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I. PERSONNEL

This report covers the period from August 1989 to August 1990. Within the Department of Physics and Astronomy, those currently involved in astronomical and astrophysical research are Drs. Barbara J. Anthony-Twarog, Stephen J. Shawl, Bruce A. Twarog and adjunct colleague Dr. Scott Baird of Benedictine College (Stellar and Galactic Studies), Dr. J.P. Davidson (IUE Data Analysis), Drs. Doug McKay, Adrian Melott, John Ralston (Cosmology and Theoretical Particle Astrophysics), Dr. Thomas P. Armstrong (on leave at NASA headquarters) and Dr. Thomas E. Cravens (Solar System Studies). Twarog and Anthony-Twarog spent most of the report period on leave at Cerro Tololo Inter-American Observatory in La Serena, Chile.

We were pleased and fortunate to have had Dr. Sergei Shandarin of the Institute for Physical Problems, Moscow as a visiting professor during this report period; he will remain as a visiting professor through August 1991.

II. INSTRUMENTATION AND DATA ANALYSIS

The Mid-American Astronomical Image Processing Laboratory continues to provide software and image display equipment designed for reduction of two-dimensional digital data by area astronomers. Our computational base is now a MicroVAX 3800 which has replaced our prior system of VAX 11/750's. With the recent installation of IRAF, we can offer a wide variety of reduction possibilities which implement the display characteristics of the IIS Model 75 for high resolution image display and manipulation. We still maintain stand-alone versions of DAOPHOT with display software for the IIS and reduction packages for stellar photometry.

Our research and academic computing capabilities have been extended with the installation of a VAX 9000 in the University computer center.

III. RESEARCH

Twarog and Anthony-Twarog have completed initial phases of observation with a filter designed to extend the applicability of the Strömgren photometric system. The Ca filter, centered over the H and K lines of ionized calcium, is used to construct an index analogous to m_1 which retains its sensitivity to metallicity changes for abundances as low as [Fe/H] = −3. Observations of 163 standard stars and a description of the filter, its standardization, and the characteristics of the *uvbyCa* filter system are in preparation for publication.

One early application of the *uvbyCa* system was to the most metal poor giants, including BD −18°5550 and CD −38°245. These two stars have been observed with high dispersion spectroscopic techniques, and have been found extremely metal-poor, with measured [Fe/H] values of −2.7 and −4.1 respectively. Most photometric metallicity indicators, including our hk index, show an inverted order of the metallicity for the two giants with our results indicating a metallicity of [Fe/H] = −3.4 for −18°5550 and a startlingly high value of −2.85 for −38°245. Even more surprising is the apparent long-term variability of the metallicity indicator based on the Calcium features for the extreme metal deficient red giant −38°245. An additional product of the extensive observations obtained with the extended *uvbyCa* filter system resulted from observations of a large sample of metal poor field giants, namely the identification of a morphologically distinct relationship between the Strömgren indices c_1 and $b-y$ for red giants which does not appear very sensitive to metallicity differences. This characteristic relationship has not been explored yet for globular cluster giants, but observations in 1990 and 1991 will determine whether the red giant $c_1, b-y$ relationship offers the possibility of reddening determinations for globular clusters. Our observations will also focus on metallicity determinations based on the two metallicity indices m_1 and hk.

In separate observational applications of the Strömgren system to globular cluster stars, Anthony-Twarog, Twarog and N. B. Suntzeff (CTIO) continued their observational search for main sequence binary candidates in the nearby cluster NGC 6397. While direct radial velocity measurements for confirmation of photometric binary candidates have not been possible for the rather faint candidates in the cluster, additional photometry in six cluster fields identifies a small sample of binary candidates. The identification of brighter stars above the main sequence is made possible by elimination of many of the foreground non-members by virtue of metal indices distinct from those of the cluster stars. It seems difficult at this time to distinguish between the possibilities of a small population of nearly equal mass binaries which suggest a larger fraction of binary stars, and the appearance of binarity induced by image superposition.

Twarog and Anthony-Twarog have collaborated with W. Weller (CTIO) in extending the applicability of CCD photometric cameras at the foci of Schmidt cameras, with several tests of the CTIO Schmidt-CCD combination. One application has been to the open cluster NGC 5822. Our experience has demonstrated that photometric accuracies of 0.01 magnitudes are obtainable from aperture photometry algorithms on frames obtained with the Schmidt system, and over fields 20′ on a side. In spite of these small photometric errors, the main sequence of NGC 5822 in $V, B-V$ and $V-R$ displays scatter two to three times larger with no indication that variable reddening is the cause. Since the cluster has been found to be rich in binaries (Mermilliod and Mayor 1990), photometric binaries are likely to be the cause of the main sequence breadth.

