

University of Wyoming
Department of Physics & Astronomy
Laramie, Wyoming 82071

[S0002-7537(93)03051-3]

The following report covers the Department activities from October 2001 through October 2002.

1. INTRODUCTION

The Department of Physics and Astronomy has experienced substantial new growth in the past year. In addition to the two new tenure-track astronomers hired for 2001/02, two additional tenure-track faculty have been integrated into the department this academic year. The graduate program in astronomy has been reinstated, and six new graduate students have entered the program this fall. The number of undergraduate majors has increased from a recent low of 17 to the present enrollment of 55. The REU and RET programs continue to be a success.

New instrumentation has been built for the 2.3 m and 0.6 m telescopes, a newly-refurbished planetarium is drawing large audiences, and the department is continuing to develop curricula for the new "Physics Plus" program, wherein students concentrate their study in physics plus meteorology, biology, or journalism.

2. PERSONNEL

Astronomy Faculty:

Antonio Bianchini, Cataclysmic variables; Mike Brotherton, Quasars and active galaxies; Ron Canterna, Gamma Ray Bursts; Daniel Dale, Infrared galaxies and clusters; Bob Howell, Planetary science and Io volcanism; Chip Kobulnicky, Galaxy chemical abundances; Harold Nations, Chromospherically active stars; Mike Pierce, Galaxies; instrumentation; and J. Allyn Smith, Stellar evolution and white dwarfs.

PhD Recipients Kenegunda Belle (Planetary Science Institute), Jennifer Cash (South Carolina State U.), Mark Huber (U. British Columbia), Elena Mason (ESO), Bob Thompson (JPL)

New Graduate Students:

Sabrina Anderson, Jon Darnel, Sehyun Hwang, Dan Kiminki, Cassandra Paul, Chris Rodgers

3. FACILITIES

3.1 Wyoming Infrared Observatory

Over the last academic year, Physics & Astronomy has made significant strides in developing cutting edge General User Instrumentation. NASA EPSCoR funding was used to upgrade the existing Cassegrain optical imager for the 2.3 m telescope to a wide-field 2048² CCD prime focus camera. In addition, an integral field, fiber-fed optical spectrograph that utilizes volume-phase holographic gratings is nearing completion.

3.2 Red Buttes Observatory

After a lightning strike crippled the 0.6 m in August 2002, the observatory has been totally restored. New computer systems, telescope electronics, security innovations, observational instrumentation, and an upgraded electrical system have been incorporated. The mirrors have been re-aluminized, and the facility has been physically restructured within. RBO will participate in a world-wide observatory response to major astronomical events (e.g. gamma-ray bursts) that will provide NASA with ground-based support. This project is funded by NASA EPSCoR.

4. RESEARCH

Antonio Bianchini is on sabbatical leave from the University of Padua. His main research activities focus on: observational studies of selected *cataclysmic variables* (CVs) and, in particular, of Intermediate Polars (IPs); evolutionary models of *post-novae* with IP characteristics; and the optical identification of *γ ray bursts*.

Assistant Professor **Michael Brotherton**'s research seeks to improve our understanding of active galactic nuclei (AGNs), their evolution, and their relationship to their host galaxies. His work on *intrinsic AGN absorbers* involves radio-selected BALQSOs, using radio (VLA), spectropolarimetry (Keck), X-ray (Chandra, XMM), and near-IR (IRTF) observations. These programs are identifying serious shortcomings in the popular notion that BALQSOs are otherwise normal quasars seen at large angles and that all quasars possess high-velocity outflows.

Brotherton also works on *AGN emission processes*. The broad emission lines trace the kinematics and physical conditions of gas in the immediate environment of the central engine. The dynamics, geometry, abundances, and origin of this gas are not yet understood. Recently however significant progress has been made in linking the strongest observed trends, the so-called "eigenvector 1" relationships which include X-ray and radio properties, with the accretion rate (Eddington fraction). Furthermore, it now appears that the central black hole mass can be rather accurately estimated based solely upon the linewidth of the Balmer lines and the continuum luminosity.

