A NEW WIDE FIELD ELECTROGRAPHIC CAMERA AS AN OPTIMUM DETECTOR FOR SCHMIDT-TYPE TELESCOPES

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1. INTRODUCTION

The electrographic (E.G.) camera is one of the most powerful modern detectors having high sensitivity, extended spectral response, extreme spatial resolution, low background, no threshold, good linearity and large dynamic image. A combination of highly uniform electric and magnetic fields produces distortion-free and extremely sharp images which are recorded by electron sensitive emulsions [1] (Figure 1).

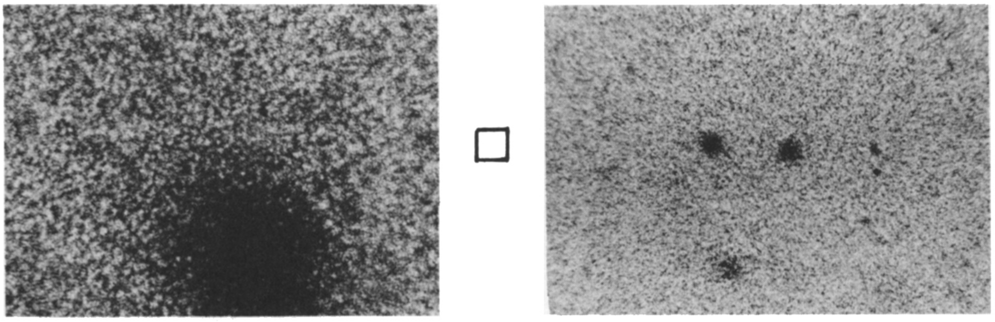

Figure 1. A microscope enlargement, with the same magnification, of a IIaO plate (left) and a medium-grained Eastman-Kodak electron sensitive film (right). At the same scale, a 15x15μm C.C.D. pixel element! (center)

It is essential, for optimum performance, to place the E.G. camera at the focus of a telescope whose optical resolution matches that of the camera. Since flux density varies in inverse ratio to the area of stellar images, a very high detection threshold can thus be achieved. Consequently, the most efficient use of an E.G. camera is at the focus of a Schmidt-type telescope. Unfortunately, there is, as yet, no E.G. camera having a field large enough to accomodate large telescopes of this type.

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M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 173–176.

https://doi.org/10.1017/S0252921100106517 Published online by Cambridge University Press

2. THE McDONALD OBSERVATORY E.G. CAMERA

During the past 16 years the McDonald Observatory, with support from the National Science Foundation, has built and operated two magnetically-focussed, 5-cm E.G. cameras [2,3,4,5,6] . Years of intensive use, by astronomers from various countries and institutions, have proved the validity of the basic concept. Thousands of electrographs have demonstrated its capabilities for precise photometry [7] and astrometry [8]. Nevertheless, to build a large-field E.G. camera with the present method of loading the film at the electronic focus, through the back of the solenoid, would not be an elegant and efficient solution of this difficult problem for larger cameras. We had to develop a new approach to make the design, construction and operation of a wide-field E.G. camera simpler and more practical without loss of geometric or photometric accuracy.

Preliminary laboratory tests showed that a uniform magnetic field can be extended out of a solenoid by using a "correcting" coil placed on the same axis, at some distance from the main coil. An extensive computer analysis was made to determine the characteristics of such a coil pair, and to evaluate the field distribution in and out of axis, image distortion, rotation, curvature and modulation transfer function [9]. A coil pair built, according to these calculations for a 9-cm camera, gave a very uniform field (+/- 0.07%) inside the main coil and outside it, up to the correcting coil. Image distortion, rotation and curvature are negligible and the MTF is 25% at 200 lp/mm. A similar coil-pair for a 20-cm camera was also calculated and built with similar results.

