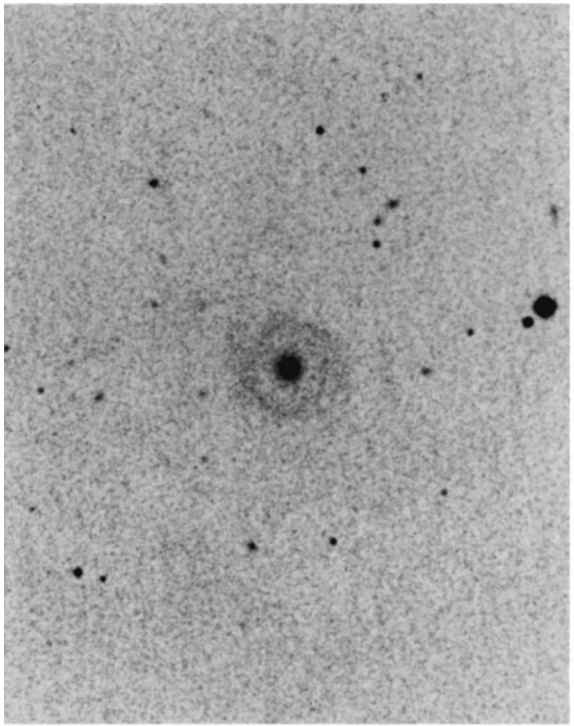

Figure 1a: The spiral galaxy UGC 6144 from the 103a0 emulsion POSS 1 plate.

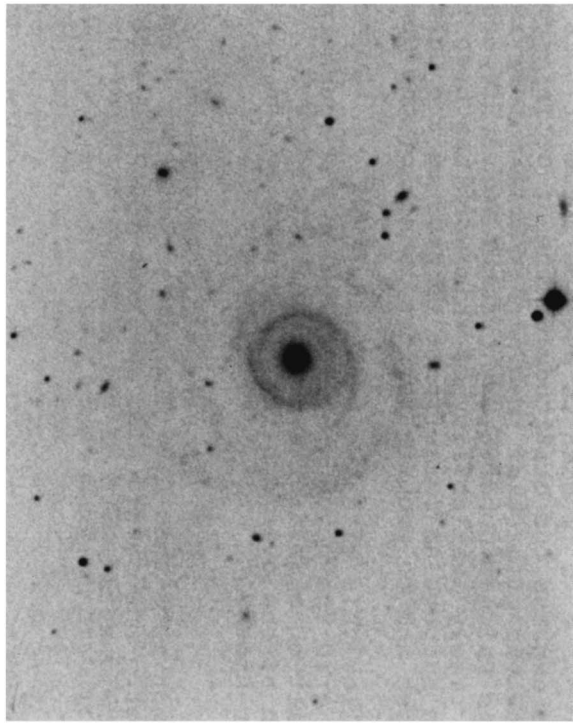

Figure 1b: UGC 6144 on a POSS 2 IIIaJ emulsion plate.

Discussion:

LASKER I wish to use the forum of this Symposium to express the gratitude of the Space Telescope community for the efforts of the Palomar Observatory in producing the Palomar Observatory Quick V Survey (epoch 1982). The timely availability of this work has been essential in supporting our efforts to produce the Guide Star Catalogue and to prepare for the launch of the Space Telescope.
If I may follow this with two questions,
1) Is your grid the obvious reflection of the southern centers, built on a grid of 1950 coordinates?
2) How much of the overlaps region is used by the sensitometer spots?
REID 1) Yes.
2) A very small percentage certainly, not more than 5%. The spots cover 5 x 5 cm in the SW corner. One should also remember that the spots are in the most vignetted part of the plate.

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