Recent UKST Experience with Kodak Tech Pan Film

1. Introduction

Kodak Technical Pan emulsion has been available since the early 1980s on a variety of substrates and formats from 35mm to large sheets, known variously as Types 2415 or 4415 depending on the thickness of the film base. Experimental coatings have also been supplied on glass as special product 153–01. In all cases the emulsion is believed to be essentially the same, though coating weights and overcoats may vary.

The sensitive material is an extremely fine grained, high resolution, panchromatic negative film with an extended red sensitivity which peaks at around 650nm, betraying its origins as a solar flare patrol film. This material has been widely used in the amateur astronomy community but has largely been ignored by the users of large Schmidt telescopes. In the main this was because samples of the on-glass material did not respond to normal reduction hypersensitization techniques and film-based products could not be readily accommodated in their large, curved focal planes. In addition, films of a size suitable for use in the UKST have only recently become available.

In this note we briefly review the important properties of this emulsion that make it so useful with small focal ratio telescopes and describe some recent results obtained with the UK Schmidt.

2. Properties

Tech Pan is a substantial improvement over the broadly equivalent, red-sensitive, IIIa-F emulsion on glass in almost all respects. The only situation where this is not true seems to be when the emulsion is coated on glass, where it responds very poorly to hypersensitization (hypering). This report therefore refers only to Tech Pan coated on 178μm thick polyester (Estar) base (i.e. Type 4415), which does hyper well.

The enhanced imaging properties of the film are the consequence of its extremely fine grain and its remarkably low granularity. Both properties are a factor of two improvement on the fine grain IIIa which were considered excellent in this regard. Tech Pan maintains contrast characteristics which are similar to the IIIa types. These essential factors combine to give a very high resolving power, ~320 lines/mm compared with ~200 for IIIa emulsions. The spectral sensitivity is also reasonably flat through the visible region, though it does not extend quite as far into the red as IIIa-F.

Unfortunately, these data (Kodak 1982, 1987) are not strictly comparable since they refer to different processing conditions, but are sufficiently convincing to explain the improved performance which is found in practice. Most surprisingly, these considerable advantages, which translate directly into significant scientific gains, are obtained with little or no increase in exposure time since the reciprocity failure of the optimally hypered emulsion is extremely low. Indeed, so promising is this material that a decade ago Heudier (1981) suggested that the DQE of this emulsion could reach 4–5%, which is a very high figure for a photographic detector.

Another major advantage of film is cost, which is about a tenth that of glass–based products, so there are substantial savings to be made from its wider use as well as the obvious transportation, storage and handling advantages of a film based material. We have also found that the hypering regime uses much less nitrogen than IIIa materials, again with useful cost savings. A further advantage is the large batch production mode of film coating, so we expect much smaller batch-to-batch variations than we find with Kodak spectroscopic emulsions on glass. All these properties have encouraged us to explore ways of using Tech Pan in astronomy.

3. The Use of Film in the UK Schmidt

The focal plane of the UKST corresponds to the surface of a sphere of 3.05m radius, so the film must be deformed by radial stretching to ensure good overall focus. The UKST plate holders are intended for glass plates, so a new holder had to be designed and constructed to accept film. This is now in regular use and exposures on Type 4415, 178μm thick Estar base Tech Pan film are now routinely obtained with excellent edge-to-edge focus. The polyester base itself is extremely stable, having excellent strength, toughness and flexibility properties (Kodak 1970).

Problems were encountered initially with hypersensitization since film based Tech Pan seemed to require much longer hydrogen soak than IIIa types and we were unable to hyper Tech Pan on glass at all. We now find that the long nitrogen pre-soak normally used for IIIa emulsions is not necessary, but that the material requires a much longer (or higher temperature) soak in hydrogen than is usual to reach an acceptably fast speed. Once optimised, however, exposure times are found to be

