Semi-Annual Progress Report

ELECTRO-OPTICAL SENSORS RESEARCH STUDY AND ASTRONOMICAL OBSERVATIONS

Period: 15 June - 15 December 1965

NASA Grant NGR-14-007-033

Submitted by

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FOREWORD

The following is a semi-annual progress report covering work carried on under NASA Grant NGR-14-007-033 during the period 15 June to 15 December 1965.

The following members of the Dearborn Observatory faculty and staff contributed significantly to the technical effort during the reporting period: Dr. J. A. Hynek, Dr. G. A. Bakos, Dr. J. Burns, Mr. J. R. Dunlap, Mr. W. T. Powers, Mrs. M. C. Rymer, and Mr. R. V. Lazenby.

Respectfully submitted,

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I. INTRODUCTION

This report describes work performed under Grant NGR-14-007-033 during the period 15 June through 15 December 1965.

Activities during the reporting period fell into three principal categories: (a) astronomical observations on short period cluster variables, (b) long time stability of performance characteristics of image orthicon tubes, and (c) development of strong field magnetically focused image tubes. A brief progress report is given below for each of these three tasks.

II. CLUSTER VARIABLES

During the reporting period the search program for variable stars in galactic clusters was completed. This program has been described in earlier reports so only a very brief resume will be given here. The survey was carried out using a modified RCA image orthicon closed-circuit television system on the 12-inch reflector of Dearborn Observatory's Organ Mt. Station near Las Cruces, New Mexico. The observational program was under the supervision of Dr. G. A. Bakos and Mr. J. R. Dunlap. Data were recorded directly from the kinescope monitor screen on 35mm film and reduction was carried out at Dearborn Observatory by Dr. Bakos with the assistance of Mrs. M. C. Rymer. Exposures of the kinescope screen were taken in pairs at 5 minute intervals (the individual pictures in each pair had different exposures to assure getting a picture of appropriate density). More than 13,500 exposures were made during the entire program and 22 different galactic clusters were studied. Of these clusters, about 15 were observed extensively over long periods of time in the course of one night and at frequent time intervals.

Two general methods were used to search for variable stars. The simplest and fastest method was to superimpose two photographs of a cluster of approximately the same density and limiting magnitude and to compare the brightness of individual stars under low magnification. Brightness changes of about one magnitude could be detected in this way.

A somewhat more sensitive procedure was to measure diameters of stellar images on the 35mm film. Bakos established at the outset of the program that the image orthicon television system gave apparent diameters of star images which vary linearly with brightness over a range of about 5 magnitudes with a mean error of ±0.05 magnitudes. By measuring star images it was therefore possible to detect much smaller brightness variations than could be found by the first method, but the second technique was much more time-consuming and therefore could be done only for selected stars in a cluster.

Some known variables have been "rediscovered" in this search and two new ones have been found, one in NGC 2682 and the other in NGC 6871. The first has been classified tentatively as a flare star of late type (B-V = 1.12) and the other is a RR-Lyrae with a period of 6.59 hours and mean brightness 13.7 magnitude. In addition several suspected variables have been found.

Considerable activity centered around the discovery of a number of stars which dimmed rapidly for a period of 10-15 minutes before returning to their original brightness. The effect did not recur, and proved to be very puzzling. Tentatively, the dimming has been ascribed to dust attracted to the faceplate of the image orthicon tube by electrostatic charge built up by action of the cooling air stream across the faceplate. A small drift of the telescope in right ascension may then allow a star image to drift slowly across an attached dust particle and become dimmed or even completely blocked. It should be pointed out that this explanation is still regarded as tentative pending further experimental verification.

III. IMAGE ORTHICON STABILITY

The purpose of this task is to develop methods for assessing the long-time stability of various performance parameters of image orthicon tubes and camera systems and to use these methods on as many I.O. tubes as possible to find out which ones are best in this respect and what range of variation in these parameters one might expect to encounter.

The key component of the system we plan to use for these tests is a high performance, ultra stable camera chain specifically designed by Mr. William Powers of Dearborn Observatory for astronomical use on our new LARC 40-inch reflector to be installed in late summer of 1966. This camera chain is being built in the Observatory shops and was scheduled to be completed early in 1966 so work on I.O. stability with this unit will be reported in the next semi-annual report.

Some experiments were carried out using analytic photography to detect minute changes in photographs of a TV kinescope. This technique utilizes a positive and negative, one each of the photographs to be compared. These are registered accurately in contact or by projection and any discrepancies either dimensional or photometric are immediately visible to the observer. Mr. James Wray analyzed the method and showed that the maximum sensitivity for detection of small photometric differences requires that the positive have a longer gray scale than the negative from which it is made and that it be processed to a contrast (gamma) of unity. Under these conditions local differences in density of a few percent can be detected without difficulty corresponding with initial image brightness differences of the order of a few hundredths of a magnitude. It is evident that the technique is a powerful one for detecting small changes in brightness or position in a complex picture. Some preliminary experiments were also done with this method using Polaroid P/N film which is a rapidly processed film pack that yields both a film negative and a paper positive of the same picture. It was difficult to time development precisely enough to yield a negative of $\gamma = 1$ as required for highest sensitivity and the combination of film and paper viewed by reflected light did not give as good results as two films or plates by transmitted light.

IV. IMAGE TUBE DEVELOPMENT

Some unexpected problems were encountered in arriving at a design for a cryostat to hold the superconducting solenoid to produce a strong magnetic field for an image tube. The problem centered on our requirement that the cryostat be capable of being tilted at least 45° and preferably 60° off the vertical in any direction while in operation so it could be used on the telescope. It was also required that the liquid helium reservoir have sufficient capacity so the unit could operate at least 2 hours scanning at the sidereal rate in right ascension without having to be refilled. There was also a ceiling on size, weight and cost which was something of an inhibition. Finally the Janus Research Company, Stoneham, Massachusetts, in cooperation with Magnion, Inc., who supplied the superconducting solenoid, devised what seems to be a suitable design which is somewhat unusual in that no liquid nitrogen jacket is used around the helium reservoir, heat loss being kept down by a series of high reflectance heat shields in vacuum. The estimated consumption of liquid helium for the unit with no motion is 0.5 liter/hour. Inasmuch as the cryostat and solenoid were not delivered during the reporting period, results of tests on and off the telescope, with and without a simple image converter, will be described in the next semi-annual report.