Tech-Pan UKST Films: Some Preliminary COSMOS Data Comparisons

Summary

Following on from the reports in the previous WFA Newsletters on the introduction of Kodak Tech-Pan 4415 emulsion at the UKST (Phillipps & Parker, 1992a; Parker & Malin, 1992) we present some preliminary findings on object parameter comparisons obtained from pairing COSMOS machine scans of 4415 film and equivalent glass plate exposures in both the 'R' and 'U' photometric pass-bands. The results indicate that Tech-Pan 4415 can effectively replace IIIa-F 'R' and IIIa-J 'U' exposures for most purposes. The image properties are well behaved and there appear to be no serious film-plate colour terms or systematic effects between repeat 4415 exposures. The enhanced imaging properties and significantly reduced emulsion noise of Tech-Pan offers the opportunity for increased scientific gains. Concerns over the astrometric reliability of the 4415 estar-substrate also appear to be unfounded.

1. Introduction

Kodak estar-base Technical Pan 4415 emulsion is an extremely fine grained, high resolution, panchromatic negative film with extended red sensitivity. Although available for quite some time (Kodak 1981), and used successfully for many years by amateurs (e.g. Martys 1991), its use as a serious astronomical emulsion on large Schmidt telescopes has only recently been demonstrated (Russell et al. 1992; Phillipps & Parker, 1992a, b; Parker & Malin 1992; Parker 1992). This is partly because the technical difficulties of mounting large format film satisfactorily in the telescope with perfect focus (together with effective hypering and processing) have only recently been overcome. Tech-Pan film is now in routine use at the UKST for most follow-up exposures of transient phenomena and for increasing numbers of research applications aimed at taking advantage of the emulsion's better imaging capabilities and lower emulsion noise. To date, ~ 160 UKST exposures have been taken on 4415 emulsion since its first use in March 1991.

However, before a general switch to 4415 film from glass plates can be sanctioned for certain exposure types there is still a pressing need for more quantitative assessment of the astronomical image characteristics produced by 4415 film when compared with the more traditional IIIa-F and IIIa-J exposures. The integrity of object positions, photometry and other general properties must be demonstrated. This can be effectively achieved by comparing measuring machine scans of film and equivalent plate exposures. Phillipps & Parker (1992a, b) have already shown that the 4415 emulsion is excellent for wide-field, low surface brightness, galaxy photometry when COSMOS mapping mode data is used (a straight pixelation of the original film). Here we look at more general object comparisons through the use of COSMOS IAM data (image analysis mode data, MacGillivray & Stobie 1984) which produces parameterised object information.

2. COSMOS IAM Data Comparisons

2.1 Scanning the films in COSMOS

Due to their flexible nature, 4415 films have been mounted in COSMOS on glass backing plates using a water/glycerin interface and more recently using 'Nonane' which has a refractive index much closer to that of glass and is somewhat easier to handle than water/glycerin. These techniques have yielded excellent COSMOS data. A proper film holder for use with the forthcoming SuperCOSMOS machine is anticipated to get around the current time consuming film mounting process.

2.2 4415 — IIIa-F 'R' exposure comparisons

For this work, 4415 and IIIa-F 'R' exposures of ESO/SERC Survey Field 443 were scanned with COSMOS in IAM mode at 16 μm resolution using standard scanning parameters. Image deblending software was also employed (Beard et al 1990). Derived COSMOS RA and DEC values

were used to pair-up detected objects from each scan which are typically accurate across a field to within an arcsecond for glass plates. Top quality exposures with each medium are required to minimise the effects of seeing variations on the derived COSMOS image parameters.

