Space Telescope Science Institute
Baltimore, Maryland 21218

This report covers the period October 1995 through September 1996.

1. INTRODUCTION

The Space Telescope Science Institute (ST ScI), operated by the Association of Universities for Research in Astronomy (AURA), directs science operations for the *Hubble Space Telescope* (*HST*), which was launched into a near-earth orbit in the spring of 1990. ST ScI is also the home to an active scientific staff of more than one hundred people employed by AURA, the European Space Agency (ESA), and the Computer Science Corporation (CSC), which is under contract to provide ground support and data analysis facilities.

This year was characterized by a huge effort in preparation for the second *HST* Servicing Mission (SM2), scheduled for launch on February 13, 1997. In this mission, the *Space Telescope Imaging Spectrograph* (*STIS*), and the *Near Infrared Camera and Multi-Object Spectrometer* (*NICMOS*) will replace the *Goddard High Resolution Spectrograph* (*GHRS*) and the *Faint Object Spectrograph* (*FOS*). In addition, other parts of the telescope will be replaced or upgraded. These include the installation of a new *Solid-State Recorder* (*SSR*) and a refurbished analog tape recorder, and the replacement of the *Fine Guidance Sensor* (*FGS-2*) by a refurbished one (with improved optics).

The *HST* observing efficiency has been continuously improving since launch, and it has currently reached 55%, compared to the 33% experienced in the first year of operation.

The deadline for proposals for Cycle 7 of *HST* observations was on September 13, 1996. About 1300 proposals were received.

Dr. Mike Hauser, who was the Chief of the Laboratory for Astronomy and Solar Physics at the Goddard Space Flight Center (GSFC), entered the job of Deputy Director at ST ScI on October 2, 1995.

As a part of its contribution to the promotion of scientific interaction, ST ScI hosted during the past year a number of scientific meetings. The topic of the annual ST ScI May Symposium was *The Extragalactic Distance Scale*. This meeting was held at ST ScI on May 7–10, 1996. Twenty-four invited talks and more than 80 posters were presented during the meeting, which was attended by about 120 participants. Many methods of determining distance, relying typically on knowledge of the luminosity of some objects (''standard candles''), intrinsic physical sizes (geometrical methods), velocities, or other relations between some of the properties of the objects (*e.g.*, the luminosity and velocity) have been described. It was encouraging to note that the differences between the ''high'' and ''low'' values of the Hubble constant have now been reduced to about 20%.

About 200 participants attended IAU Symposium 179, *New Horizons from Wide Field Imaging*, on August 26–30, 1996. The Symposium was hosted by ST ScI and The Johns Hopkins University (JHU). The main goal of the meeting was to bring together researchers involved in the various sky surveys (both existing and future ones), across the spectrum, in an attempt to explore the relations between the surveys and astrophysical opportunities, and to build strategies for working with the huge (multiple terabyte) databases associated with the surveys. The proceedings will be edited by Brian McLean and published by Kluwer.

On March 25–27, 1996, the Galaxies Journal Club hosted a mini workshop entitled: *The Evolution of Low Luminosity Galaxies and Faint Blue Galaxies*. The idea behind the workshop was to combine the knowledge about local low-luminosity galaxies with that on faint blue galaxies seen at moderate redshifts. The talks were organized around three main themes: ''Star Formation Properties/Histories,'' ''Dynamics, ISM, and Other Physical Processes,'' and ''Low Luminosity Galaxies—Do They Matter?'' The workshop was attended by 55 participants.

2. SOLAR SYSTEM

R. Brown conducts a variety of research programs on the question of planetary systems around other stars. He has observing programs on both *HST* and *IRTF* seeking to detect ''super planets'' in self-luminosity. Young planets of Jupiter mass or greater are hot and several orders of magnitude more luminous than mature planets. The *HST* program targets weak line T Tauri stars at about 1 micron wavelength; *IRTF* observes local stars exhibiting signs of youth at 3–4 microns wavelength. Brown also conducts a program of educational research, which seeks to understand and develop appropriate strategies for the social benefits of astronomical exploration, particularly ''origins'' related research. This educational program, called *Exploration in Education* (ExInEd) has produced a variety of educational materials available at http://www.stsci.edu/exined/.