Brotherton discovered two spectacular instances of massive post-starburst populations in interacting quasar systems: a radio-quiet/radio-loud binary quasar, and a *post-starburst quasar* with a Milky Way's worth of stars formed at one epoch.

Assistant Professor **Daniel Dale** continues to study the *infrared properties of galaxies*. Current efforts focus on developing a phenomenological model for the infrared spectral energy distributions (3-1100 μ m) of normal star-forming galaxies, and using near-infrared integral field spectroscopy to study their bright star-forming regions. This line of research will be enhanced with the launch of the Space Infrared Tele-

scope Facility. Dale's first SIRTf project focusses on a complete imaging and spectroscopy campaign of 75 nearby galaxies ("SINGS: The SIRTf Nearby Galaxy Survey"; PI R. Kennicutt), a SIRTf Legacy Science project.

Dale's second area of research involves probing the environmental influences of the galaxy cluster environment on the *Tully-Fisher relation*, a relation frequently used to measure extragalactic distances and peculiar motions. This ongoing study utilizes spiral galaxy rotation curves obtained on the Palomar 5 m, and recently has concentrated on understanding the effects that the hot X-ray intracluster gas has on spiral galaxies.

Chip Kobulnicky joined the faculty as Assistant Professor after leaving an Associate Scientist position at the University of Wisconsin, Madison. In collaboration with the University of Wisconsin and the South African Astrophysical Observatory, Chip has been assisting with the design of an *advanced imaging spectrograph and polarimeter* which will become the workhorse prime focus instrument on the 10 m Southern African Large Telescope in 2004. With the Wisconsin team, Chip presented a talk on the design of PFIS at the SPIE conference on astronomical instrumentation in Kona, Hawaii in August.

In collaboration with researchers at the University of California, Santa Cruz, Chip is continuing to study the *chemical properties of high-redshift galaxies* to understand the process of chemical enrichment in the universe and the story of galaxy evolution with cosmic time. In collaboration with Kelsey Johnson at the University of Wisconsin, Chip is pursuing infrared imaging of ultra-young radio star clusters in nearby galaxies. These clusters are still hidden by their birth molecular clouds, and may have ages less than 100 Myr, making them the youngest examples of newly-forming globular clusters yet discovered. In collaboration with Crystal Martin at UC Santa Barbara, Chip continues to study the X-ray properties of starburst galaxies and the rate at which they eject metals into the intergalactic medium. Their work was published in the August issue of the *Astrophysical Journal* and has been featured in the November issue of *Astronomy Magazine* and by the July 25 *Astronomy Picture of the Day*, the internet's most visited astronomy website! Chip is also a member of the 12-member GLIMPSE (Galactic Legacy Infrared MidPlane Survey Extraordinaire) team which will use the SIRTf Observatory to conduct a four-year survey of the plane of the Milky Way at four infrared wavebands.

Visiting Assistant Professor **J. Allyn Smith** continues to work in the *Sloan Digital Sky Survey standard star system*. He is currently developing a southern hemisphere extension with D.L. Tucker (FermiLab) as part of a four year NOAO Survey Program. Smith also recently joined the *SNAP (SuperNova Acceleration Probe) calibration team*.

5. EDUCATION & OUTREACH

The department has spearheaded the development of a new Physics Computer Lab Facility. The 15 computers and video projector will be used to enhance the teaching of both service and junior/senior level courses during the day, and to serve as a linked cluster for advanced computing power during the evening.

