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Photographic Enhancement of Hα Films

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Abstract: The appearance of Tech Pan film in sizes that were useful in large Schmidt telescopes immediately offered new opportunities and advantages to users of Schmidt telescopes. Among the advantages were a spatial resolution that was well matched to the image quality produced by the optics of the telescope under the best conditions. For the first time such images were well sampled on Schmidt telescopes. Tech Pan was initially formulated by Eastman Kodak as a 35 mm solar patrol film designed to have enhanced sensitivity around the 656·2 nm Hα line. It is this feature, combined with the excellent imaging characteristics, that we seek to exploit with the new UK Schmidt Telescope (UKST) Hα survey. This paper briefly reports some preliminary comparative tests of Tech Pan with the new Hα filter at UKST and suggests ways in which data from the new survey can be quickly exploited using advanced photographic techniques such as photographic amplification. This simple contact copying process rapidly reveals extended low surface brightness features that simple inspection cannot.

Keywords: techniques: image processing — ISM: structure

1 Introduction

The advantages of photography as a detector in wide field astronomy are such that it continues to be used on large Schmidt telescopes, despite the advance of electronic detectors. These advantages primarily centre on the essentially unlimited area of the detector and excellent uniformity of detection over the whole focal surface. This is combined with ease of use, useful sensitivity to low light levels, high output signal-to-noise and relatively low cost (Parker, Phillipps & Morgan 1995).

2 Tech Pan Film

The most technically advanced of these photographic materials, Eastman Kodak's Tech Pan, has been in use on the UK Schmidt Telescope (UKST) since 1992. It has an effective pixel size of about 5 μm, well matched to the 15 μm/arcsec image scale of this telescope. The detective quantum efficiency of the optimally hypersensitised material appears to be about 10%, significantly higher than the comparable IIIa-F material used hitherto. These advantages come at no cost in terms of exposure time, which is essentially the same as optimally hypersensitised IIIa-F, but the resulting negatives show fainter stars and extended objects when exposures are limited by the night sky brightness. Such 'sky-limited' exposures are terminated where the subsequent developed photographic density due to sky is about unity.

However, the Tech Pan emulsion is only effective when coated on a film (Kodak 'Estar') base. Despite extensive testing (unpublished) at the Anglo-Australian Observatory, glass-based Tech Pan does not appear to respond well to hypersensitisation. This may be the result of the anti-abrasion overcoat applied to film-based products.

Though large-format plates have been available for many years, it was only when the film-based material became available in 1992 that Tech Pan could be considered for use on large telescopes. As a result, much effort has been expended to design a system that could effectively use a film-based material in a hypering system, telescope and processing line designed for glass plates. These difficulties have now been overcome and use of hypersensitised film with good hypersensitised speed is a routine procedure at UKST.

An important feature of Tech Pan is a legacy of its origins as a solar patrol film. The spectral sensitivity in a narrow region around 640 to 670 nm is considerably higher than elsewhere in the red part of the spectrum. This gives Tech Pan its excellent Hα sensitivity compared with the normal red-sensitive material used on Schmidt telescopes. This implies that a relatively narrow interference filter could be used to exploit this sensitivity enhancement and discriminate Hα from red continuum with practical exposure times. The excellent imaging properties of the film also contribute significantly to

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the usefulness of such exposures since star images under good conditions are very small. This is very important for the detection of extended emission in crowded Galactic Plane fields.

These features have encouraged us to undertake the first complete Hα survey of the Galactic Plane and the Magellanic Clouds (Parker & Phillipps 1988, present issue p. 28). To this end a large format Hα filter was