Figure 1a gives a direct comparison of 4415 and IIIa-F 'R' COSMOS magnitudes of paired objects from Field 443. The IIIa-F data come from a COSMOS scan of an 'A' grade survey plate. The 4415 film exposure was also assessed to be of good quality. A 1-in-10 sampling of the paired data from across the entire field was used to produce the figure (~ 8000 objects plotted). As one would expect from the similarity between the 4415 and IIIa-F emulsion sensitivity curves (Kodak, 1987), there is excellent agreement between the calibrated 4415 and IIIa-F COSMOS magnitudes (given as magnitudes above the sky background) with no significant colour terms evident. A best fit regression line gives a gradient of 1.05 whilst the mean square deviation about the line is 0.11 magnitudes. No corrections of any kind have been applied to the COSMOS data.

2.3 Repeat 4415 OR exposure comparisons

Figure 1b is the comparison of the COSMOS magnitudes of paired images on two good quality 4415 film exposures of a field in VIRGO. Excellent consistency in the COSMOS data was found indicating no exposure–to–exposure systematic effects in the image parameters. The magnitude relationship is highly linear with the best fit regression line producing a gradient of 1.009 and a mean square deviation about the best line of only 0.049 magnitudes. This was achieved without the application of any zero-point offsets or other corrections. For all three 4415 films scanned from both the VIRGO and 443 fields, no magnitude or image area positional effects were found such as would be expected if there were any de-focusing in the film across the field.

2.4 4415 — IIIa-J 'U' exposure comparisons

'U' exposures at the UKST are normally taken with IIIa-J or IIa-O emulsions through the UG1 filter. Some test exposures have recently been taken with the UG1 filter and 4415 emulsion of ESO/SERC Survey Field 502 to try to take advantage of the superior imaging qualities and cheaper cost of the film. Unfortunately neither the film nor IIIa-J plate taken for the comparison were in good seeing. Nevertheless, COSMOS data from the matched U-film and U-plate gave very good agreement of general object properties. The crucial point for the 4415 'U' exposure is that, since the 4415 emulsion sensitivity extends to 690 nm (unlike IIIa-J), there were concerns about the severity of a red leak through the 4415+UG1 combination. COSMOS data of the equivalent IIIa-F 'R' survey plate was matched with the U plate and the reddest 3% of stars selected from an R, (U-R) colour-magnitude diagram. These red stars were plotted on a magnitude-binned $U_{plate} - U_{film}$ versus U_{plate} diagram in Fig. 2. The error-bars are the σ values associated with magnitude differences in each bin. The plot shows that there is no obvious difference between these red stars and all stars in the field thus indicating a negligible red leak. Furthermore, the small number of objects which appeared much brighter on the film than on the plate were found to be evenly distributed in colour in the colour-magnitude diagram. These are probably variables or image deblending errors.

3. COSMOS RA-DEC Positional Comparisons

Van Haarlem et al. (1992) have demonstrated that film copies made from glass positives retain essentially the same astrometric accuracy as the original plate. However, concerns have been expressed over the astrometric reliability of 'original film exposures' because of the effects of possible non-uniform deformations of the film when in the telescope. The thick estar-base on which the 4415 emulsion is deposited does have excellent toughness and rigidity properties (Kodak 1970) and our own experience at the UKST with using 4415 film exposures to provide sub-arcsecond positions for transient phenomena such as for comet Grigg-Skjellerup (Russell & McNaught — private communication) indicated that very good astrometry could be achieved. Tolerances of only 1.5 arcsec were necessary to achieve ~ 85% pairing success for the two VIRGO 4415 exposures down to the plate limit. The mean difference between derived COSMOS object RA and DEC co-ordinates from