Our observatories, planetarium, and the Wyoming Space Grant Consortium form the foundation of many outreach activities. The newly-refurbished UW planetarium is now hosting over 3500 visitors yearly, in both Friday evening showings and special presentations to public schools. Physics & Astronomy holds an annual WIRO Open House on homecoming weekend. In 2002, we ferried nearly 150 visitors to the summit to view the stars through the 2.3 m. A new initiative by the Wyoming Space Grant Consortium is expanding the Women in Science program. Space Grant is working with representatives from the National Weather Service Cheyenne and Riverton offices to bring 200 visiting students to visit campus scientists in their labs, and to hear a forum led by a panel of scientists. We assisted in hosting and judging entries in the state high school science fair, and we held our second annual contest for secondary schools. This past year the contest challenge had a photo-journalism theme, whereby the students submitted a photograph taken by them accompanied by a short caption explaining how the picture depicts the impact of physics on their lives.

The NSF-funded REU program hosted eight students during the summer of 2002. In addition to receiving individual mentoring, each student learned the fundamentals of astronomical observing by participating in RBO and WIRO runs. WyoSTAR (Wyoming Students, Teachers, and Researchers) is a program that joins astronomy educators and students across the state with amateur and professional astronomers. Currently we are focusing on summer research mentoring of high school science teachers; three teachers were involved in research this past summer.

Michael Brotherton has sold his first novel to Tor which will be published in hardback in the fall of 2003. *Star Dragons* features an expedition to search for alien creatures living in the accretion disk of SS Cygni, a cataclysmic variable binary star system.

PUBLICATIONS

The publication list includes all papers published or submitted between October 2001 and October 2002.

Brotherton, M. S., Croom, S. M., De Breuck, C., Becker, R. H., & Gregg, M. D. 2002, *AJ*, in press "The Twice-Overlooked, Second FR II Broad Absorption Line Quasar LBQS 1138-0126"

Brotherton, M. S., Ly, C., Wills, B. J., Laurent-Muehleisen, S. A., van Breugel, W., & Antonucci, R. R. J. 2002, *AJ*, 124, 1943 "Multiband VLA Observations of the Faint Radio Core of 3CR 68.1"

Brotherton, M. S., Grabelsky, M., Canalizo, G., van Breugel, W., Filippenko, A. V., Croom, S., Boyle, B., & Shanks, T. 2002, *PASP*, 114, 593 "Hubble Space Telescope Imaging of the Post-Starburst Quasar UN J1025-0040: Evidence for Recent Star Formation"

Brotherton, M. S., van Breugel, W., Smith, R. J., Boyle, B. J., Shanks, T., Croom, S. M., Miller, L., & Becker, R. H. 2002, *ApJL*, 571, L191, Erratum "Discovery of Radio-Loud Broad Absorption Line Quasars Using Ultraviolet Excess and Deep Radio Selection"

Brotherton, M. S., Green, R. F., Kriss, G. A., Oegerle, W., Kaiser, M. E., Zheng, W., & Hutchings, J. B. 2002, *ApJ*,

