THE CONCEPT OF LIMITING MAGNITUDE AND THE
PERFORMANCE OF THE ISAAC NEWTON TELESCOPE FOR
PRIME FOCUS PHOTOGRAPHY

D. E. BLACKWELL and P. A. IBBETSON
Department of Astrophysics, University of Oxford, England
C. A. MURRAY
Royal Greenwich Observatory, Herstmonceux, England
N. M. PRATT
Royal Observatory Edinburgh, Scotland

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Abstract. A quantitative definition of limiting magnitude for stellar photographs is proposed, together with a method of measurement employing a Racine prism. Limiting magnitudes in U, B and V for the Isaac Newton telescope at Herstmonceux derived from a total of 72 prime focus photographs are presented and the results correlated with the size of the photographed image. The limiting magnitude for an extrapolated value of the seeing of 1" is $B = 22.0$, in good agreement with a value obtained by scaling the limiting magnitudes of the 200 inch telescope.

1. Introduction

The concept of the limiting magnitude of an astronomical telescope used in a photographic mode has been discussed by Baum (1960) and by Bowen (1964). These authors considered the dependence of the limiting magnitude on the dimensions of the telescope and on atmospheric parameters, and gave values of the limiting magnitude for Palomar and Mt Wilson telescopes. The limiting magnitude of the 200-in. Hale telescope when used with the $f/3.67$ Ross corrector has also been considered by Racine (1971) who finds the values, $U = 20.5$, $B = 22.7$ and $V = 22.0$. In this note we attempt to sharpen the definition and also present some observational data obtained with the Isaac Newton telescope at Herstmonceux. These data are of intrinsic interest, especially in view of the proposal to move the telescope from Britain.

2. The Photographic Data

The present investigation is based primarily on photographs of the galaxy M33 taken through the Wynne corrector at the prime focus of the telescope for a separate investigation of stellar content. As part of this work, in order to establish a photometric sequence, photographs were also taken using a Racine prism (Racine, 1969) attached to the telescope. This prism produces secondary images at a separation of about 30" from the primary images with a magnitude difference of about 5". It was calibrated using photographs of the galactic cluster NGC 7063 for which photometric data are...
available from the work of Hoag et al. (1961), and these photographs, together with others of NGC 7062 (Hoag et al., 1961) provided additional material for assessing the performance of the telescope. The $B$ plates were taken with the emulsion/filter combination 103aD/GG13, whilst most of the $V$ plates used the combination 103aD/GG14; a few $V$ plates were taken with the combination IIaD/GG14 but these plates did not give significantly different results from those obtained with the 103aD emulsion. Exposures on $B$ and $V$ plates were usually about 30 min, which is sufficient to show the sky background at density 0.2. A few $U$ plates have also been taken with the combination IIa0/UG2 with an exposure time of about 80 min, but these do not reach the sky background. Guiding was done manually in all cases. In compiling our statistics we have rejected all plates having obvious flaws due to poor focus or guiding. The plate material comprises 42 $B$ plates, 25 $V$ plates and 5 $U$ plates taken over 25 nights, chiefly during the months September, October and November over the years 1969/1972.

3. Definition and Measurement of Limiting Magnitude

The limiting stellar magnitude of a photograph can be estimated by eye inspection, using the criterion that a recognizable image is just discernible but always keeping in mind the possibility of mistaking a minor plate flaw for a real image. A convenient way of assessing the meaning of such a limit is to take a photograph with a Racine prism incorporated into the telescope optical system, for then a large amount of statistical information can be obtained from pairs of primary and secondary images. Furthermore, a magnitude sequence extending only as far as $17^{m}5$ will usually provide a calibration to $22^{m}5$, which is sufficient for the Isaac Newton telescope. On such

![Fig. 1. Relation between magnitude difference ($U$) of primary and secondary images, and magnitude ($U$) of secondary image, for INT prime focus plates. The eye estimate of limiting magnitude is shown.](image)