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## 1. PERSONNEL

This report covers the period from July 1, 1994 through June 30, 1995. During that interval the staff consisted of C.M. Gaskell, K.C. Leung, E.G. Schmidt, N.R. Simon and D.J. Taylor.

Graduate students S.N. Goderya, K.M. Lee, S. Snedden, and T. Young worked on thesis research projects. Undergraduates R. Nickeson, O. Francis and M. Hiller participated in research projects.

Gaskell was an invited speaker and session chairman at the meeting "Jets from Stars and Galactic Nuclei" held in Badhonnef, Germany.

Schmidt completed his tour of duty as Program Director for Stellar Astronomy and Astrophysics at the National Science Foundation in August, 1994 and returned to the University of Nebraska.

## 2. FACILITIES

Two additional SPARC stations were added to the astrophysics computing network for the analysis of quasar data from the Hubble Space Telescope (HST). An extra 4 Giga-bytes of hard disc space were also added. Snedden installed the STSDAS software in addition to IRAF.

Gaskell and Taylor are continuing to work on the new on-campus undergraduate teaching observatory. We now have the 16-inch telescope, its ST-7 CCD, and the dome, but are seeking a suitable location for the dome. The originally intended site turned out to have unforeseen problems. We hope to have the new observatory ready for operation by spring of 1996.

## 3. RESEARCH

### 3.1 Variable Stars

Schmidt has continued his photometric survey of poorly studied variable stars. About 400 light curves have been obtained so far; an estimated 1800 stars will ultimately be observed. Among stars of astrophysical interest which have been discovered during the survey are 16 eclipsing binaries which were previously classed as RR Lyrae stars, several double mode Cepheids including one (V371 Per) which appears to have a peculiar period ratio, several long period RR Lyrae stars with peculiar light curves, a number of members of unusual classes of variable stars and several stars with peculiar light curves. Recent photometry shows that the period of one of the newly discovered eclipsing binaries, V719 Her, is decreasing at an unusually high rate. A more intensive study of the long period RR Lyrae stars has been started to learn the nature of the light curve peculiarities.

Schmidt has completed photometry of about 40 stars which are classed as constant or probably constant in the General Catalogue of Variable Stars. The motivation was to

detect stars which are now variable but may have experienced episodes of non-variability in the past. Of these stars, six are varying with relatively large amplitude at the present time while an additional seven may be variable at low amplitude. The stars with large amplitude include one eclipsing binary, a long period semi-regular variable and several short period irregular variables.

Simon and Kanbur compiled a list of long-period Cepheids, and compared these stars with hydrodynamic models using the technique of Fourier decomposition. The models crudely matched the observations but there were some significant differences. In further work on Cepheids, Simon discussed some difficulties for current evolutionary tracks in accounting for observed stars in both the long- and short-period domains. Simon and Young looked at long-period Cepheids in external galaxies, and studied how the structure of the instability strip might affect the determination of cosmic distances.

Lee is working on RR Lyrae Stars. The project involves observing a large number of RR Lyraes repeatedly at maximum light to look for multiperiodicity. It is hoped that estimates of the frequency of both double-mode pulsators and Blazhko-effect stars can be improved. Secondary periods will be determined and correlated with fundamental periods and metallicity.

### 3.2 Binary Stars

Goderya, Leung and Schmidt have completed their investigation on the binary stars identified in the "Behlen Observatory Variable Star Survey: First Results." Analysis of V508 Cyg V719 Her, DN Aur, and KN Per has been completed with the following findings:

The period for V719 Her from 347 data points in 0.400983 days. The period of this system appears to decrease at a rate of about 0.5 sec/yr. The photometric solution shows a mass ratio of 0.29 and an A-type W UMa configuration. V719 Her probably is in a zero-age state.

For DN Aur the period from 647 data points in 0.616889 days. Two photometric solutions with third light are found, one with a spot and the other without. Both show a mass ratio of around 0.21 with an A-Type W UMa configuration. DN Aur could be an evolved contact showing case A (core H-burning) mass loss.

The period of the KN Per system from 669 data points in 0.866460 days. Two solutions with mass ratio of around 0.25 are found. One suggest a dark spot on the secondary. The configuration is an A-type W UMa system. This star is possibly another example of evolved case B mass loss.

Goderya and Leung are also continuing their investigation of poorly studied eclipsing variable stars. The analysis of two stars is in progress. Goderya, Leung, and Schmidt are also investigating some spectroscopic data on binary stars ob-

tained at the Dominion Astrophysical Observatory. For this purpose Goderya has installed IRAF running under LINUX on the PC computer. The reduction of spectroscopic data with IRAF is in progress.

### 3.3 Star Clusters

Young, Schmidt, and Simon are continuing to investigate RR Lyrae stars in the poorly studied clusters including NGC 5053, NGC 4147 and of late, primarily NGC 6426. For NGC 5053, 13 220s exposures in R were collected, and 12 300s exposures in V. For NGC 6426, 50 300s exposures in R were collected, and 80 300s exposures in V.

Data was photometrically reduced using the SUBSTAR/ALLSTAR packages for crowded field photometry of the DAOPHOT/IRAF program on the SPARC 10/40 workstation. The goal of the investigation is to eventually produce values for the absolute magnitudes of the RR Lyrae stars, and thus the cluster distances. The results will be used in Young's investigation into different distance scaling techniques and their validity for specific objects and situations.

### 3.4 Ultraviolet Astronomy

Schmidt has continued the analysis of wide field far ultraviolet images in collaboration with Carruthers (NRL). Stellar photometry for 770 stars in fields centered on the Galactic center and upper Scorpius has been completed. The former field overlaps two fields which were previously studied. The photometric accuracy and calibration was investigated using stars in common between two fields. The overlapping fields provide a strip of sky more than 40 degrees long with far ultraviolet photometry for nearly all of the stars. The analysis of the far ultraviolet extinction curve in this region using these data is underway.

### 3.5 Active Galaxies

Gaskell continued his participation in the International AGN Watch (IAW). Francis, Hiller and Snedden participated in various aspects of the Behlen Observatory observing and data analysis. *IUE* and *ROSAT* observations were obtained of the interesting radio-loud quasar 3C 390.3. A paper incorporating the X-ray, UV and ground-based observations from the first year is now in preparation. *IUE* time has been allocated for a second year of observations.

Analysis of the intensive December 1993 monitoring of NGC 4151 from X-ray to optical wavelengths continues and two papers are in preparation. A paper is also in preparation describing *IUE* observations of the bright southern Seyfert Fairall 9.

Snedden and Gaskell began a major study of the line profiles of broad emission lines in quasars observed with the *HST*. They are using the *HST* data to do detailed analyses using both optical and UV spectra in the same objects. They are particularly interested in the physical properties of the region producing the highest ionization lines. They will be trying to understand the mysterious blueshifting of high ionization lines with respect to the low ionization lines and the cause of displaced peaks in line profiles.

Many quasars show peaks in their emission lines that are moving by more than a thousand  $\text{km s}^{-1}$  with respect to the rest frame of the host galaxy. Gaskell is testing the idea that this is the result of more than one black hole moving about in the quasar. Analysis of a long series of spectra of one quasar reveals a strikingly regular change in the radial velocity of one displaced peaked. Gaskell has obtained a lower limit of 210 yr for the orbital period. This is just what is predicted by the binary black hole model, but it gives severe difficulties for other popular models. Gaskell has also been examining the statistics of occurrence of displaced peaks in quasars. He finds that while the most spectacular cases occur in quasars with strong radio jets, the frequency of occurrence in radio-quiet quasars is also high.

### PUBLICATIONS

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