- 565, 800 “Far Ultraviolet Spectroscopic Explorer Observations of the Seyfert 1.5 Galaxy NGC 5548 in a Low State”
- Brotherton, M. S.** 2002, ASP Conf. Ser. 255: Mass Outflow in Active Galactic Nuclei: New Perspectives, 157 “Radio-Selected Broad Absorption Line Quasars”
- Brotherton, M. S.** 2002, ASP Conf. Ser. 255: Mass Outflow in Active Galactic Nuclei: New Perspectives, 127 “Far Ultraviolet Spectroscopic Explorer Observations of the Seyfert 1.5 Galaxy NGC 5548 in a Low State”
- Burgh, E. B., Nordsieck, K. H., **Kobulnicky, H. A.**, Williams, T. B., O’Donoghue, D., Smith, M. P., & Percival, J. W. 2002, SPIE, 4841-164 “The Prime Focus Imaging Spectrograph for the Southern African Large Telescope: Optical Design”
- Chapman, S., Helou, G., Lewis, G. & **Dale, D.** 2002, ApJ, submitted “The Bi-Variate Luminosity-Color Distribution of IRAS Galaxies, and Implications for the High Redshift Universe”
- Chapman, S., Smail, I., Ivison, R., Helou, G., **Dale, D.** & Lagache, G. 2002, ApJ, **573**, 66 “Optically faint counterparts to the ISO-FIRBACK 170 μm population: the discovery of cold, luminous galaxies at high redshift”
- Contursi, A., Kaufman, M., Helou, G., Hollenbach, D., Brauhar, J., Stacey, G. **Dale, D.**, Malhotra, S., Rubio, M., Rubin, R. & Lord, S. 2002, AJ, **124**, 751 “ISO-LWS observations of the two nearby spiral galaxies: NGC 6946 and NGC 1313”
- Dale, D.** & Helou, G. 2002, ApJ, **159**, 576 “The Infrared Spectral Energy Distribution of Normal Star-Forming Galaxies: Calibration at Far-Infrared and Submillimeter Wavelengths”
- Dale, D.**, Helou, G., Neugebauer, G., Soifer, B.T., Frayer, D. & Condon, J. 2001, AJ, **122**, 1736 “Multiwavelength Observations of the Low Metallicity Blue Compact Dwarf Galaxy SBS 0335-052”
- Dale, D.** 2002, *The IGM/Galaxy Connection—The Distribution of Baryons at $z=0$* , in press “Signatures of Galaxy-Cluster Interactions: Spiral Galaxy Rotation Curve Asymmetry, Shape, and Extent”
- Dale, D.** & Helou, G. 2002, BAAS, **200**, 43.05 “The Infrared Spectral Energy Distribution of Normal Galaxies: Calibration at Far-Infrared and Submillimeter Wavelengths”
- Dale, D.** & Helou, G. 2002, *NASA Origins Conference “Galaxy Spectral Energy Distributions from the Near-Infrared through Radio”*
- Elsner, Gladstone, Lewis, Waite, Crary, Grodent, **Howell et al.** 2002, APS Conf., B17.078 “Observations of the Jovian System with the Chandra X-ray Observatory”
- Elsner, R.F., Gladstone, G.R., Waite, J.H., Crary, F.J., **Howell, R.R. et al.** 2002, ApJ, **572**, 1077 “Discovery of Soft X-Ray Emission from Io, Europa, and the Io Plasma Torus”
- Elsner, R.F., Waite, J.H., Crary, F., Majeed, T., Gladstone, G.R., Lewis, W.S., Ford, P.G., **Howell, R.R. et al.** 2002, BAAS, DPS meeting, 34, 36.05 “Chandra X-ray Observations of the Jovian System”
- Filippenko, A. V., **Brotherton, M.**, & Nandra, P. 2002, IAU Circ., No., 7905, 4 “Supernova 2002cw in NGC 6700”
- Gregg, M. D., Lacy, M., White, R. L., Glikman, E., Helfand, D., Becker, R. H., & **Brotherton, M. S.** 2002, ApJ, **564**, 133 “The Reddest Quasars”
- Hackman, C.L., **Smith, J.A.**, **Canterna, R.W.**, Tucker, D.L., Neilsen, E.H., Allam, S., Stoughton, C., Chen, B., Newberg, H.J., Pier, J.R. BAAS, 200, 9.03 “An Investigation of the Age and Metallicity of Galactic Star Clusters”
- Howell, R.R.** 2001, BAAS, DPS meeting, 33, 24.05 “X-Ray Emission from the Galilean Satellites”
