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This report covers the period from September 1998 through August 1999. Traditionally, we have included rather detailed descriptions of recent research in these pages. However, much of this material is now readily available in our departmental and individual websites. Thus, we have decided to limit the research discriptions in this report to brief descriptive titles of projects worked on during this period, along with specific internet addresses, and include only selected publications. For more information on facilities, personnel, and research programs, see the astronomy and astrophysics group web site: http://www.public.iastate.edu/∼astro.

1. PERSONNEL AND EDUCATION

Faculty and staff active during this period were P. N. Appleton, G. H. Bowen (emeritus), D. A. Carter-Lewis, J. J. Eitter (Observatory Manager), S. Kawaler, F. Krennrich, R. Lavery, R. C. Lamb (emeritus) C. Struck & L. A. Willson.

Graduate students in astronomy included R. Benson, J. Dostal, M. Reed, F. Samuelson, D. C. Smith, S. Schulz, G. W. Turner & K. Volmer. During this period, the Ph.D degree was awarded to Frank Samuelson (now at Los Alamos National Lab.).

Undergraduates involved in astronomical research during this period were Agnes Bischoff (Bernice Black Durand Fellowship awardee), Eric Hoversten, Kevin Marasinghe, & Nick Mostek.

Appleton continued his term as AURA member representative for ISU, and is also serving on the AURA Space Telescope Institute Council (STIC). Kawaler continues as Director of the Whole Earth Telescope (WET) collaboration. Willson continues to serve on the AURA Board of Directors. She also continues to serve on the Council of the AAVSO.

Dr. Stephane Le Bohec worked as a postdoctoral fellow with the Whipple Observatory. Dr. Scot J. Kleinman worked as an assistant research scientist with the group. He is working with Kawaler on the Whole Earth Telescope project, and served as the Associate Director of WET Operations.

Visitors to the department during this period were Mark Bransford (NMSU), Tony Marston (Drake), Ray Norris (Australia), Charlene Heisler (Australia), and George Rieke (Arizona). The Whole Earth Telescope completed a global observing run with two targtets in April 1999, with visiting headquarters personnel Anjum Mukudam, Atsuko Nitta (both from the Univeristy of Texas) and David Kilkenny (SAAO).

2. FACILITIES

Observations at Fick Observatory were obtained on about 70 nights during this period. CCD observations were obtained on 34 nights. The new remote control CCD autoguider is now installed and working well at the Newtonian port of the 24 inch Mather telescope. This autoguider not only increases the efficiency of observations but also improves observational safety. Photometry was obtained on about 10 nights using a WET photometer. Radial velocity observations were obtained on 25 nights for an additional 1150 observations.

ISU's International Institute of Theoretical and Applied Physics again provided facilities for the Whole Earth Telescope's run-time headquarters.

3. RESEARCH PROGRAMS

3.1 TeV Gamma-ray Astronomy

D.A. Carter-Lewis and F. Krennrich: Ground-based gamma-ray astronomy has opened up a new observational window for observing TeV (10^12 eV) photons from active galactic nuclei (AGNs), supernova remnants and pulsars. Our group, as part of the Whipple collaboration has pioneered the technique of detecting gamma-rays from using large (Whipple 10 m), ground-based optical telescopes. We are currently involved in constructing an array of seven 10 m diameter telescopes (VERITAS project) to increase the sensitivity of the technique. Current scientific work includes the measurement of energy spectra of AGNs and the study of particle acceleration in the vicinity of a supermassive black hole. We are also concerned with the detection of short bursts of gamma rays (see http://egret.sao.arizona.edu/).

3.2 Galaxies

R. J. Lavery: Observational studies of distant collisional ring galaxies investigating the evolution of the galaxy merger rate (various aspects with graduate student A. Remijan, Illinois and S. Odewahn, Arizona State). Initial results of this program, involving the analysis of HST observations, indicate a very steeply increasing merger rate with redshift. Observations of specific cases of gravitational lensing by distant clusters of galaxies. These include the production of allied image pairs (mirror-like images on the same side of the deflector), image reconstruction of extremely thin gravitational images (with graduate student L. Rimoldini, Pittsburg), and detailed dynamical study of the lensing cluster A963 (with J. P. Henry, Hawaii). See ''Research Programs'' at www.public.iastate.edu/∼ lavery.