A. Storrs continues to work on small bodies in the solar system. *WFPC2* images of asteroid 4 Vesta, obtained in May, show unprecedented detail on shape and mineralogy. This will be the subject of a photo release in October, and discussed at the meeting on ''Vesta and the HED meteorites'' in Houston, October 16–18, and at the DPS meeting in Tucson, October 23–26 (papers by Binzel *et al.*, Thomas *et al.*, and Zellner *et al.*). *HST* observations of comet Hyakutake during its close approach to the Earth, as well as ongoing studies of comet Hale-Bopp, will also be presented at the DPS (paper by Weaver *et al.*). Observations of asteroids to search for companions and mineralogical differentiation have largely been deferred until after the servicing mission. One object, asteroid 54 Alexandra, has been observed and shows no companions or differentiation. Storrs continues to work on the restoration of high SNR images at increased spatial resolution. Storrs is also working on low spectral resolution (FOS PRISM) data on small Jovian and Uranian satellites (DPS papers by Wells *et al.* and Storrs *et al.*).

3. STARS AND STAR CLUSTERS

For the past six months, F. Boffi has worked on her Ph.D. Thesis with advisor A. Renzini (ESO, Garching, Germany and Univ. of Bologna, Italy). During this period she has mostly focussed on the search for light echoes from historical supernovae. She works on this project, which is part of her Ph.D. Thesis, with W. Sparks, N. Panagia and D. Macchetto (ST ScI). Light echoes could be used as a new geometrical method of distance determination. She finds a number of candidate light echoes on the basis of the photometric data collected from ground based observations. Boffi has also co-authored a paper on the radio emission from two type II supernovae together with D. Branch, J. Cowan and C. Eck (U. OK).

Research activities of C. Burrows have centered upon *HST* Observations of the Beta Pictoris circumstellar disk, which have revealed the presence of a warp that can most naturally be interpreted as due to the perturbations induced by a Jupiter sized planet. Detailed models of the dynamics and evolution of the disk have been developed and reported at the AAS meeting in San Antonio.

Burrows' *HST* observations of circumstellar nebulosity have shown the environments of a number of newly forming stars at hitherto unrealized resolution. HL Tau has been shown to be purely a reflection nebula with the central protostar totally obscured in the optical, contrary to previous assumptions. HH30 has been shown to be a disk-like structure with an orthogonal bipolar outflowing jet—A first and excellent direct picture of the standard model for star formation. T Tauri has been shown to have an inner reflection nebula which we interpret as probably a circumbinary elliptical accretion disk. XZ Tau shows a unique bubble of outflowing nebulosity in addition to a bipolar jet. All of these four observations are published or submitted (as first or second author).

Burrows' *HST* observations of GL229B have confirmed that it is a proper motion companion to GL229A, detected it for the first time in the R band, and provided the first accurate visible astrometry and photometry on this unique brown Dwarf (publication in preparation, pending a third spacecraft visit).

C. Charbonnel has worked on the physics of microscopic diffusion and rotation-induced mixing in stars. She introduced the most recent physical descriptions of these transport processes in the Toulouse-Geneva stellar evolution code. Detailed numerical simulations were performed in order to test the effects of these mechanisms on the stellar structure and on the nucleosynthesis at different phases of the evolution. With her collaborators, she proposed the first solar model which is in agreement with helioseismic data and which simultaneously reproduces solar Li and Be abundances. She showed how mass loss- and rotation-induced mixing accounts for chemical anomalies in giant stars, and strongly destroys helium 3 on the red giant branch of low-mass stars. This led her to propose a new scenario for the galactic evolution of helium 3. Charbonnel also examined the sensitivity of stellar structure to the microphysics, and studied in particular the influence of the equation of state on the evolution of low mass stars at different metallicities.

R. Dempsey continued work in studying the coronae and chromospheres of active binary stars. In particular, he organized and executed a coordinated observing campaign for the RS CVn HD 155555. The main point of this program consisted of 26 CVZ orbits of *HST* observing with the GHRS that produced almost 49,000 spectra. In addition, there were simultaneous observations with the *EUVE*, *AAT*, *AT*, and *ESO* observatories covering 4 days. He also continued working on the *ROSAT* All-Sky Survey project.

R. Downes, Szkody and Silber (U. WA), Sion (Villanova U.), Howell (PSI), and Costa and Moreno (U. Chile) obtained spectral of the cataclysmic variable AL Com in a rare superoutburst. The optical data were obtained from 3 to 21 days after outburst, while *IUE* data were obtain at 10 and 19 days into the outburst. The *IUE* spectrum show no evidence of P Cygni profiles and do show an early presence of Lyman α, which may be indicative of a 25,000 K white dwarf. The optical spectra show weak Balmer absorption, which remained fairly constant over the three week interval. The spectra of AL Com during outburst are considerably different than that of WZ Sge, despite the similar outburst properties of the two stars.