Shawl and Donald Bord (University of Michigan – Dearborn) have continued their search for companions to long period variable stars. Observations obtained in September/October 1989 and January 1990 with the 2D-Frutti detector on the 1-meter Cassegrain spectrograph at CTIO yielded spectra of 13 program stars (most near the desired time of minimum light), 20 M-type spectral standards, and some stars known to have composite spectra. The wavelengths of interest are those shortward of about 4000Å, where we expect an increase in continuum flux should a companion be present. The spectra for V1161 Sgr (obtained near maximum at phase 0.13), and RX Mic (obtained near minimum at phase 0.58) show blue continua that seem to remain high compared with the continua seen in spectra of HD 178 (MK type M5/6), and HD 14002 (M3/4). On the other hand, this effect may be due to the incipient emission from the Balmer lines and their convergence to the Balmer limit. Additional observations to increase the sample size and to sort out emission effects are planned.

Shawl and Bord have studied HD 124989 to determine if its classification as a visual binary system is correct. Spectra of this system, obtained as a part of their search for companions to long-period variables, find the primary to be spectral type M6/7, later than that given in the *Michigan Spectral Atlas*, and the secondary to be F7, in agreement with previous determinations. Short exposure

CCD frames of the system show the stars to be separated by 4.8″at a position angle of 165°; these data are consistent with no change in position. These data, combined with UBV photometry of both components, are used to argue that the stars are probably optical doubles rather than a physical binary.

Baird has computed synthetic spectra to compare with moderate dispersion vidicon spectra of RV Tauri stars in an effort to obtain the basic atmospheric parameters of those stars. Preliminary results for ω Cen V1, M5 V42, and M5 V84 were presented at the June 1990 AAS meeting.

Baird also continued work on H-line variation in SRd stars. Balmer line variation of 10% or more in a 30-minute interval have been found in SZ Aqr. H-beta CCD photometry was carried out by Baird and Michael Brox to monitor 3 other SRd stars for variation of the H-beta line; no such variations have yet been found.

Baird and Horace Smith of Michigan State, in a study of stellar populations in the SMC, have identified 200 new variable stars in a 1°x 1.3°field centered on α (1975)= 1^h2^m, δ (1975)= $-71°30'$.

IV. MISCELLANEOUS

This year's meeting of the MidAmerica Regional Astrophysics Conference in Kansas City marked the 20th anniversary of these annual meetings at which astronomers and students from Kansas, Missouri, Nebraska and Iowa meet to present their research results and discuss problems of mutual interest.

A workshop on the Legacy of Ya. B. Zel'dovich for Astrophysics and Cosmology was organized by Melott and Shandarin and held in Lawrence from May 2-6, 1990. Over 30 persons from the U.S., the U.S.S.R., and several European countries attended. It was funded by the NSF and the Soviet Academy of Sciences.

A Bachelor of Science degree in Astronomy was awarded to Douglas Lindholm (currently a graduate student at the University of Colorado).

Anthony-Twarog attended the 102nd annual meeting of the Astronomical Society of the Pacific in Boston, Massachusetts, and presented several poster papers related to the meeting topic "Formation and Evolution of Star Clusters". Shawl continued his service to the AAS both as a Shapley lecturer and on the Education Advisory Committee.

Visiting speakers during the year included Arlin Crotts (Goddard Space Flight Center), Ed Bertschinger (MIT), Peter Coles (University of Sussex), L. Kofman (Tartu, Estonia), and Robert Scherrer (Ohio State).

(Visitors during 1988-1989 were inadvertently left out of last year's report and included James Truran (Illinois), Jorge Sahade (La Plata), Dick Lamb (Iowa State), David Schramm (Chicago).)

A public panel discussion on the 25 years since the discovery of the cosmic microwave background radiation, held in conjunction with the Zel'dovich workshop, included P. J. E. Peebles (Princeton), L. P. Grischuk (Moscow State University), I. D. Novikov (Lebedev Physics Institute, Moscow), L. Kofman (Tartu, Estonia), and Shandarin.

V. PUBLICATIONS

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