AN AUTOMATED METHOD OF GENERAL STAR COUNTS FOR DARK CLOUDS

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ABSTRACT

An automated method of general star counts has been developed for the purpose of deriving the distributions of extinction of large dark clouds. The result of the application to the Southern Coalsack is given.

1. INTRODUCTION

Recently, methods of digital analysis of photographic plates of stellar fields have been developed for various particular purposes (eg. Duerr and Craine, 1982). We have developed a system of general star counts optimised to derivation of surface distribution of extinction of large dark clouds with an aim to discuss the problem of star formation in those clouds (Saito et al., 1981).

Since dark clouds are generally located in the Milky Way and the method of star counts is essentially statistical, following points have been taken into consideration in developing the system.

(1) The system is capable of treating so many stellar images as hundreds of thousands;
(2) All images may be assumed to be stellar images;
(3) Individual stellar images which compose a blended one can be counted separately;
(4) Accurate photometry of individual stars (Herzog and Illingworth, 1975; Buonanno and Corsi, 1978) is not necessary.

2. METHOD

A Schmidt plate is scanned by a two dimensional microdensitometer. The pixel size and the sampling rate are so selected that the faintest

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M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 329–332.

star images are divided into a few pixels.

We set two criteria in detection of stellar images. One is for the photographic densities of images and the other is for their extent. Both criteria are determined empirically so that the resulting detection for a small selected area of the plate is satisfactory from comparison with the eye inspection of the area. This is a reasonable tactic since both of the sky background density and the image quality are different from plate to plate which would be processed by this system.

Each image detected is diagnosed whether it is blended or not according to the following principles. For simplicity, consider an image blended with two components. In cases where both components show individual maxima in the density profile, the locus of minima between the two maxima can be defined as the boundary of the components (Figure 1a).

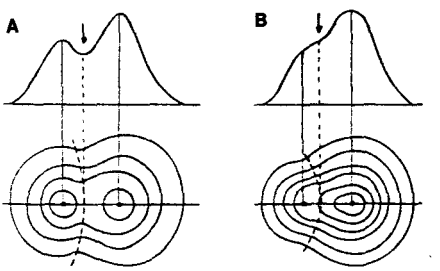

Figure 1a (left) and 1b (right). Two cases of blending of stellar images. See text for details.

On the other hand, in cases where the blending is so heavy that the fainter star does not show a corresponding maximum, it has been found that the curvature of the profile changes its sign between centres of the two components. Thus, a locus of these points is used as the boundary (Figure 1b).

These principles may be generalized to be applicable to multiplied blended images. As a practical treatment, an image is first divided into components, if any, in one direction of the pixel array. Thereafter, each resulting component is diagnosed for further blending along its ridge.

3. APPLICATION

A plate of the Southern Coalsack taken by a 50 cm Schmidt telescope of Bosscha Observatory in Indonesia was analysed. The plate size is 11cm x 11cm which covers about 22 square degrees. The limiting magnitude is $\bar{V}$ > 17 mag.

This plate was scanned at Kiso Observatory by using a fast two dimensional microdensitometer with a linear CCD array as its sensor. The

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smallest pixel size, 13μm x 24μm, was selected in scanning to give 38 megapixels over the whole plate.

The pixel data, the coordinates and the transmissions, stored on magnetic tapes were processed by using a FACOM M-200 in Kyoto and a VAX-11/780 in Manchester.

A part of the result of the image detection is shown in Figure 2; the machine result is overlaid on the reproduction of the plate. The total number of stars detected on this plate is 480 thousand.

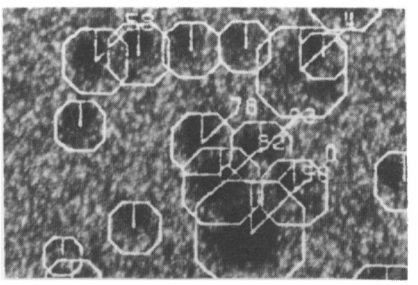

Figure 2. Detected star images are overlaid on a reproduction of a part of the original plate.

The distribution of extinction has been derived from the distribution of the star number density for the whole plate area (Figure 3a). A minimum value of the total dust mass in the Coalsack has been found to be 20 solar masses. A detailed extinction map of the region of Tapia's globules 1 and 2 (Tapia, 1973) is also shown in Figure 3b.

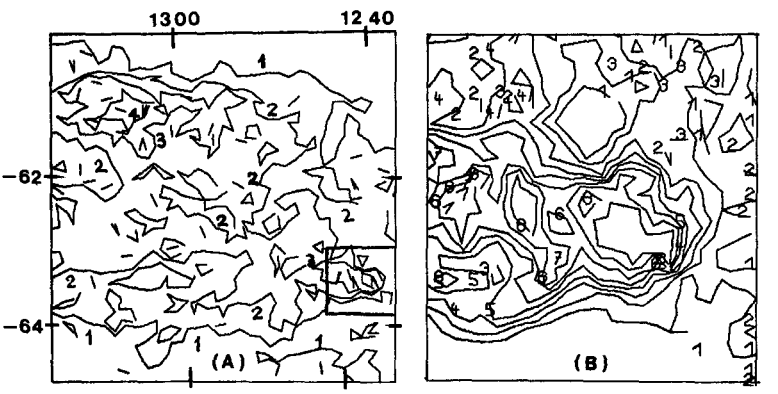

Figure 3. Distribution of extinction. (A) The whole region of the Coalsack. Contours 1 to 5 correspond to Av = 0.5, 1.5, 2.5, 3.5 and 4.0 respectively. (B) Details of a part indicated in (A). Contours 1 to 8 are for Av = 0.5 to 4.0 with step 0.5.

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DISCUSSION

M. SANTANGELO: Have you tried to compare the results of your statistical analysis of star counts with the results given by multicolour photometry of stars in dark nebulae?

H. OHTANI: Yes. In the regions where Rodgers' (M.N.R.A.S. 120, p. 163, 1960) results are available, our result is consistent with his. The total dust mass obtained by us is greater than Rodgers' estimate by 40%. This difference may be attributed to the fact that Rodgers observed only few stars through the most dense parts of the clouds.