C. Struck: Dynamical models of star and gas dynamics of several classes of collisional galaxies, including work on a bridge-plus-ring sample (with B. J. Smith, Eastern Tenn.), and ocular galaxies (with an extensive collaboration). Numerical models of quasi-steady thermal and dynamical states of the gas disks of isolated galaxies and their secular evolution as dissipative structures (with grad. student D. C. Smith). Simple analytic models of dissipative structures supported against gravity by wave pressure or turbulence, including (advective) stellar winds, multiphase gas galaxy

disks, and galaxy cores. This project involves multiple local collaborations. Analytic models and family classifications of caustic waves generated in galaxy disks by galaxy collisions. A major review article on galaxy collisions was completed. See www.public.iastate.edu/~ curt.

P. N. Appleton: Observational studies of interacting and colliding galaxies, especially in the optical, IR and radio (with V. Charmandaris, Cornell, C. Horellou, Onsala Space Obs., Y. Gao, IPAC, M. Bransford, New Mexico State, C. Struck, I. F. Mirabel, Saclay France). High resolution radio studies of the Compact Objects in Low-luminosity AGNs (COLA) project (with A. Marston, Drake University, R. P. Norris, CSIRO, C. Heisler & M. Dopita, MSSSO, M. Bransford, New Mexico State, C. Struck & J. J. Eitter). A molecular line and CCD imaging study of a Bok Globule in Cygnus (with J. J. Eitter, C. Horellou & P. Bergman, OSO). For recent publications see www.public.iastate.edu/~ pnapplet.

3.3 Stars & ISM

S.D. Kawaler: Investigations in stellar structure and evolution. Late stages of evolution: white dwarfs and horizontal branch stars. Theoretical models of stellar evolution and pulsation. Stellar seismology as a tool to probe stellar interiors using observations and matching to theoretical models. Recent results include decoding the pulsation spectrum of a pulsating subdwarf B star, and calibration of seismological distances using spectroscopy. Kawaler directs the Whole Earth Telescope (a global collaboration of observers who monitor pulsating stars continuously over a several-week period) (See http://wet.iitap.iastate.edu for more info on recent activity with the Whole Earth Telescope. For more on Kawaler's research and teaching activities, see http://www.public.iastate.edu/~sdk.)

L. A. Willson and G. H. Bowen continue to work on problems associated with mass loss from evolved red giants, especially in developing improved dynamical models and using them to interpret relevant observations. This work resulted in one published conference review (see below) and one in press in this period. Willson also began work on an article for ARAA.

Willson and former graduate student M. Bransford continued work on the production of light elements in stellar flares. This work was presented at the Chicago AAS meeting, and a journal paper is in preparation.

PUBLICATIONS

P. N. Appleton 1999, ''Collisional Ring Galaxies,'' in Galaxy Interactions at Low and High Redshifts: IAU Symposium 186, ed. J. Barnes & D. Sanders, (Kluwer, Dordrecht) p97-105

P. N. Appleton, V. Charmandaris, C. Horellou, F. Ghigo, J. L. Higdon & S. Lord 1999, ''Plasma and Dust Distributions in the Collisional Ring Galaxy VII Zw 466 from VLA and ISO Observations,'' ApJ, (In Press for Dec 10 1999)

M. A. Bransford, **P. N. Appleton**, C. F. McCain & K. C. Freeman 1999, ''The HI and Ionized Disk of the Seyfert Galaxy NGC 1144= Arp 118: A Violently Interacting Galaxy with Peculiar Kinematics,'' ApJ (In Press for Nov 10 1999)

M. A. Bransford & **L. A. Willson** 1999, ''Light Element Production in Solar Flares and Present Solar System Abundance of Li, Be, and B,'' BAAS, 193, abs. 100.07