Downes, in collaboration with Anderson and Margon (U. WA) obtained *FOS* spectra of the globular cluster x-ray sources in NGC 7078 and NGC 6712. For AC 211 in NGC 7078, the FOS data revealed both strong absorption and emission features, and are much less contaminated them previous IUE data. The energy distribution is consistent with a 15,000 K blackbody, although there is a clear flux deficit form 1600 to 2500 Å. The spectrum of Star S in NGC 6712 revealed a featureless continuum. The optical energy distribution is consistent with a 9000 K blackbody, while the ultraviolet distribution could not be fit with a blackbody of $T < 100{,}000$ K.

T. Gäng and collaborators presented new results from their on-going long-term monitoring program of early-type stars at the AAS meeting in San Antonio and in various articles. They also started a new ultra-high resolution optical survey of Luminous Blue Variables (LBVs) in order to scrutinize their atmospheric conditions for inhomogeneities. For this program they have obtained high-resolution (R = 60,000–230,000) spectra of a sample of 20 LBVs and LBV-candidates in the Milky Way and the Magellanic Clouds. The observations were carried out at AAT with UCLES in October 1995 and January 1996, at ESO/CAT with CES in April 1996 and at KPNO with the Coude Feed Telescope in May 1996.

Due to the exceptional data quality, previously undetected features and extreme spectral morphologies are found in a significant number of the spectra. First results of this project were presented at the LBV-workshop in Hawaii in October 1996.

J. Kingdon, in collaboration with Williams, Panagia, and Livio, has continued the examination of the post-outburst nova V1974 Cyg/92. This analysis involves devising a method of deriving abundances from emission lines which are formed in various regions of the nebulae under differing physical conditions. The individual line profiles are divided into distinct velocity and spatial regions for comparison. In

conjunction with this project, observations are being planned to study a wide variety of emission-line objects at different spectral and spatial resolutions to compare how the derived abundances differ.

M. Livio, in collaboration with Southwell, Charles, and Sutherland (Oxford), examined the nature of the supersoft x-ray source J0513−69. They showed that the object produces collimated jets, and proposed a model which involves variable accretion onto a white dwarf which undergoes steady nuclear burning at its surface.

Livio, working with Rasio (MIT), simulated the common envelope phase in the evolution of binary systems. They performed the first three-dimensional calculation which started from an exact equilibrium configuration and showed that at the end of the dynamical phase, a disk which corotates with the binary is formed.

Livio, along with Della Valle (Padova), examined the question of whether some of the observed microlensing events are contaminated by dwarf nova eruptions. They concluded that dwarf nova eruptions of some old nova systems could produce non-negligible contamination.

Livio, collaborating with Yungelson (Moscow), Tutukov (Moscow), Fedorova (Moscow) and Truran (Chicago), constructed population synthesis models for the Galactic population of supersoft x-ray sources. They showed that these sources belong to at least five classes of objects.

Livio and Armitage (Cambridge) performed three-dimensional numerical simulations of the interaction between the stream from the L1 point and an accretion disk. They showed that the observed dips in the light curves of x-ray binaries can be explained by the stream-disk interaction.

Livio, in collaboration with Nota, Clampin, Pasquali (ST ScI), and Pollacco (Cambridge), examined the nebula around the LBV HD 168625, and proposed models for the generation of the observed morphology.

Livio and Pringle (Cambridge) showed that the disks formed around the central stars of planetary nebulae from the dissipation of a low mass secondary companion, are unstable to radiation-induced warping. These warped disks can precess, together with the jets which they produce. This can explain the formation of ''point symmetric'' nebulae.

K. Long pursues research topics on the ultraviolet characteristics of cataclysmic variables, supernova remnants, and the properties of the interstellar medium in nearby galaxies. He remains an active co-investigator in the *Hopkins Ultraviolet Telescope* project, analyzing data from *Astro-1*, which was flown in 1990 December and *Astro-2*, which was flown in 1995 March.

