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This report covers activities in the astronomy and astrophysics group at UNLV during the period January 2000 to December 2000.

1. FOREWORD

The astronomy/astrophysics group within the Department of Physics at UNLV is engaged in vigorous programs of research in the areas of active galaxies, large scale structure, stellar atmospheres, and theoretical and laboratory astrophysics related to studies of the interstellar medium. Our small ranks include an HST/STIS Co-Investigator, a former NASA/STScI Hubble Fellow, postdoctoral fellows, and research assistants. The Department is part of the Nevada Space Grant Consortium, the purpose of which is to develop research and educational opportunities in space science in Nevada, with the support of NASA, the State of Nevada, and private organizations. An important goal in our growth is to offer M.S. and Ph. D. degrees in astronomy within the Department of Physics; we anticipate formal approval of this graduate program soon. In preparation, we are offering and developing a number of graduate astronomy courses, have succeeded in securing several lines of NASA, HST, and NSF funding, and are exploring telescope partnerships with other institutions. Our vision is to achieve recognized excellence in building a small, personal but rigorous graduate astronomy program. In this report, we review activities during the 2000 calendar year.

2. PERSONNEL

UNLV physics staff with astronomical/astrophysical interests are as follows.

2.1 Faculty

- J. Farley, Professor (Ph.D. Columbia 1977) *Laser Spectroscopy of Molecular Ions with applications to Chemistry of Plasmas, Atmospheres, and the Interstellar Medium*
- J. R. King, Assistant Professor (Ph.D. Hawai'i 1993) *Stellar Atmospheres and Interiors, Photospheric Abundances, Galactic Chemical Evolution, Galactic Stellar Populations, Big Bang Nucleosynthesis, High-Resolution Spectroscopy*
- V. Kwong, Professor (Ph.D. Toronto 1977) *Laboratory Studies of Atomic Processes and Structure in Astrophysical Plasmas*
- S. Lepp, Associate Professor (Ph.D. Colorado 1984) *Atomic and Molecular Astrophysics, Theoretical Modeling of the Interstellar Medium, Supernovae, Star Formation Regions, Active Galaxies, and the Early Universe*
- G. Rhee, Associate Professor (Ph.D. Leiden 1989) *Observational Cosmology, Galaxy Clusters, Dark Matter, Galaxy Formation, Gravitational Lensing, N-body Simulations and Structure Formation*
- D. B. Shaffer, Adjunct Professor (Ph.D. Caltech 1974) *Radio Astronomy, Very Long Baseline Interferometry*
- D. Pyper Smith, Associate Professor (Ph.D. UC Santa Cruz 1968) *Stellar Photometry and Spectroscopy, Am Stars, Chemically Peculiar Stars*
- L. Spight, Associate Professor (Ph.D. Nevada, Reno 1969) *Cosmology and Interacting Galaxies*
- D. Weistrop, Professor (Ph.D. Caltech 1971) *Extragalactic Astronomy— Active Galaxies, Starforming Galaxies, BL Lac Objects, Large Scale Structure, UV and Space-based Astronomy*
- B. Zygelman, Associate Professor (Ph.D. CUNY 1983) *Theoretical/Computational Atomic and Molecular Physics with Applications to Astrophysics and Atmospheric Science*

2.2 Postdoctoral Fellows

- C. H. Nelson (Ph.D. Virginia 1994) *Active Galaxies, Starburst Galaxies, Space-based UV Spectroscopy and Photometry*

2.3 Research Staff

- Diane Eggers, Research Assistant (M.S. Nevada, Las Vegas 1998) *Data reduction and analysis of space- and ground-based data on active galaxies*
- John Kilburg (B.S. Computer Science, Nevada, Las Vegas 1993) *Systems manager responsible for the Department's highly stable diverse modern network*

3. FACILITIES

The UNLV astronomy group occupies much of the second floor of the Robert L. Bigelow Physics Building, a 70,000 square foot facility completed in 1994 containing astronomy and physics staff offices, classrooms, and teaching laboratories. We continue to enjoy convenient desk-top access to a highly stable network of Sun Unix and Linux workstations and Windows PCs.

