ENHANCEMENT OF FAINT IMAGES FROM UK SCHMIDT TELESCOPE PLATES

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INTRODUCTION

The UK Schmidt Telescope has taken several thousand photographs especially on fine grain Eastman Kodak IIIa-J and IIIa-F emulsions (see Cannon, 1984) which were hypersensitised before exposure in the telescope to improve their ability to record very faint signals.

Relatively little work has been done on further post-processing techniques to enhance photographically the faint signal from sources very near to the sky background level. Work is currently being undertaken by Malin (AAO) and others including staff at ROE to enhance faint photographic signals without a corresponding increase in noise, either by making high contrast enlargements from small areas of the original plate, or by making contact copies of the whole plate onto high contrast line material. The UK Schmidt photographs are 356mm x 356mm, covering a field $6\frac{1}{2}°$ square and over such an area there are several sources of large scale, small amplitude variations in the background density level. These include the vignetting function of the telescope (Dawe, 1984), non-uniform losses of sensitivity (Malin 1978a, Campbell 1982), limitations inherent in processing large plates uniformly, and the effects of ghost images (UKSTU Handbook 1980). These non-uniformities are enough to make direct high contrast copying of complete plates unsatisfactory.

MASKING

To compensate for the inherent non-uniformities, a photographic positive mask is made, higher in density where the sky background on the original plate is low and less dense where the backtround is high. In effect, the mask is a variable neutral density filter specifically matched to the original telescope plate calibrated so that the sum of the densities of the mask and plate will be the same at corresponding points in the field. In order to retain the small scale variations,

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 73–76.

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the mask is made "unsharp" by separating the mask material from the original plate with a spacer. The spacer may be a sheet of glass, of thickness appropriate to the spacial frequencies required, or it may be convenient to place the mask material in contact with the back of the original plate, thereby using the plate itself as the spacer. The mask material, in ROE's case Kodak Aerographic Duplicating Film type 4421, is then exposed to a diffuse light source, through the original plate and spacer simultaneously, and processed to a gamma between 0.6 and 0.9. The mask thus follows the larger scale density variations of the original plate, but does not record the sharp detail from the original.

HIGH CONTRAST COPYING

After processing, the completed mask is relocated onto the back of the original plate and a positive copy is made by exposing through the pair onto the high contrast material which is in contact with the emulsion of the original plate. This exposure is also made to a diffuse light source. The significant point about this process (Malin, 1978b) is that the metallic silver grains in the original plate which are produced by the faint astronomical signal are located in the surface of the emulsion, but the fog or noise grains are distributed randomly throughout the emulsion thickness. By using a diffuse light source, the fog grains deep in the emulsion are not resolved on the positive copy, which records only those parts of the original at or very near the surface of the emulsion. Exposure and processing in this technique are very critical, because the noise and signal densities are very close to each other on or near the toe of the characteristic curve of the original plate and the high contrast copy. The objective is to copy the signal onto the straight line, high contrast portion of the characteristic curve, leaving the noise compressed in the low contrast toe of the curve. This is particularly difficult because the "elbow" between the toe and straight line portions of the characteristic curve is extremely sharp.

The high contrast positive is then printed onto a further high contrast film or paper where the fainter densities of the images are more easily distinguishable on a negative print.

Contrast enhance techniques have been particularly successful when applied to very deep UK Schmidt photographs of nearby galaxies. They make visible faint features not previously suspected, at brightness levels down to 28 magnitudes per square arcseconds. Since the average sky background, from atmospheric airglow, zodiacal light, and our own galaxy is about 23 magnitudes per square arcsecond in blue light on a dark night, this difference of 5 magnitudes, corresponding to a factor of 100 in brightness, means that we can detect features whose light output corresponds to only 1% of the overall night sky brightness.

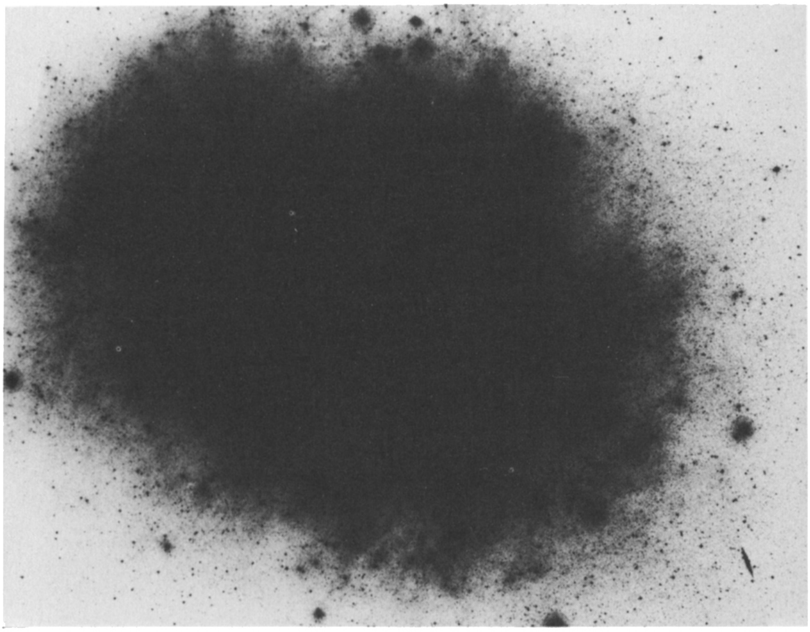

Fig. 2. Copying the original plate by direct high contrast methods only makes the intrinsic non-uniformities more conspicuous.