V. Charmandaris, O. Laurent, I. F. Mirabel, P. Gallais, M. Sauvage, L. Vigroux, C. Cesarsky & **P. N. Appleton** 1999, ''Dust in the Wheel: The Cartwheel in the Mid-IR,'' A & A, 341, 69

R. F. Griffin, **J. J. Eitter** 1999, ''Spectroscopic Binary Orbits from Photoelectric Radial Velocities. Paper 146: 6 URSAE MAJORIS,'' Obs, 119, 131

M. Kaufman, E. Brinks, B. G. Elmegreen, D. M. Elmegreen, M. Klaric, **C. Struck** M. Thomasson, & S. Vogel 1999, ''The Interacting Galaxies NGC 5394/5395: A Retrograde Ring/Spiral and Its Post-Ocular Companion,'' AJ, (In press)

S. D. Kawaler 1999, ''Pulsating White Dwarf Stars,'' invited review in NATO Advanced Study Institute: Variable Stars as Astrophysical Tools, ed. C. Ibanoglu (Dordrecht: Kluwer)

S. D. Kawaler, T. Sekii, & D. O. Gough 1999, ''Prospects for Rotational Inversion of Pulsating White Dwarf Stars,'' ApJ, 516, 349

D. Kilkenny, C. Koen, D. O'Donoghue, F. Van Wyk, K.A. Larson, B. Shobbrook, D.J. Sullivan, M. Burleigh, P. Dobbie, & **S.D. Kawaler** 1999, ''The EC 14026 stars - X. A multi-site campaign on the sdBV star PG 1605+072,'' MNRAS, 303, 525

F. Krennrich, *et al.* (including **Carter-Lewis, Lamb, & Samuelson**) 1999, ''Measurement of the Multi-TeV Gamma-Ray Flare Spectra of Markarian 421 and Markarian 501,'' ApJ, 511, 149

F. Krennrich, S. Le Bohec, & T. C. Weekes, 2000, ApJ, 529, (in press, astro-ph/9909078)

R. J. Lavery 1999, ''Allied Pairs of Gravitationally Lensed Images Associated with Distant Clusters of Galaxies,'' BAAS, 30, 1416.

R. J. Lavery & A. J. Remijan 1999, ''Probing the Evolution of the Galaxy Interaction/Merger Rate Using Distant Collisional Ring Galaxies.'' In A.S.P. Conference Series, ''Galaxy Dynamics from the Early Universe to the Present,'' (in press)

M.D. Reed & S.D. Kawaler 1998, ''PG2131+066: A Binary PG1159 Type Pulsating Star,'' BAAS, Meeting 193, abstract 64.01

M. Reed, S. Kawaler, & S. Kleinman 1999, ''Examining the Pulsation Properties of Subdwarf B Stars,'' BAAS, Meeting 194, No. 104.01

A. J. Remijan, R. J. Lavery, & M. D. Reed 1999, ''Distant Ring Galaxies and the Galaxy Interaction Rate at High Redshift - II.,'' BAAS, 30, 1247.

F. W. Samuelson, *et al.* (including **Carter-Lewis, Krennrich & Lamb**) 1998, ''The TeV Spectrum of Markarian 501,'' ApJ, 501, L17

B. J. Smith, **C. Struck**, J. D. P. Kenney, & S. Jogee 1999, ''The Molecule Rich Tail of the Peculiar Galaxy NGC 2782 (Arp 215),'' AJ, 117, 1237

C. Struck & D. C. Smith, 1999, ''Simple Models for Turbulent Self-Regulation in Galaxy Disks,'' ApJ, (In press for Dec. 20, 1999)

C. Struck 1999, ''Galaxy Collisions,'' Phys. Reps., (In press for Oct. 1999)

L. A. Willson & G. H. Bowen 1998, ''Pulsation and Stellar Winds: Some Lessons Learned from Dynamical Models of the Atmospheres of Cool Stars,'' in ''Cyclical Variability in Stellar Winds,'' eds. L. Kaper & A. W. Fullerton, (New York: Springer), p. 294

C. Struck

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