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The following report covers the Department activities from Sept. 1, 1995 through Sept. 1, 1996.

1. PERSONNEL AND FACILITIES

William Herbst and Arthur Uggren continue as Professors of Astronomy and John Salzer as Assistant Professor of Astronomy. Edward Weis continues as Research Associate. Caryl Gronwall has joined the staff as a Post-Doctoral Fellow working with Salzer. She received her Ph.D. degree from UC-Santa Cruz and will work on the KISS project (see below). Eric Williams has also joined the staff in the newly created position of Technical Assistant/Lab Instructor. He received his M.S. degree from San Francisco State University. Jurgen Stock continued as an Adjunct Professor during this period and Linda Shettleworth as Administrative Assistant for the department.

Lisa Frattare received an M.A. degree in Astronomy at the June convocation. Frattare has accepted a position in research support at the Space Telescope Science Institute. Katherine Rhode and Kristin Kearns continue as graduate students. Karen Kinemuchi joined the program in August, 1996. Three students received B. A. degrees in Astronomy at the June convocation: Aaron Steinhauer, Chris Mazzurco and Kristin Burgess. Steinhauer has enrolled in the Astronomy Ph.D. program at Indiana University. Burgess is continuing her education in the BA/MA program of the Wesleyan Physics department. Mazzurco has accepted a teaching and computer consultant position for a preparatory school in Maine. Philip Choi, a 1995 graduate, received an NSF graduate fellowship and has enrolled in the Ph.D. program at U.C. Santa Cruz. Current seniors in the department are: Scott Randall, Nick Harrison, Stuart Norton and Adam Heinlein. Norton held a summer position at Cornell University while Randall, Harrison and Heinlein worked in the department during the summer. Junior majors include Ben Holder and Anil Seth.

A meeting honoring Arthur Uggren and his thirty years of astronomy at Wesleyan was held in April. Colleagues and former students attended the two day event held at the Van Vleck Observatory. Salzer completed his term as chairman of the CTIO/KPNO Users committee in May. The department continued its active participation in the Keck Northeast Astronomy Consortium. We regret to announce that Ruth Sturm, a benefactor of the department for many years, in whose honor the annual Sturm Lecture series was initiated, passed away in May.

The public outreach program at Van Vleck Observatory reached new heights this year. Several thousand people visited, including more than one thousand on Comet Night. This event was jointly sponsored by a local TV station and the University and drew more than one thousand people to the campus to view Comet Hyakutake and hear a lecture by Herbst. The transit room underwent extensive renovation and

remodeling this summer to convert it into a computer laboratory. Salzer has purchased a new UltraSparc which will serve the KISS project and function as the department server. A number of new X-terminals and PCs have also been acquired.

2. RESEARCH

2.1 Stellar and Galactic

The long running T Tauri star monitoring program directed by Herbst, which employs the 0.6 m telescope of Van Vleck Observatory continues. As in past years, fields in the Orion nebula cluster are imaged in the I band on most clear nights. As mentioned last year, a new target has also been added - portions of NGC 2264. A substantial amount of data were reduced and analyzed this year by Nancy Eaton, Rhode, Kearns and Steinhauer. Rotation periods with false alarm probabilities of less than one percent are now known for more than 130 stars in the ONC and 9 stars in NGC 2264. Of the ONC stars, more than 75 have FAPs less than 0.5 percent and/or multiple season detections. When a star is found to be significantly periodic in multiple seasons, the period always agrees to within the error of measurement (about 1%) between seasons. This is substantial confirmation of the method and of the claim that we are measuring the rotation periods of these pre-main sequence stars.

Rob Wittenmeyer of Williams College spent the summer working with Herbst as part of the Keck summer exchange program. They discovered that standard methods of calculating false alarm probabilities (FAPs) lead to an overestimate of the significance level of features in the periodograms of classical T Tauri stars (CTTS). Correlations among data obtained over a short time period, such as a single night, exist and must be accounted for when estimating FAP's. A monte carlo technique which corrects for this effect was used to investigate its importance. It was shown that apparently significant rotation periods claimed for some CTTS are, in fact, not significant. This casts doubt on claims that CTTS can change period substantially from epoch to epoch.