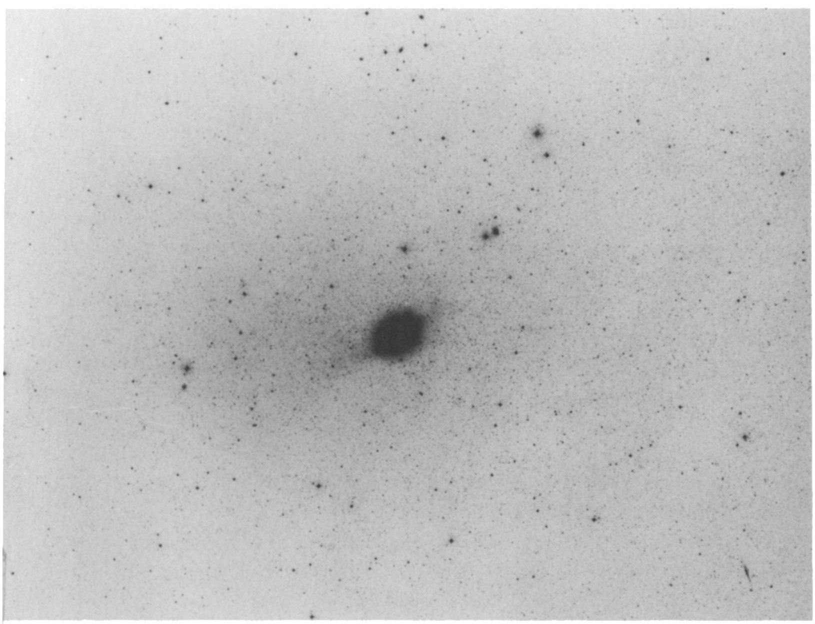

Fig. 1. The Original Plate

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Cannon, R.D.: 1984, this volume, p. 25.
Dawe, J.A.: 1984, this volume, p. 193.
Malin, D.F.: 1977, ASS Photobulletin No. 16, p. 10.

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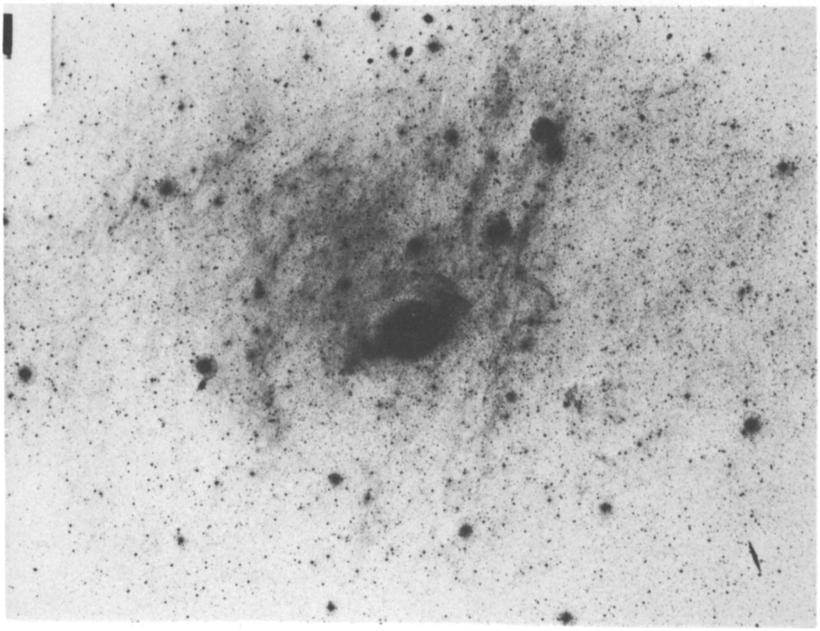

Fig. 4. The original plate copied through an unsharp mask at high contrast to reveal the faintest signal.

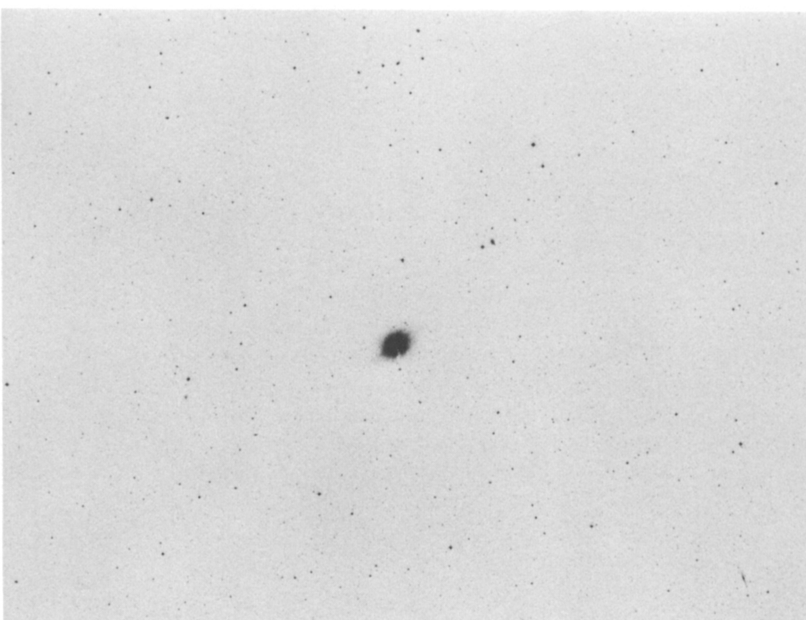

Fig. 3. The original plate copied through an unsharp mask at normal constrast to remove the large scale small amplitude variations.

Malin, D.F.: 1978a, 'Modern Techniques in Astronomical Photography', ed. West & Eudier, p. 107.
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