Departmental facilities include a 16-inch computer-operated student training telescope mounted on the roof of the Bigelow building and numerous computer workstations dedicated to digital image processing. The Department is also part of a four-college consortium that operates the 30-inch Automated Photometric Telescope at the Fairborn Observatory site at Washington Camp near Nogales, AZ. Additionally, the Department is a member of the National Undergraduate Research Observatory which shares 60% of the observing time on Lowell Observatory's 31-inch telescope on Anderson Mesa near Flagstaff, AZ. The Department also houses the W.M. Keck Computational Physics Labora-

tory, a cluster of multiple and single CPU computers with a peak performance of ~ 8 GFLOPs; the software environment includes a wide variety of compilers, Internet tools, network authentication and notification, data reduction packages, and custom-written software. This powerful system enables UNLV researchers to attack grand challenge problems in astrophysics.

4. RESEARCH

As a Co-Investigator on the team which developed the Space Telescope Imaging Spectrograph (STIS), Donna **Weistrop** is participating in several investigations using HST and STIS. Research Associate Dr. Charles **Nelson** has been working with Weistrop and other STIS team members to determine the range of masses of black holes at the centers of galaxies. Their results for the upper limit to the mass of the black hole in the S0 galaxy NGC 7332 were reported at the 196th meeting of the AAS, held in June 2000 in Rochester, NY.

Weistrop, graduate students M. **Hancock** and K. **Plaks**, and Research Assistant D. **Eggers** continued their investigations of young stellar populations in the galaxies NGC 3395/3396, NGC 3994/3995 and NGC 4194. Comparisons with Starburst99 models indicate many of the starforming knots are less than 10 million years old. There is no obvious age segregation of the knots in the central regions of the galaxies. Results for NGC 3395/3396 were reported by Hancock at the 196th AAS meeting. Weistrop and Eggers reported results for NGC 4194 at the 196th AAS meeting and the Gas and Galaxy Evolution Conference, held May 2000 in Socorro, NM. Undergraduates R. **Bachilla** and J. **Yates** analyzed emission lines in the groundbased spectra of the galaxies to estimate ages, reddening, and star formation rates. Their conclusions are consistent with the HST results. Weistrop's work is supported by a continuing contract for the STIS team and a grant from the Nevada Space Grant Consortium.

King continued numerous investigations into stellar photospheric abundances. In collaboration with A. Boesgaard (U. Hawaii), he carried out a study of Be abundances in Pop I field dwarfs and Hyades open cluster dwarfs utilizing high resolution echelle spectroscopy from the Keck 10-m. The results suggest correlated, simultaneous depletion of Be and Li in Pop I F dwarfs indicative of the action of rotationally induced mixing. Two ApJ papers containing the results were submitted.

King also initiated a study of existing halo Be and B abundance data. Utilizing four different sets of stellar parameters, consistent Be, B, Fe, and O abundances were obtained. The implications for production of Be and B constitute work in progress. King also collaborated with K. Cunha (Nac. Obs. Brazil) and V. Smith (U. Texas El Paso) on the Boron-Oxygen chemical evolution relation manifested by Pop I F dwarfs. The results indicate a B-O logarithmic slope of ~ 1.4 , requiring a primary production component. The findings were presented at the IAU meeting in Manchester in August, and submitted for publication to AJ.

King, in collaboration with D. Soderblom (STScI), continued analysis of low resolution spectra of 5000 nearby solar-type stars selected from the *Hipparcos* catalog. The fo-

cus of this year's work was to begin determination of these stars' activity levels and gross metal abundance from the spectra. King's work was supported by a new 3-year NSF grant as part of the NASA/NSF NStars program.

King also continued work on deriving a host of spectroscopic abundances in various little evolved open cluster stars (as part of the WIYN Open Cluster Study in collaboration with a team at Indiana U.) and globular cluster stars (in collaboration with A. Boesgaard at U. Hawaii).