Mazzurco and Kearns have analyzed one season's worth of data on NGC 2264. Several new rotation periods have been discovered for stars in that cluster. It is interesting that they tend to be shorter than periods found in the ONC, which is expected given the somewhat older stellar population. Contraction and some spin-up of these pre-main sequence stars appears to have occurred. We are collaborating with a group from UMass, including Steve Strom, Brian Patten and Russ Makidon to investigate rotation in this cluster more extensively.

Steinhauer and Herbst have studied the longer time scale variations of some stars in the ONC using the five year baseline of the VVO monitoring program. A number of large amplitude variables have been identified but no definite new FUors. Some stars could probably be described as EXors. A possible eclipsing binary was discovered in this set by

Rhode and will be reported in the literature soon. In collaboration with Bob Mathieu of Wisconsin, Rhode and Herbst will carry out a $v \sin i$ study of rapid rotators in the ONC. The aim of this project is to obtain independent estimates of the radii of T Tauri stars by comparing angular velocities and surface rotation velocities. Observations will be made with the WIYN spectrograph at Kitt Peak National Observatory.

The supernova monitoring program at Wesleyan is continuing. All bright supernovae north of declination negative twenty are observed in BVRI with the 0.6 m telescope. Heinlein and Herbst have obtained background correction images and are analyzing the data for SN 1994ae. It is a Type Ia supernova and comparison with standard templates reveals its time of maximum and peak brightness. The data are being prepared for publication in the AJ.

Upgren and Weis continued astrometric observations with the 0.5m refractor. They and J.T. Lee continued measures on the PDS microdensitometer at Yale. A list of parallaxes and proper motions is being prepared for publication; it contains positions and orbital motion for about six resolved binary stars. Upgren and K. Ratnatunga completed a study of the effect of a maximum-likelihood method upon the motions of nearby dwarf stars. As with most stellar samples, even the best known lists of dwarfs are very incomplete in parallax, radial motion, and photometric information, and the method takes these data shortages into account. The results indicate two stellar populations, representative of the thick and thin disks, with a possible but very small third halo or spheroidal component. This work is in press in the *Astrophysical Journal*. Provisional parallaxes of four white dwarf members of the Hyades cluster, with visual magnitudes near 14, were reported at the conference on binary stars and open clusters, held at Calgary, Alberta, and edited by E.F. Milonbe and J.-C. Mermilliod.

Upgren and J. Harlow completed and published a second list of stellar radial velocities, mostly of K and M type dwarfs. One of the stars, Vys 560, shows clear evidence of variability, not previously known. With a period of 48 days and a semi-amplitude of 33 Km/s, it shows a mass function of 0.042 ± 0.01 . Stock, Upgren, Lee and A. Morales are continuing their work on image centering algorithms for the purpose of improvement of measurement of CCD and photographic images for astrometric study. Their research has been extended to objective-prism spectral images in addition to direct ones. At Yale, Upgren and P.D. Hemenway have reported on the early type stars in their proposals for inclusion in the Hipparcos Input Catalogue. Photometric and other data show many of the stars are metallic or peculiar in nature; accurate distances should reveal any differences in luminosity or color compared to normal stars.

2.2 Extragalactic

Salzer continues to work on the long-term all-sky Tully-Fisher peculiar velocities project being carried out with R. Giovanelli, M. Haynes (Cornell U.), L. DaCosta (ESO) G. Wegner (Dartmouth), and W. Fruedling (ESO) To date, over 2400 I-band images of Sc galaxies have been obtained by this group. These data are combined with existing HI profiles to allow us to derive velocity-independent distances to this