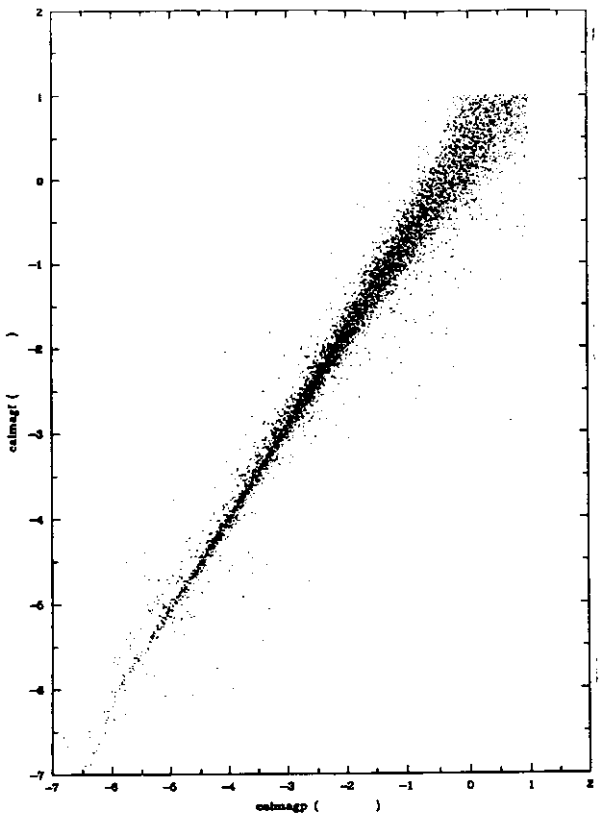

Figure 1a. F443 4415 – IIIa-F COSMOS magnitude comparison.

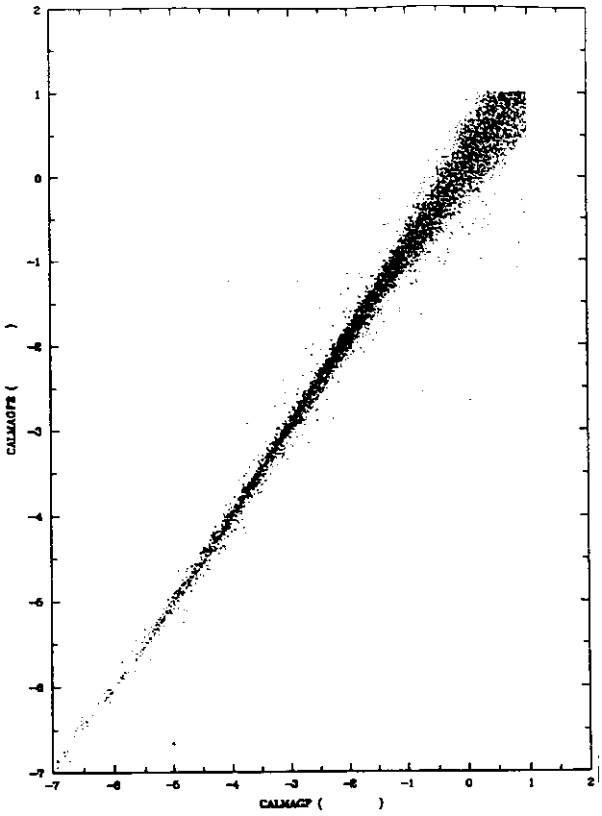

Figure 1b. VIRGO 4415 –4415 COSMOS magnitude comparison.

film pairs was only 0.125 arcsec with σ = 0.36 arcsec. This compares with differences of ~ 0.24 arcsec with σ ~ 0.67 arcsec from the 443 film-plate pair.

The article by Dafydd Evans in this Newsletter puts more stringent constraints on the film astrometry from APM scans of 4415 via a more sophisticated astrometric analysis. Without recourse to such sophisticated analyses the standard COSMOS RA and DEC positions obtained from fits to standard stars in each field provide agreement of object positions between plates and film to within 0.5 arcsec. This is more than adequate for most work.

4. Conclusions

The preliminary investigation outlined above indicates that COSMOS data obtained from 4415 film scans is sufficiently reliable and repeatable to replace COSMOS data from IIIa-F 'R' and IIIa-J 'U' glass plate exposures in most instances. The superior imaging properties of the emulsion, the very low noise and the speed of the hypered product give significant information gains over the IIIa-equivalent exposures and should yield new scientific results. A more detailed description of the work outlined above is being prepared for publication.