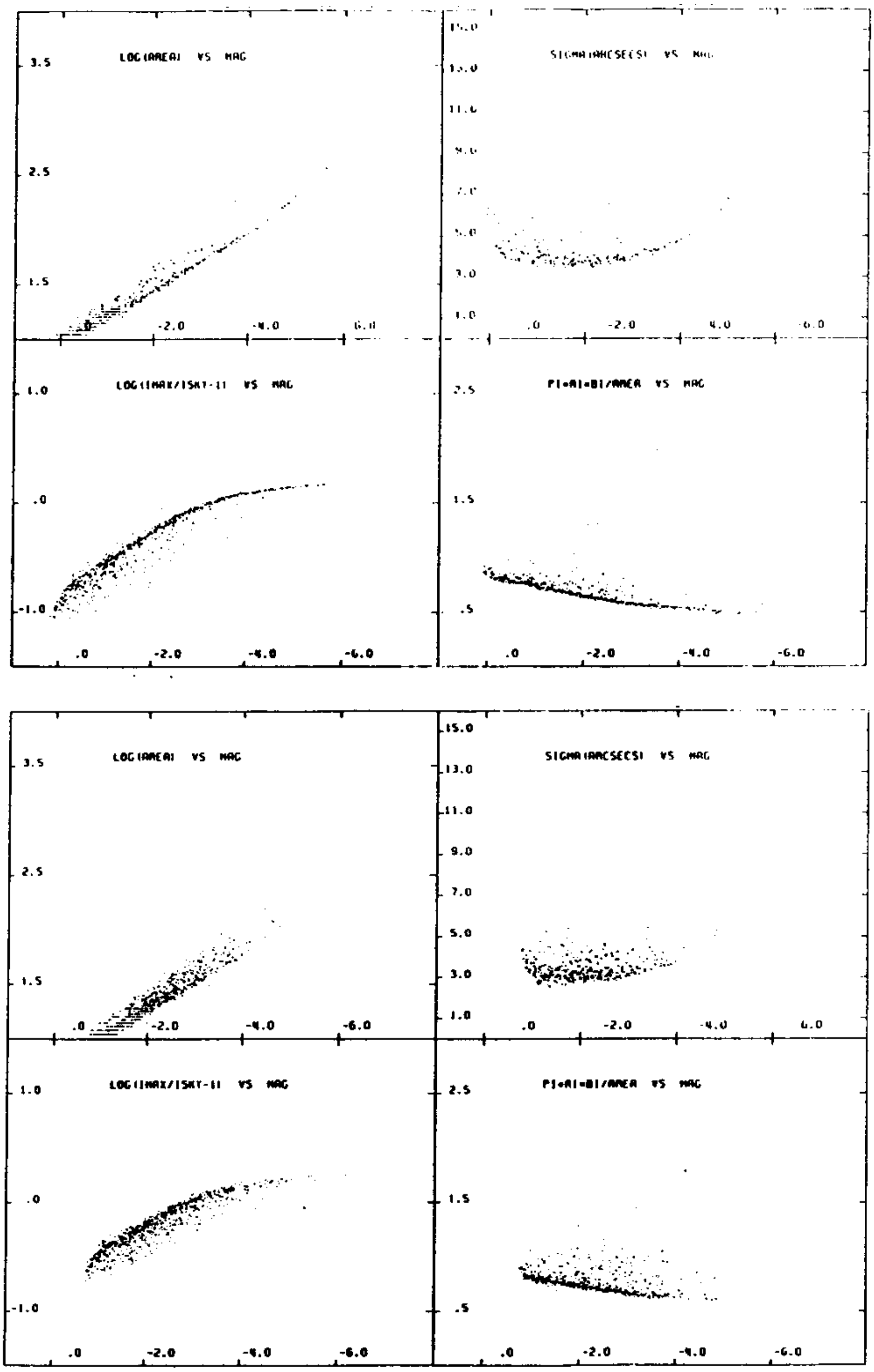

Figure 1.

comparable to the earlier generation of emulsions. Experience at UKST also indicates that hypered Tech Pan keeps for several months when stored at low temperature in nitrogen before any serious degradation in speed or fog-level occurs.

4. Recent Astronomical Results and Performance

To extract quantitative data from Tech Pan exposures they must be scanned with a measuring machine such as COSMOS, but qualitative tests also show that they respond well to photographic image enhancement techniques, as demonstrated by Russell et al. (1992). COSMOS data from recent scans of films indicate substantial information gains over IIIa-F. Examination of COSMOS quality control plots reveal no non-uniformities that can be attributed to the emulsion. COSMOS star/galaxy separation plots for Tech Pan data and an equivalent grade IIIa-F plate are given in Fig. 1. The difference is striking, with the stellar locus being extremely well defined and extending to fainter magnitudes than the IIIa-F. The enhanced star/galaxy discrimination should lead to much improved deep galaxy catalogues.