large, homogeneous sample of galaxies, and thus determine the peculiar velocities and any bulk streaming motions of galaxies in the local universe (out to 7500 km/s). In a related project, the same group are also looking at clusters of galaxies at distances to 15,000 km/s. A number of papers were completed during the past year. An analysis of the large-scale streaming motion of the nearby galaxies was published (Da Costa *et al.* 1996). This paper shows that previous reports of large bulk flows appear to be incorrect, and that the universe is more quiescent than previously thought. The derived peculiar velocity field is used to reconstruct the local mass density, which agrees well with the observed distribution of galaxies in redshift surveys. In a related paper, this sample is used to test the recent claim by Lauer and Postman for large bulk flows in the local universe (Giovanelli, *et al.* 1996). The data do not support the much publicized 690 km/s bulk flow reported by Lauer & Postman. Three additional papers were submitted during the year: two from the clusters project, presenting the observational data and its analysis (Giovanelli *et al.*, 1997a,b), and a paper which uses the cluster data to derive a value for the Hubble Constant (Giovanelli 1997c). The value obtained is $H_0 = 69 \pm 5$ km/s/Mpc.

A survey for emission-line galaxies was continued in 1996 by Salzer and collaborators V. Lipovetsky and A. Kniazev (Russia - SAO), T. Thuan (U. Virginia), T. Boroson (NOAO/KPNO), Y. Izotov (Ukraine), and J. Moody (BYU). Called KISS - KPNO International Spectroscopic Survey, the new survey combines the advantages of using a CCD detector with the wide field survey capability of a Schmidt telescope + objective prism. The survey will select candidates via line emission, and should be complete to roughly $B = 20$. This semester of observing saw the KISS team complete its first survey strip, a 1×100 degree slice which coincides with the Century Redshift Survey. Masters student Lisa Frattare spent the year writing reduction software and analysis tools necessary for the project. Her M.A. Thesis, carried out under Salzer, involved the development of astrometry and photometry routines which were added to the existing KISS software package. A complete IRAF package for the reduction of objective-prism data has been completed and is currently undergoing final testing under the supervision of Gronwall. Kniazev (1996) presented a report on the survey at I.A.U. Symposium 179.

In collaboration with Dave Westpfahl (New Mexico Tech) and former undergraduate student Lisa Radice, Salzer and graduate student Katherine Rhode continued to work on a study of nearby dwarf galaxies which possess expanding HI holes. Recent HI mapping work by Westpfahl and collaborators at the VLA has revealed that most dwarf galaxies, when mapped with sufficient spatial and velocity resolution, have expanding HI holes. They suggest that the holes are being created by multiple supernovae explosions. To test this hypothesis we obtained BVR and H-alpha images for several nearby dwarfs using the KPNO 0.9 meter telescope in February 1994 and April 1995. If the HI holes are due to SNe, then based on their predicted ages (10 - 100 million years) we'd expect to see evidence for remnant star clusters at the centers of the holes. These clusters would still be quite blue,

as they would still have their A and F main sequence stars present. Rhode completed the reductions and analysis of the April, 1995 data, and confirmed the results found by Radice from the less-deep 1994 data: no indication of any stellar sources indicative of a cluster capable of creating the HI holes was found.

In a related project, Salzer continues to collaborate with Liese van Zee and Martha Haynes (Cornell U) on an optical and HI study of dwarf galaxies with high HI mass to blue light ratios. Such systems have the potential of being relatively young (such as I Zw 18 and HI1225+01). During the past year we have been actively obtaining imaging data (UBVR and H-alpha) with the 0.9 meter telescope at KPNO, spectroscopy with the 5 meter telescope at Palomar Observatory, and HI maps from the VLA. The first of a series of papers on these dwarf galaxies, a detailed study of UGCA 20, appeared in print (van Zee *et al.*, 1996), and another describing the VLA mapping of several of these dwarfs is in preparation.

Salzer, together with M. Haynes, completed work on a review article on HI Redshift Surveys and Large-Scale Structure, which will appear as part of the Minnesota Lecture Series on Extragalactic Neutral Hydrogen. The article details the contribution that 21-cm redshift surveys have made to our understanding of the distribution of galaxies in the local universe, and makes predictions for the future of HI redshift work. In particular, it describes the special role that 21-cm observations can play relative to optical redshift surveys, namely the ability to detect low surface brightness galaxies (often dwarfs), and the application of the Tully-Fisher relation for redshift-independent distance estimates.

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