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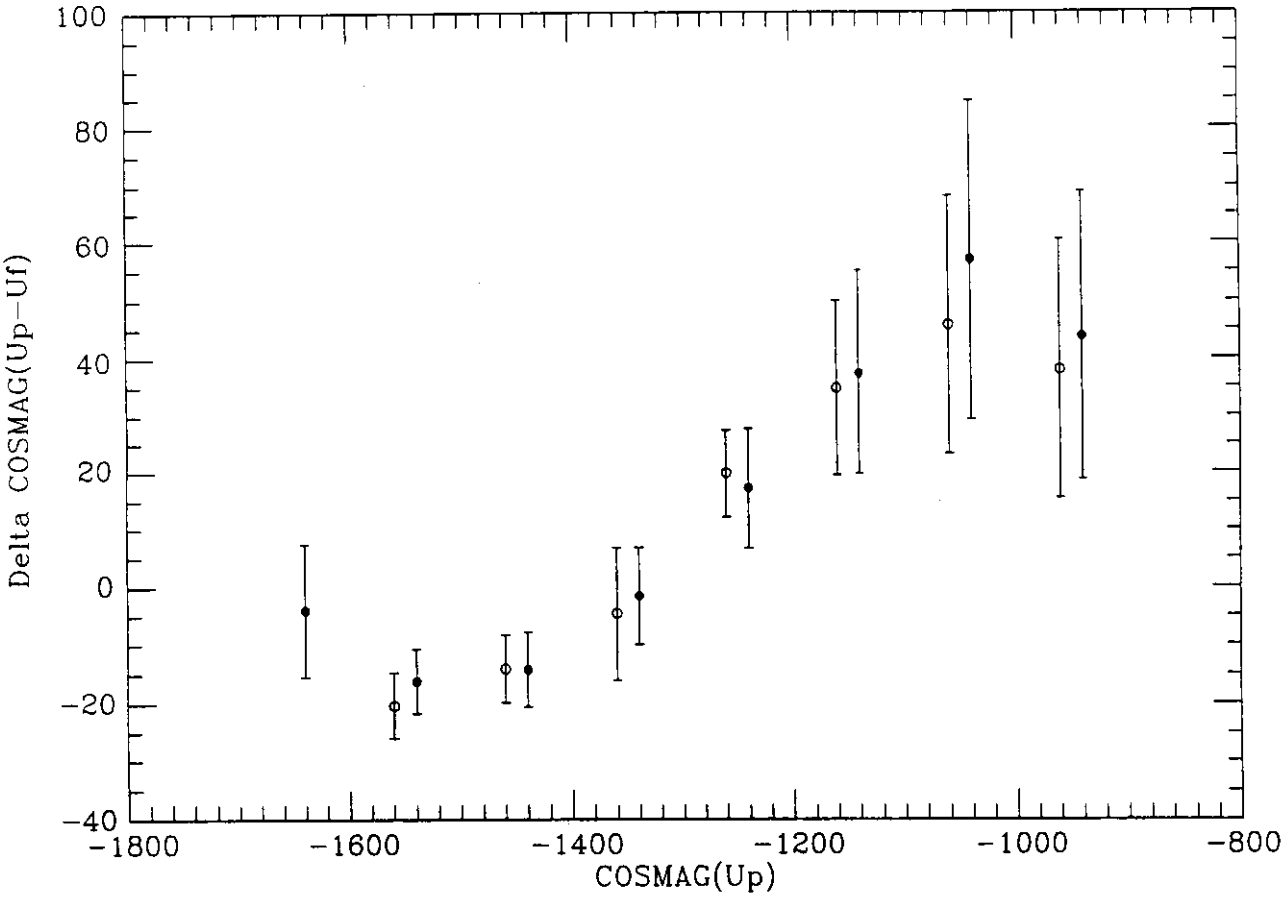

Figure 2

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