5. INSTRUCTION

The Department's two introductory astronomy courses aimed at non-science majors had final enrollments of 681 students during the 2000 calendar year. The optional introductory laboratory course enrolled 406 students. An honors and associated laboratory course with a 50% astronomy component contained 26 students. Two graduate courses—Astrophysics of Nebulae & AGN and Astrophysics II—were offered by Weistrop and **Rhee**, and each enrolled 4 students. The upper level undergraduate courses Projects in Observational Astronomy and Introduction to Astrophysics were offered by Smith and King, enrolling 6 students. King and **Lepp** prepared to offer new graduate courses in Stellar Atmospheres and the Interstellar Medium during the 2001 calendar year.

Farley served as a reviewer of Tipler's introductory physics text for W.H. Freeman publishers. King served as a reviewer for McGraw-Hill publisher's CD-ROM animations accompanying Fix's *Astronomy 2nd edition* introductory text.

King is continuing efforts at innovating the introductory solar system astronomy course. These include pre- and post-concept testing, development and employment of collaborative learning exercises during lecture, utilizing a suite of classroom assessment techniques, instituting homework exercises with a specific focus on critical thinking and logic via quantitative reasoning, and provision of numerous web-based resources to facilitate student learning in the course. King, Weistrop, and Rhee reviewed introductory astronomy text offerings and took a significant step by adopting a rigorous popular-level (non-text) book for use in our introductory offerings. We believe this serves our students well via its conciseness, quality of explanation and presentation, and cost. The lack of a formal text (with the usual unmanageable litany of information) and associated ancillaries has placed greater emphasis on individual instructor effort and focus; we believe, however, that this is one of our strengths, and benefits our students.

6. MISCELLANEOUS

6.1 Meeting Participation

Research Associate **D. Eggers**, graduate student **M. Hancock**, King, Lepp, Nelson, Rhee, graduate student **S. Thanki**, and Weistrop made 7 poster presentations at the Atlanta and Rochester AAS meetings in January and June. King made poster presentations at the IAU Joint Discussion 8 in Manchester in August, the Fourth Tetons Summer Conference in Wyoming in July, and the SPIE Technical Conference on Astronomical Telescopes and Instrumentation in Mu-

nich in March. Eggers, Nelson, and Weistrop presented a poster at the Gas and Galaxy Evolution Conference in Socorro in May.

Farley made poster presentations at the APS meeting in Storrs, CT in June and the Twenty-seventh IEEE International Conference on Plasma Science in June in New Orleans. **Kwong** presented a poster at The Challenge of High Resolution X-Ray through IR Spectroscopy of Photoionized Plasmas conference held at the University of Kentucky in November.

Farley and graduate student **S. Mitchell** both made oral presentations at the Fifty-fifth Ohio State Molecular Spectroscopy Symposium in June. Nelson made an oral presentation at the 196th AAS meeting in Rochester in June.

6.2 Invited Talks

Lepp delivered an invited talk “The role of molecules in the early universe” at the conference *Molecules and dust in regions of high excitation* in London in February. **Zygelman** presented the invited talk “Theoretical studies of charge transfer involving multiply charged ions at low collision velocities,” at the Second IAEA Research Co-ordinating Meeting “Charge Exchange Cross Section Data for Fusion Plasma Studies” in Vienna in September.

King, Lepp, and Zygelman made a total of 4 invited colloquium/seminar presentations at the University of Delaware, University of Georgia, and University of Minnesota.

6.3 Grants and Proposals

The astronomy/astrophysics group vigorously pursued a number of grant opportunities during 1999. Farley, Lepp, King, Kwong, Rhee, Smith, and Weistrop were PI or Co-Is on newly funded grants totaling some \$1.0 million from NSF, NASA, DOE, private foundations, and internal sources. Farley, Lepp, Kwong, and Rhee were PI or Co-Is on submitted grants to NASA, NSF, DOE, private foundations, and internal competitions totaling some \$1.4 million.