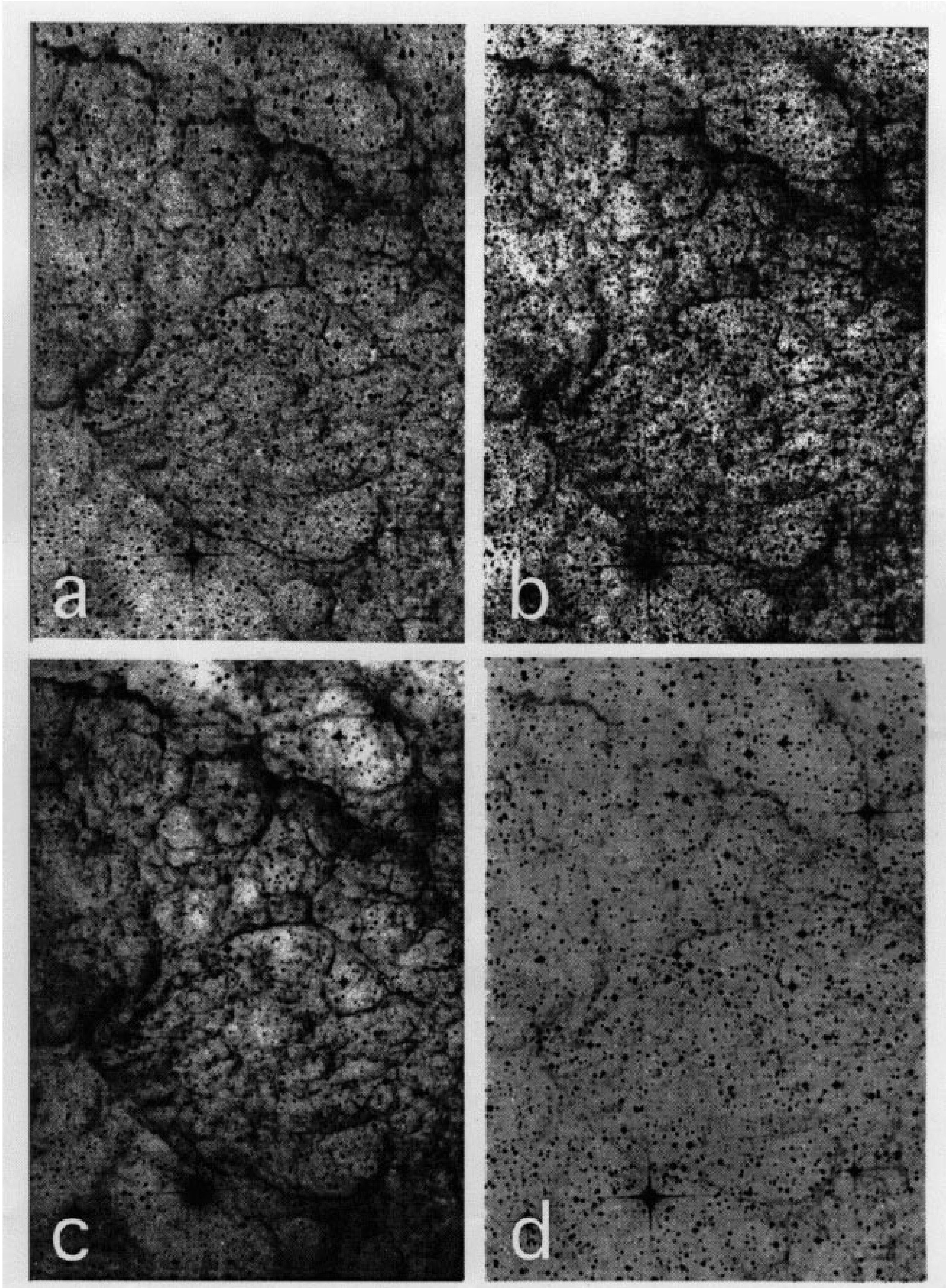

Figure 1—Enlargements of sections of UKST images of part of the Vela supernova remnant, with exposures made on 098–04, IIIa-F and Tech Pan emulsions. Parts (a), (b) and (c) are after photographic enhancement, while part (d) is as (c) but without photographic enhancement. Each image is about 20 arcmin high.

constructed by Barr Associates in the USA and first tests confirm that the filter–film combination works very well (Parker & Bland-Hawthorn, present issue p. 33).

In this short paper I will make some comparisons between Hα images taken on earlier generations of plates (and filters) and suggest ways in which faint emission features can be further enhanced against the sky background.

3 Photographic Amplification

Photographic amplification (Malin 1978) is a photographic enhancement process based on a simple,