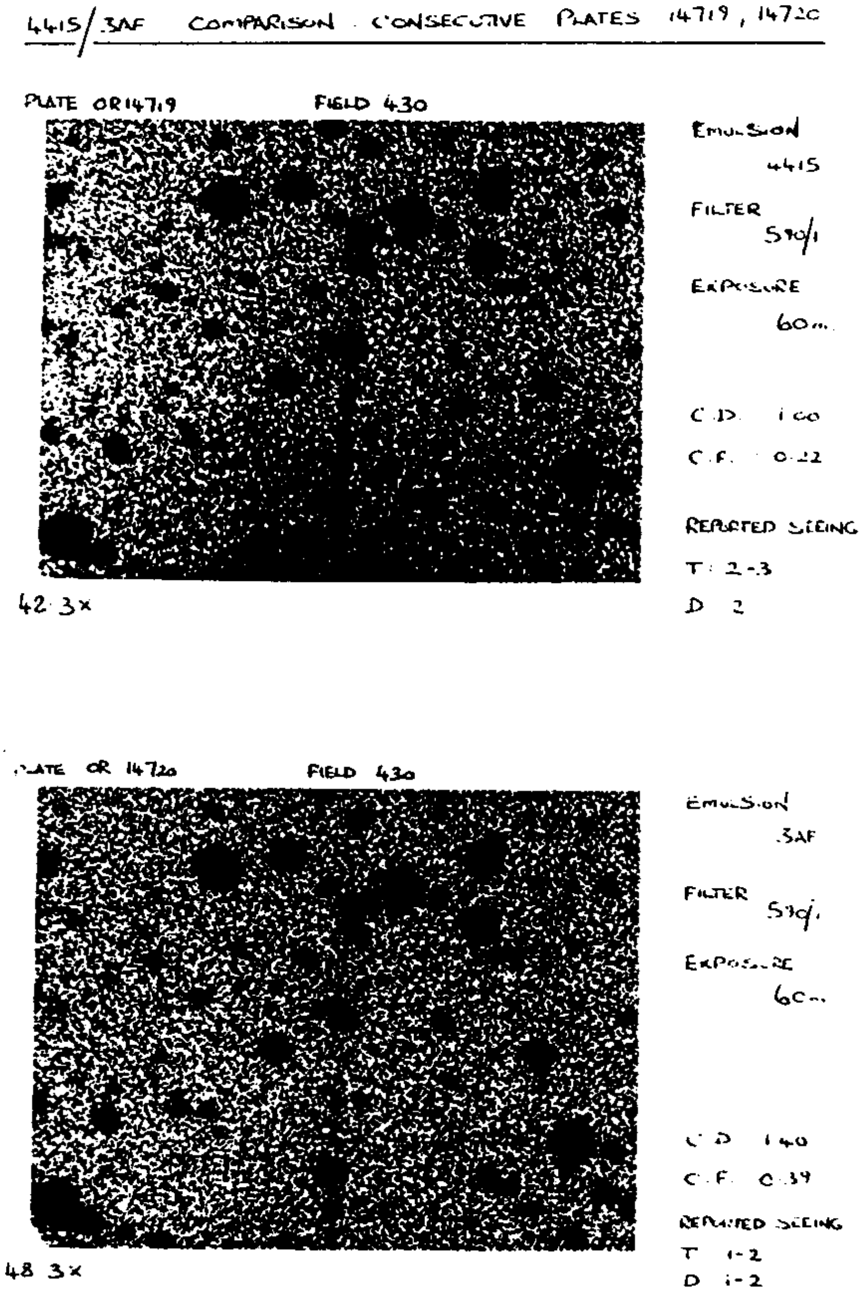

Figure 2.

Phillips and Parker (1992) have shown that low surface brightness galaxy intensity profiles obtained from COSMOS 8μm pixel mapping mode scans of Tech Pan film can reach 26.5–27 R magnitudes per square arcsec, corresponding to less than 0.4% of the sky background, and at least 1 magnitude better than IIIa-F. The sky noise per pixel was also ~0.8% so the observations are at least equivalent in depth to 5–10 minute CCD observations with the AAT but with the advantage of a wide-field and without any processing of the raw data.

The repeatability between COSMOS scans of two test films of the Virgo cluster was excellent, with galaxy profiles faithfully reproducing published profiles but extending to considerably fainter isophotes. These results indicate that Tech Pan exposures are likely to be excellent for faint galaxy photometry, and are able to detect fainter objects than on normal, survey-quality UKST plates. Finally, Fig. 2 provides a direct comparison between images of the same area of sky recorded with consecutive exposures on Tech Pan and IIIa-F. The sharp, faint images are seen against a very low noise background and amply confirm the promise of Tech Pan.

5. Conclusions and Recommendations

Provided a few simple procedures are adhered to there is every reason to expect that deep, low-noise, high-resolution astronomical photographs can be consistently obtained with Schmidt telescopes using Tech Pan emulsion coated on thick Estar base. Speeds comparable to optimally hypered IIIa-F are achieved if the hydrogen hypering is optimised and if the films are developed in D 19 for 8–10 minutes.

Because of its improved resolution, high contrast and fine grain the film clearly provides better image quality. This is evident in fainter isophotal limits, better contrast retention, higher photometric accuracy, increased signal to noise and fainter overall magnitude limits. These factors, together with the substantial cost savings and other substantial storage, handling and transportation advantages offer important new opportunities for small focal ratio, wide field optical telescopes.

An expanded version of this report will be published elsewhere.

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