King, Nelson, Rhee, and Weistrop were PI or Co-Is on observing proposals for some 45 nights of time on ground-based facilities including the Keck 10-m, the Japanese national Subaru telescope, the Hobby-Eberly Telescope, the MDM facility, and various KPNO and CTIO telescopes. Despite rigorous competition, our success rate was an enviable 90% based on number of nights awarded. King, Nelson, **Spight**, and Weistrop were PI or Co-Is on Hubble Space Telescope proposals requesting some 47 orbits.

6.4 Professional Service

Farley, King, Lepp, Weistrop, and Zygelman served as reviewers for some 15 manuscripts submitted to *A&A*, *ApJ*, *ApJ Letters*, *MNRAS*, *J. Phys. Chem.*, *Phys. Rev. A*, and *Phys. Rev. Lett.*

Farley, King, Lepp, Weistrop, and Zygelman also served as NASA, NSF, and Research Corporation proposal review panelists.

Weistrop continued service as Chair (1999-2001) of the National Undergraduate Research Observatory (NURO) Steering Committee. NURO is a consortium of several col-

leges and universities, which, together with Lowell Observatory, operate a 31-inch telescope at Anderson Mesa southeast of Flagstaff, AZ. As a member of NURO, UNLV is guaranteed several nights of observing time each year. NURO membership provides UNLV students with the opportunity to observe with a research class telescope at a dark site. Weistrop also served on two senior NASA agency review panels, an external committee reviewing the Department of Physics and Astronomy at Georgia State University, and on the American Astronomical Society Nominating Committee (2000-2002). Additionally, she chaired a session on Supermassive Black Holes at the January AAS meeting.

Zygelman chaired a session at the Second IAEA Research Meeting “Charge Exchange Cross Section Data for Fusion Plasma Studies” in September.

6.5 Outreach and Community Service

Farley continued to host an organization of Las Vegas area high school physics teachers, and directed the summer Research Experience for Teachers program. He also organized and participated in a Physics Department Open House for local high school physics students in March. Farley also organized a Physics Olympics competition for local high school physics students in April, and presented physics demonstrations to a science class at Thurman White Middle School (Henderson, NV) in November.

King served as an e-mail mentor to two Silverado High School (Las Vegas) students as part of their physics class projects on black holes. King also served as an e-mail mentor to a Gray-New Gloucester (Maine) High School student as part of his science project on space exploration. King hosted an Astronomy section/tour as part of the Physics Department Open House for local high school physics students in March. He also appeared as an invited guest on the local John David Wells radio talk show (KNUU 970 AM) in May to combat misinformation surrounding the planetary alignment.

Pyper-Smith hosted a telescope observing session for the Gibson Elementary School (Las Vegas) 3rd and 4th grades in March, and served as Faculty consultant to the Las Vegas Astronomical Society.

Rhee made astronomy presentations at Sunrise Elementary School (Las Vegas) for 4th and 5th graders.

Weistrop described some of her STIS team’s results in the public lecture “Star Formation, Active Galaxies, and Black Holes: Recent Observations with the Hubble Space Telescope” at the Space Science Center of Columbus State University. She also presented a public UNLV University Forum Lecture “Recent Observations with the Hubble Space Telescope, Colliding Galaxies and Active Galaxy Nuclei” to a standing room only crowd. Weistrop continued her service on the Nevada Rhodes Scholarship Committee of Selection.

PUBLICATIONS

The publication list includes all astrophysics-related papers published during the 2000 calendar year by Department members.