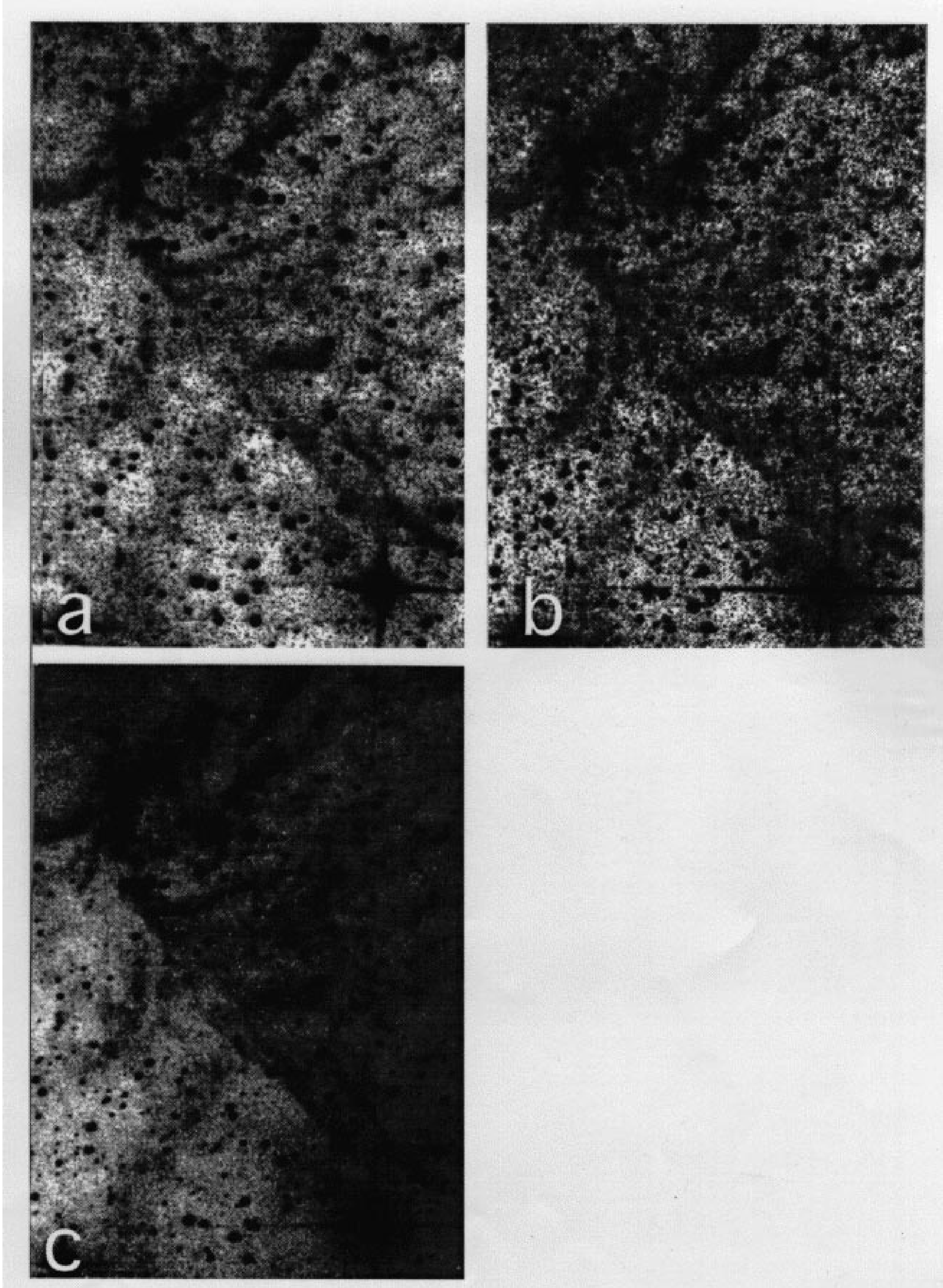

Figure 2—Further enlargement of the same plates used for Figure 1. Each image is $7\cdot5$ arcmin high.

non-destructive contact copying procedure. It is intended to emphasise extended features that are much fainter than the night-sky background. It has been especially useful in research on galaxies (e.g. Malin & Carter 1983), where features $5 \cdot 5$ magnitudes fainter than the sky are routinely detectable on sky-limited plates. The process works as well on Tech Pan film as on plate material. Its practical advantage is its simplicity and utility. Finished prints revealing faint features of large areas of plate can be available in less than an hour after receipt of the original processed plate (the process does not work well on copies). The process reveals features that are as faint or fainter than those derived digitally (Couch et al. 1984; Bothun, Impey & Malin 1991).

The value of a narrow-band filter, well matched pixel size and photographic amplification are well shown in Figure 1. Three of these four images compare photographically amplified derivatives from original UKST exposures of identical parts of the Vela supernova remnant. These enlarged images are made from a series of plates taken over more than 20 years.

Figure 1a shows an early unhypersensitised exposure on an Eastman Kodak Type 098–04 plate. This fast but coarse grained emulsion was exposed behind the Meaburn (1976) filter for 90 minutes. Stars and structured nebulosity are evident. In Figure 1b a sky-limited exposure was made on the successor to 098–04, type 127–04, later to be known as IIIa-F. This exposure was made on a hypersensitised plates with the broad-band RG 630 filter and an exposure time of 90 minutes. In Figures 1c and 1d we see the same part of the sky photographed with the new, narrow-band UKST Hα filter and Tech Pan, with Figure 1c being photographically enhanced, and with Figure 1d before enhancement.

Figure 1c shows the effect of the filter in eliminating much continuum from stars, while the imaging properties of the film ensure that the star images are small. This, combined with the good response of the film to Hα, allows the complex structure of the faint Hα emission to be seen much more clearly, revealing an evident 'billowing' appearance for the first time. It is also noted that the faint, diffuse emission in this part of the Gum nebula is recorded in the lower right (SW) corner of Figure 1c.

The importance of minimising the star image size through both filtration and small point spread properties is shown in the series of images in Figure 2, which follow the same sequence as Figure 1, but at an increased enlargement, and without the un-enhanced plate. Again, the decreased stellar background and finer grain allows much more fine structure in the emission nebula to become apparent.

4 Conclusion

The use of Tech Pan film with the newly-acquired narrow-band Hα filter on the UK Schmidt telescope will substantially improve the discrimination of emission nebulosity from stellar continuum. The detection of faint nebulosity is greatly improved if the exposed and processed films are copied using a photographic amplification technique. This process is very rapid and can be applied to a complete 356×356 mm film in one operation.

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