Long, in collaboration with Mauche (LLNL), Szkody (U. WA), Raymond (SAO), and Mattei (AAVSO) obtained the first spectra of U Gem in the extreme ultraviolet. The observations, which were made with *EUVE*, cover the peak and decline of a normal outburst. The (75−225 Å) spectra are complex, and there is an eclipse of the continuum source near orbital phase 0.7. At outburst maximum, the effective temperature of the continuum, is about 140,000 K and the effective size of the emitting region is about that of the white dwarf in the system. The eclipse spectrum, which is most likely associated with a wind emerging from the vicinity of the whited dwarf, is dominated by emission lines, expected in a relatively cool ($T<160{,}000$ K) photoionized plasma. The EUV lines arise from the dominant state of the wind, and their strengths suggest that the wind mass loss rate, at least in U Gem, is a substantial fraction of the white dwarf accretion rate. In other studies of U Gem, Szkody, Long, Sion (Villanova), and Raymond used *ASCA* to show that there was also a partial eclipse of the X-ray source in U Gem near orbital phase 0.7 during optical quiescence, and Long, Blair (JHU) and Raymond showed that the FUV (820−1840 Å) spectra of U Gem far from outburst were well-modelled in terms of a white dwarf with a T of 30,000 degrees, with the possible exception of the region below 950 Å, where there is excess emission.

Long, Blair, and Raymond observed a number of quiescent dwarf novae, including SS Cyg, YZ Cnc, WX Hyi, and VW Hyi, on *Astro-2*. Only U Gem (mentioned above) and VW Hyi show the broad Lyman profiles and narrow metal lines expected from a white dwarf salted with material accreted from the secondary star. And Long, Blair, Hubeny (NASA/GSFC) and Raymond found that although the spectrum of VW Hyi could be modelled as an approx. 17,000 K white dwarf with subsolar abundances, a better fit could be obtained from the combination of a white dwarf with near-solar abundances and an accretion disk. In the other systems, it seems likely that the disk is dominant, a suggestion which Long, Mauche, Ko (U. MI) and Kallman (NASA/GSFC) are following up in an ongoing *HST* investigations of WX Hyi and SS Cyg.

Long and postdoc Knigge have also continued earlier efforts to analyze the outburst spectra of dwarf novae observed with *HUT*. Specifically, Knigge, Long, Blair and Wade (PSU) have recently completed an analysis of the spectrum of Z Cam as observed on *Astro-2*. They were able to approximate the overall spectrum in terms of a steady state accretion disk with $\dot{m}$ of 3×10^{17} g/s. They also succeeded in reproducing the profiles of 5 high ionization resonance lines in the Z Cam spectrum using a Monte Carlo radio transfer code and a description of the geometry, density and velocity profile for the wind which had been used earlier by Knigge to model CIV in the novalike variable UX UMa.

Long, Raymond, and Blair also used *HUT* to obtain FUV spectra of a number of supernova remnants, including SN1006, Vela, Puppis and the Cygnus Loop. Due to the availability of slits as large as $18\times120''$ and due to the fact that the *HUT* wavelength range includes O VI 1035 which is not accessible to *HST* or *IUE*, *HUT* is extremely useful for such studies. With *HUT*, Raymond, Blair and Long were able to detect the non-radiative filament on the NW rim on SN1006 for the first time and to show that in this 2300 km/s shock the velocities of different ions are independently randomized in the shock. Plasma turbulence is not effective in equilibrating temperatures among different ion species and is unlikely to be effective in equilibrating electron-ion temperatures. This result is consistent with conclusions being obtained by Winkler (Middlebury) and Long from *ROSAT* HRI imagery showing that X-ray emission peaks about 7 arcsec inside the optical rim on SN1006 in the NW. Blair, Long,

and Raymond have also completed an analysis of the spectrum obtained of the Schweitzer-Middleditch star which lies behind SN1006, in which they confirm earlier detections of absorption from Fe II due to SN ejecta, and constrain the total amount of Fe III, in an attempt to inventory the total amount of iron ejected by the SN explosion.

S. Lubow together with P. Artymowicz (Stockholm) have continued investigations of the nature of disks around young binary stars. They have also found that circumbinary disks can transfer mass via gas streams to the binary, under certain circumstances. A semianalytic description of the gas stream was found. The gas stream mass flux is modulated on an orbital timescale. They are also investigating the role of this mass flow on the evolution of young planets. They are investigating whether superplanets could have gained their observed eccentricity by their interactions with nebulae during their early stages.