- Howell, R.R. et al.** 2001, Journal of Geophysical Research, **106**, E12, 33129 “Ground-based observations of volcanism on Io in 1999 and early 2000”
- Jessup, K.L., Spencer, J., Ballester, G.,E., Yelle, R., Roessler, F., **Howell, R.** 2002, BAAS, DPS meeting, 34, 40.02 “Spatially resolved UV spectra of Io’s Prometheus Plume and anti-Jovian hemisphere”
- Johnson, K. E., **Kobulnicky, H. A.**, Massey, P. & Conti, P. S. 2001, ApJ, **559**, 864 “A Sample of Extragalactic Compact HII Complexes”
- Kobulnicky, H. A. et al.** 2002, SPIE, 4841-183 Percival, J. W. 2002, SPIE, 4841-183 “The Prime Focus Imaging Spectrograph for the Southern African Large Telescope: Operational Modes”
- Lu, N., Helou, G., Werner, M., Dinerstein, H., **Dale, D. et al.** 2002, ApJ, in press “Infrared Emission of Normal Galaxies from 2.5 to 12 μm : Spectra, Near-Infrared Continuum and Mid-Infrared Emission Features”
- Malhotra, S., Kaufman, M., Hollenbach, D., Helou, G., Rubin, R., Brauhar, J., **Dale, D.** et al. 2001, ApJ, **561**, 766 “Far-Infrared Spectroscopy of Normal Galaxies: Physical Conditions in the Interstellar Medium”
- Martin, C. L., **Kobulnicky, H. A.** & Heckman, T. 2002, ApJ, **574**, 663 “The Metal Content of Dwarf Starburst Winds: Results from Chandra Observations of NGC 1569”
- Nations, H.L.** & **Pierce, M.J.** 2002, BAAS, 200, 64.07 “A Fiber-Coupled, VPH Grating Spectrograph for the Wyoming Infrared Observatory”
- Nordsieck, K. H., Jahnig, K. P., Burgh, E. B., **Kobulnicky, H. A.**, Percival, J. W. & Smith, M. P. 2002, SPIE, 4843-24 “Instrumentation for High-Resolution Spectropolarimetry in the visible and far-ultraviolet”
- Ortolani, S., Tamburini, F., **Bianchini, A.** 2002, ASP Conf. Ser.: Bio-Astronomy “Polarimetric and Spectropolarimetric Properties of Late-Spectral-Type Stars and Extrasolar systems”
- Pierce, M.J.** & Berrington, R.C. 2001, BAAS, 199, 100.02 “The Intrinsic Precision in the Fundamental Plane of Elliptical Galaxies”
- Pierce, M.J.** & **Nations, H.L.** 2002, BAAS, 200, 64.06 “A New Prime Focus Camera for the Wyoming Infrared Telescope”
- Smith, JA et al.** 2002, AJ, **123**, 2121 Uomoto, A, Gunn, JE, Hamabe, M, Watanabe, M, Tolea, A, Henden, A, Annis, J, Pier, JR, McKay, TA, Brinkmann, J, Chen, B, Holtzman, J, Shimasaku, K, and York, DG 2002, AJ, **123**, 2121 “The $u'g'r'i'z'$ Standard Star System”
- Spencer, J.R., Bagenal, F., Davies, A.G., de Pater, I., Herbert, F., **Howell, R.R. et al.** 2002, in The Future of Solar Sys-

- tem Exploration (2003-2013), ASP Conference Proceedings, 272, 201 “The Future of Io Exploration”
- Tappert, C., Thorstensen, J. R., Fenton, W. H., Bennert, N., Schmidtobreick, L., **Bianchini, A.** 2001, A&A, 380, 533 “The cataclysmic variable CW 1045+525: A secondary-dominated dwarf nova?”
- Tamburini, F., **Bianchini, A.**, 2002, in The physics of CVs and related objects, eds. B.T. Gnsicke, K. Beuermann, K. Reinsch, ASP conference series vol XXX. “Floquet Analysis in Accretion Disk dynamics”
- Tamburini, F. Ortolani, S., **Bianchini, A.** 2002, A&A, 394, 675 “Polarization statistics of extra-solar systems”
- Yuan, Q., Green, R. F., **Brotherton, M. S.**, Tripp, T. M., Kaiser, M. E., & Kriss, G. A. 2002, ApJ, 575, 687 “Associated Absorption Lines in the Radio-loud Quasar 3C 351: Far-Ultraviolet Echelle Spectroscopy from the Hubble Space Telescope”

D.A. Dale