Bower, G.A., Green, R.F., Quillen, A.C., Danks, A., Gull, T., Hutchings, J., Joseph, C., Kaiser, M.E., **Weistrop, D.**,

- Woodgate, B., Malumuth, E.M., & **Nelson, C.** 2000, "The Ionization Source in the Nucleus of M84, *ApJ*, 534, 189
- Brumley, W.C., Grange, A.H., Kelliher, V., Patterson, D.B., Montcalm, A., Glassman, & **Farley, J.W.**, "Environmental Screening of Acidic Compounds Based on Capillary Zone Electrophoresis/Laser-Induced Fluorescence Detection with Identification by Gas Chromatography/Mass Spectrometry and Gas Chromatography/ High-Resolution Mass Spectrometry," *Journal of AOAC International*, 83(5), 1059
- Crenshaw, D.M., Kraemer, S.B., Hutchings, J.B., Danks, A., Gull, T., Kaiser, M.E., **Nelson, C.H. & Wiestrop, D.** 2000, "Space Telescope Imaging Spectrograph Echelle Observations of NGC 4151: Variable Ionization of the Intrinsic UV Absorbers," *ApJ*, 545, L27
- Crenshaw, D.M., Kraemer, S.B., Hutchings, J.B., Bradley II, L.D., Gull, T., Kaiser, M.E., **Nelson, C.H.**, Ruiz, J.R., & **Weistrop, D.** 2000, "A Kinematic Model for the Narrow-Line Region in NGC 4151," *AJ*, 120, 1731
- Eggers, D., Shaffer, D. B., & Wiestrop, D.** 2000, "Optical Variability of Radio-Luminous PG Quasars," *AJ*, 119, 460
- Deliyannis, C. P., Cunha, K., **King, J. R.**, & Boesgaard, A. M. 2000, "Beryllium and Iron Abundances of the Solar Twins 16 Cygni A and B," *AJ*, 119, 2437
- Fang, Z., Chen, D., & **Kwong, V.H.S.** 2000, "Measurement of charge-transfer-rate coefficients of ground state He^+ with N_2 and CH_4 at electron-volt energies," *Phys. Rev. A* 62, 42709
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- Kaiser, M.E., Bradley II, L.D., Hutchings, J.B., Crenshaw, D.M., Gull, T.R., Kraemer, S.B., **Nelson, C.H.**, Ruiz, J., & **Wiestrop, D.** et al. 2000, "The Resolved Narrow Line Region in NGC 4151," *ApJ*, 528, 260
- Karchenko, V., Dalgarno, A., **Zygelman, B.**, & Yee, J.H., "Energy transfer in collisions of oxygen atoms in the terrestrial atmosphere, *J. Geophys. Res.*, 105, 24
- King, J. R.** 2000, "Galactic [O/Fe] and [C/Fe] Ratios: The Influence of New Stellar Parameters," *AJ*, 120, 1506
- King, J. R.** 2000, "Spectroscopic Abundances in Cool Pleiades Dwarfs and NGC 2264 Stars," *ApJ*, 533, 944
- King, J. R.** 2000, "The Lithium-Rotation Correlation in the Pleiades Revisited," *AJ*, 119, 859
- Kwong, V.H.S.**, Chen, D., & Fang, Z. 2000 "Dissociative charge transfer between ground-state He^+ and CO at electron-volt energies, *ApJ*, 536, 954
- Kraemer, S.B., Crenshaw, D.M., Hutchings, J.B., Gull, T.R., Kaiser, M.E., **Nelson, C.H.**, & **Weistrop, D.** 2000, "Space Telescope Imaging Spectrograph Longslit Spectroscopy of the Narrow Line Region of NGC 4151. II. Physical Conditions along Position Angle 221 degrees," *ApJ*, 531, 278
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- Rees, M.N., Amy, P., Jacobson, E., & **Weistrop, D.E.** 2000, "A Successful Program for Women Faculty and Graduate Students in Natural Sciences, Mathematics, and Engineering at the University of Nevada, Las Vegas," *Journal of Women and Minorities in Science and Engineering*, 6(4)
- Schaefer, B. E., **King, J. R.**, & Deliyannis, C. P. 2000, "Superflares on Ordinary Solar-Type Stars," *ApJ*, 529, 1026

Jeremy King