Lubow and Pringle (IoA) have continued investigations of wave propagation in accretion disks. They are attempting the understand how resonant excited waves can propagate in thermally stratified disks.

Lubow, Tout (IoA), and Livio are investigating the role of resonant torques in despinning close orbiting planets and circularizing their orbits.

Lubow and Murray (CITA) are investigating models of superoutbursts in CVs. The current view is that superoutburst light is the product of enhanced dissipation once the disk meets the 3:1 resonance. They are investigating the viability of that model. They are also determining the permitted range of α value that is consistent with forming an eccentric disk during superoutburst.

S. Moehler worked for most of the year with M. Dahlem on a project to use correlation techniques for the analysis of low S/N spectra of hot compact stars (*e.g.*, white dwarfs). The idea is to be able to get some idea of what the star is from spectra with S/N of 1–5, which may be the expexcted S/N of spectra taken of white dwarfs in globular clusters. It will be possible to distinguish between white dwarfs and hot subdwarfs with this method and also determine whether the white dwarf is helium- or hydrogen-rich. It will not be possible to derive temperatures or surface gravities that way.

In addition, Moehler continued her work with Heber (Bamberg) and others on hot subluminous stars in globular clusters. They could derive a mean mass for the sdB stars in NGC 6752 and verify that these objects are most probably formed as extended horizontal branch stars. In addition, for the first time they found sdB stars in another globular cluster (M 15), one of them being helium-rich. Helium-rich sdB stars are very rare in the field (compared to the helium-poor ones; 48 helium-rich are known vs. more than 1000 helium-poor) and have never before been found in globular clusters.

M. Romaniello worked on his Ph.D. thesis with his advisor Panagia (ESA/ST ScI). The main topic of his thesis is the study of the young and intermediate stellar populations in different astrophysical environments, in order to shed light on the properties of starbursts such as the IMF, the pre-main sequence evolution and the mechanisms that trigger star formation.

In collaboration with Panagia, Scuderi (Oss. Catania) and Kirshner (CfA), Romaniello studied the stellar population around Supernova 1987A in the LMC. Using the *HST-WFPC2* camera, they observed the field around the supernova in 6 wide bands and in two narrow band filters (O III and Hα) and they determined the luminosity, the temperature and the reddening for each star. Comparing the observed quantities with theoretical models, they were able to identify several different generations of stars, ranging from a few Myrs to several Gyrs. In particular, the youngest population was identified using Hα emission as a diagnostic for detecting pre-main sequence stars.

Scuderi, Capetti (SISSA, Trieste), Panagia, Romaniello, Lamers (Utrecht, Holland) and Kirshner have further developed this topic by studying the unresolved stellar populations in the core of the spiral galaxy M51. By studying the color-color and the color-magnitude diagrams, they were able to deredden the images and to study the spatial distribution of the dust and the intrinsic properties of starlight. In particular, they found that the nuclear region is dominated by a starburst that occurred about 450 Myrs ago, *i.e.*, almost coeval to the closest passage of the companion dwarf galaxy NGC 5195, whereas the bulge is composed of stars older than 8 Gyrs.

K. Sahu, in collaboration with Van de Steene (ESO) and Pottasch (Kapteyn Lab, Groningen), completed a project to study the optical spectra of a sample of *IRAS*-selected, radio-detected, planetary nebula candidates. The sample of PN-candidates was selected based on their position in the *IRAS* color-color diagram. They were then observed in the 6-cm radio continuum with positive detections, suggestive of nebular emission. The optical spectra, obtained with *ESO* telescopes, confirmed them to be low-excitation PNs, with central star temperatures of 60,000 K or less.

Sahu, in collaboration with R. Oudmaijer (Imperial College) and others, studied the spectral energy distribution and mass-loss history of the peculiar hyper-giant IRC+10420. It was shown that the object has increased in temperature by more than 1000 K during the past 20 years. The spectral energy distribution cannot be fitted with a single-shell model, and needs a hot circumstellar disc component. It is also shown that IRC+10420 is not a post-AGB star.

In collaboration with G. Stasinska (IAP), D. Schaerer studied the impact of new theoretical ionizing fluxes obtained from his ''combined stellar structure and atmosphere'' (CoStar) models on single star H II regions. These results have been included in a large database for the modeling of Galaxy Evolution. Schaerer studied the IMF and the origin of He II emission in young starburst galaxies. New evolutionary synthesis models for WR galaxies were developed in collaboration with W. Vacca (IfA).