3. A 9-cm E.G. CAMERA

The split solenoid solves elegantly the problem of building a large field E.G. camera (Figure 2). While the photocathode is within the main coil, the electronic focus can be placed between the two coils, permitting a direct, sideway access to it. Such a layout offers numerous advantages: (i) the film magazine design is much simplified as the film can travel straight from the supplying to the receiving spool. Since there is no need to roll the film on a roller of small radius, a thicker film base (7-mil Estar), which is easier to handle, may be used; (ii) the full area of the photocathode can be recorded; (iii) the design of the entrance and exit slit-like gate valves is much simplified, and they are much easier to seal; (iv) the film magazines can have large capacity; (v) a simple motor can drive the film loader under control by the observer at the telescope.

A 9-cm E.G. camera is under construction and should be ready for testing in the spring of 1984. It will serve as a pilot model for a larger, ~20-cm camera, of the same concept which - subject to adequate support - can be built for use with large-field telescopes. Such a camera would be the ideal detector for a diffraction-limited folded Schmidt-type space telescope.

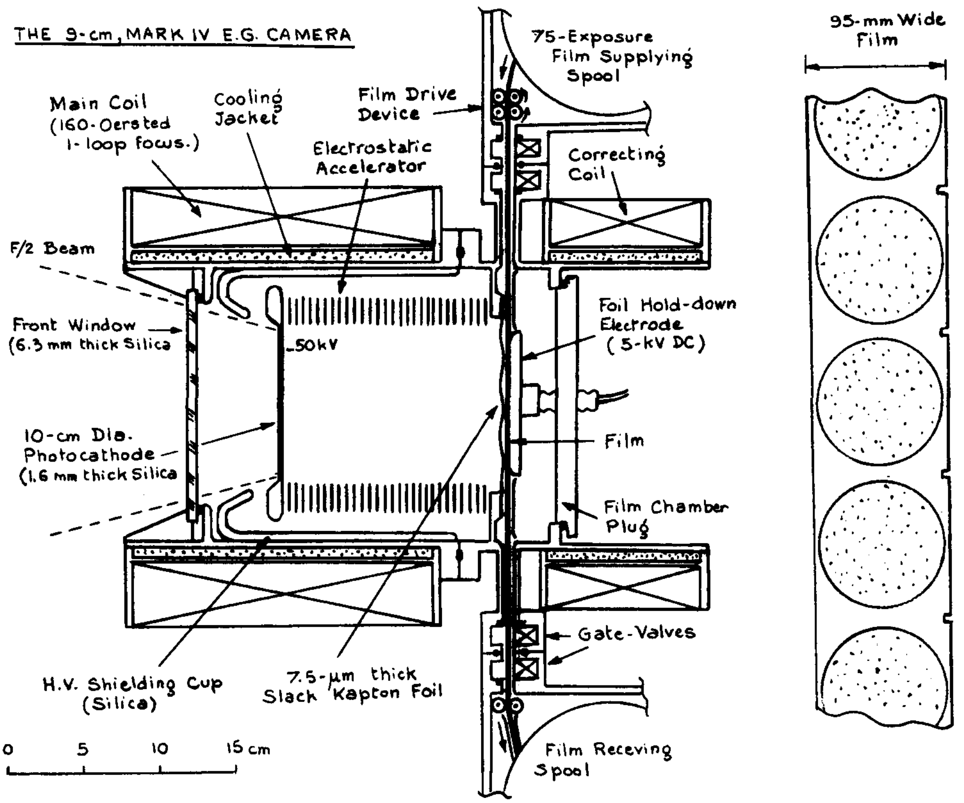

Figure 2. A sketch of the 9-cm, Mark IV, electrographic camera with a 75-exposure, remotely controlled, roll-film magazine. The film and photocathode chamber sputter ion-pump and H.V. feedthrough are at 90° with respect to the drawing plane.

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DISCUSSION

D. CARTER: In the past, electrographic images have been ruined by the quality of the emulsion. What are your emulsions like now?

G. DE VAUCOULEURS: The Kodak emulsions are excellent. It would be catastrophic if their production were stopped for economic reasons. There is no alternative source. The astrometric quality and photometric uniformity of the films taken with the Griboval camera has been well documented by users (see references to above paper).