H. Stockman, working with G. D. Schmidt (U. AZ), completed the analysis of time-resolved *HST* data obtained for two eclipsing magnetic Cataclysmic Variables (mCV). By comparing the UV spectra to that predicted for the photoionized accretion column in such systems, he was able to find a good match of line strengths and total UV line emission for clumpy accretion, *i.e.*, low filling factor gas, in a wide, extended column. These results are consistent with models invoking penetrating blobby accretion to hide the expected hard X-ray fluxes in these systems. Further studies of eclips-

ing mCVs are underway using data obtained during Cycle 6.

N. Walborn and R. Bohlin prepared an atlas of Copernicus data displaying the systematics of OB spectra in the 1000–1200 Å range. It extends the correlations between the stellar-wind phenomenology and the optical spectral types found previously in the *IUE* data for the OB stars at longer wavelengths. Perhaps the most important new contribution is the demonstration of a pronounced luminosity effect in the S IV 1063, 1073 Å wind profiles, identical to those previously recognized in Si IV 1394, 1403 Å and C III 1176 Å, which share essentially the same ionization potential.

In Walborn's *HST* Cycle 5 program, a compact cluster in the 30 Doradus periphery, previously classified as WN + OB in integrated light from the ground, has been resolved spectroscopically into 11 components, including in addition to the WN a peculiar Be star and a peculiar Of star with twice the mass of any other members—a good candidate for a stellar merger. *HST* spatially resolved optical spectroscopy of 3 further compact groups in the 30 Dor periphery and the LMC giant shell H II region Henize N11 is being carried out in Cycle 6.

Currently, Walborn, in collaboration with C. Blades is completing a major classification study of 100 stars in the 30 Doradus Nebula, based on it AAT multiple-fiber and *CTIO* 4m data, which reveals new spatial and temporal structures among the associated clusters, as well as numerous individual objects of special astrophysical interest. The average difference between the derived and calibration absolute visual magnitudes is 0.05, indicating that the classification, calibration, and adopted distance modulus (18.6) are accurate. The most massive star known in the complex has been identified. Further high-quality classifications in 30 Dor will become available from a current program led by A. Moffat, in which repeated observations with the *CTIO* 4m Argus fiber system are being made to search for spectroscopic binaries; Walborn is deriving spectral types from the high-S/N sums of the individual observations. A report on this work was presented at the Madison AAS meeting.

R. E. Williams has continued his research into the analysis of nova shells and the interpretation of emission-line spectra in the presence of density inhomogeneities. With M. Shara and D. Zurek, *WFPC2* images of the shells around the novae T Pyx and GK Per have been obtained in the lines of various ions to determine the characteristics and structure of condensations. Together with N. Panagia, M. Livio, and J. Kingdon, a procedure is being developed and applied to *HST* spectra of Nova V1974 Cyg/92 by which emission line profiles are deconvolved into their major individual components based upon a kinematical model of the ejecta. Physical conditions will then be derived for the kinematically distinct regions from selected line ratios rather than attempting to calculate a detailed photoionization model with an ad hoc assumed geometry. Those emission ratios which are most invariant to conditions in the gas are being identified from the Emission Line Chart, where the ultimate goal is a process by which abundances can be determined reliably independent of a detailed knowledge of the structure of the emitting gas.

R. Williamson, in collaboration with P. Thejll and C. Flynn (Nordita), and R. Saffer (ST ScI), determined proper motions for a large group of subdwarf B (sdB) and subdwarf O (sdO) stars for kinematical analysis and intercomparison with each other. Good agreement was found of sdB star space velocities and absolute magnitude for those with previously published radial velocities. Reduced proper motions for sdO and sdB stars which had proper motion data only seemed to indicate that if the sdB stars evolve from sdO stars then the sdO star absolute magnitude is 1 magnitude brighter and 1 magnitude broader than sdB distributions.

Williamson, with D. J. MacConnell as advisor, is deriving proper motions for all known carbon stars to search for carbon dwarf stars. Approximately 700 stars to date have been reduced, with no definitive motions for carbon stars yet.

4. INTERSTELLAR MEDIUM

R. Allen, McKellar (NRC Ottawa), Loinard, and Lequeux (Paris), have carried out a search for the CO-H2 dimer in the ISM near 3 mm wavelength using frequencies computed from IR-absorption cell data supplied by McKellar. Since the binding energy of this ''van der Waals'' complex is very low it is easily destroyed by collisions, and the abundance of this dimer may be a sensitive tracer of low temperatures in the ISM. The search was carried out using the 30m *IRAM* radio telescope; several different Galactic cold molecular clouds were examined for traces of emission, and an absorption experiment was done using the (presumed) extragalactic source 2013+370. No detections were recorded, and useful upper limits were obtained. A paper describing the experiment is in preparation.

J. Kingdon and Williams completed a revision of Williams' Emission Line Chart, which was based on an extensive grid of photoionization models. The results of this grid were used to identify those line ratios which are insensitive to conditions in the gas and which are therefore good for deriving abundances in emission-line objects.

Kingdon is continuing his investigation into temperature fluctuations in gaseous nebulae in order to explain the observed discrepancy between abundances derived from recombination and collisionally excited lines. He is currently studying whether radial variations in abundances can resolve the discrepancy.

B. Lasker, in collaboration with J. Walsh (ESO), D. Garnett (MN), Y.-H. Chu (IL), and others, continued an *HST* program of parallel observations of nebulae in the Magellanic Clouds. Recent results on spatially resolved structure too fine for study from the ground include fine filaments ($0\farcs3$ or less), wind-blown bubbles, and one small ($0\farcs9$) dust globule; a report was presented at the Paris *HST* meeting.

5. NORMAL GALAXIES

R. Allen attended the meeting in South Africa on cold gas and dust in galaxies, and presented a review of the present state of knowledge of the molecular content of disk galaxies. He has concluded (Allen 1996) that there are presently no reliable tracers of the amount of H2 actually present in galaxy disks, and that significant amounts of cold molecular gas are likely to be present, especially in the inner disks of Sa-Sb galaxies.

Allen, Bohlin, and Knapen (Hertfordshire) continued their analysis of the H I, Hα, and UIT-UV data in M81. The morphology of these tracers is being analysed in the framework of a PDR model; the UV produces the H I by photodissociation. Up to now, such models have been applied to small regions ($\sim$10 pc) of intense star formation in the Galaxy. However, an attempt to model the spiral arm structures observed on larger scales ($\sim$100 pc) in nearby galaxies has not been done. A plausible model based on PDRS can indeed be constructed which explains both the qualitative features of the morphology as well as the amounts of UV and H I actually observed. A paper is in preparation.

Allen, Loinard, and Taylor (ST ScI/CSC) continued their program of searching for faint CO(1-0) emission in the outskirts of several nearby galaxies. Detections have been achieved so far in the outer parts of M51 and M61 using long integrations with the multi-beam system at *FCRAO*. This program will be continued in the coming year.

Together with Cuillandre (Toulouse), Lequeux (Paris), and Mellier (Paris), Allen has identified dust clouds in the far outer regions of M31, at and beyond the Holmberg radius of the galaxy. The identification was made by detecting the reddening of field galaxies viewed through the known H I clouds present there. If this dust has the Galactic reddening law, and if H I is the only component of the gaseous ISM present, then the dust to gas ratio is 0.5 of the value in the solar neighborhood. A scattered population of B-stars has also been identified in the same regions. A paper has been submitted (Cuillandre *et al.* 1996).

Allen has completed his work with Canzian on identifying the kinematic signature of corotation in the spiral galaxy NGC 4321, and a paper has been submitted (Canzian & Allen 1996). The result has been obtained using the method of identifying galaxy-wide features in the velocity field developed by Canzian; in this case the Hα data were used.

N. Caon, in collaboration with D. Macchetto, W. Sparks and M. Pastoriza (Instituto de Fisica, Porto Alegre, Brazil), has completed the mapping of the distribution of the ionized, line-emitting gas in a sample of 73 elliptical and lenticular galaxies, as part of the *ESO* Key Project: ''Towards a physical classification of early-type galaxies.'' Morphology, extension and total luminosity of the ionized gas were derived from narrow-band Hα+N II and broad-band images, finding that more than 70% of the sample galaxies contain detectable amounts of warm gas.

These data were used to test the model in which the gas excitation and ionization mechanism is conductive heating of the warm gas by hot electrons associated with an X-ray emitting coronal halo; the Hα luminosities predicted by this model compare very well with the measured values. A strong correlation was also found between the Hα luminosity and the luminosity in the B band inside the region occupied by the line-emitting gas, consistent with the model in which post-AGB stars provide the UV ionizing photons and account for the observed Hα luminosities and equivalent widths in early-type galaxies. It is likely that both conductive heating and UV photons work together to excite and ionize the gas.

Long-slit spectra for 14 objects chosen among the ones with the most luminous and extended line-emitting regions were collected at the 3.6m telescope at *ESO* La Silla (Chile), in order to compare the gas and the stellar kinematics, and study the characteristics of the emission (equivalent widths, line ratios). Preliminary results for 6 objects show evidence for kinematic decoupling between gas and stars, suggesting an external origin (accretion) for the gas.

Maps of the dust distributions have also been obtained from multi-color imaging. They will be complemented with *ISOCAM* observations in the spectral region 5–17 μm(in 3 passbands), to map the warm dust and establish detailed comparisons with the features found in the optical images (knots and filaments of the line-emitting gas, dust lanes).

H. C. Ferguson continued his involvement in the *Hopkins Ultraviolet Telescope* (*HUT*) project, analyzing data from the the *Astro-2* mission of March 1995. Brown, Davidsen (JHU), and Ferguson constructed a grid of stellar model atmospheres for stars in the temperature range $10{,}000 < T_{eff} < 250{,}000$ K. Together with Dorman (GSFC), they applied this grid to study the UV-emitting stellar population in elliptical galaxies. The results favor high-metallicity, helium rich extreme-horizontal branch (EHB) stars as the dominant contributor to the ubiquitous ''UV upturn'' in elliptical galaxies, although metal-poor models cannot be completely excluded. Dixon (Berkeley), Davidsen (JHU), and Ferguson used *HUT* observations of ''blank sky'' to search for O VI emission from the Galactic halo. The 4 σ detection along two lines of sight, is consistent with the expectation from self-photoionizing Galactic fountain models. Dixon, Hurwitz (Berkeley), and Ferguson also used the *HUT* data to search from O VI within clusters of galaxies, and the upper limits provide interesting constraints on the amount of warm $t \sim 5 \times 10^5$ K gas that can be present at the center of cluster cooling flows.

L. Loinard (Grenoble & ST ScI) continued his project to map the CO(1-0) emission in M31 using the *FCRAO* millimeter radio telescope. The atomic and dust content are known quite well for M31 down to a scale of $\sim$100 pc; however, the only complete mapping of CO(1-0) in M31 has been done on the scale of 1 kpc, and only a few isolated regions have been observed at better resolution. The *FCRAO* radiotelescope provides a linear resolution of about 150 pc on M31, which is useful for the comparison with other ISM tracers; a project was therefore started last year to map the southern half of the galaxy with the multi-beam receiver at *FCRAO*. Preliminary results of the survey have been published by Loinard *et al.* (1996), and roughly 80% of the southern half of M31 has been mapped. Observing time has been granted to finish the remaining 20%, and this is expected to be complete by January 1997. Allen, Bohlin, and Loinard are using this CO(1-0) data together with UIT UV data (at 150 nm) and existing 21 cm H I data in an attempt to understand the morphology of these tracers in M31 in the framework of PDR models.

K. Long, Charles (Oxford), Blair, and Gordon (LBNL) completed their analysis of a 50 ks *ROSAT* PSPC observation of M33 in which they identified 50 sources, many of which are associated with Pop I tracers in M33. There are 10 sources which are positionally coincident with supernova

remnants identified in a companion optical/radio survey of M33 carried out by Gordon, Kirshner (Harvard), Long, Duric (NM), Blair, and Smith (MI). From a spectral analysis of the PSPC data, it is quite likely that a number of the other sources in the X-ray survey are also supernova remnants. Long and Charles are also continuing the effort to characterize X-ray source populations in M33 as they analyze a large amount of HRI data on this object. As part of a optical search for supernova remnants in nearby spirals, Blair and Long completed their analysis of interference filter imagery of the Sculptor group spirals NGC 300 and NGC 7793, identifying 28 SNRs in each galaxy. These are the first large samples of SNRs to have been identified outside the Local Group. The properties of these SNRs parallel the more extensive sample identified in M33, although the dividing line between S II and Hα ratios in the Sculptor group spirals is less distinct, especially in N7793.

C. O'Dea, Stanghellini (IRA, Noto), Baum, and Charlot (IAP, Paris) analysed optical images in the *r* and *i* filters of a sample of 40 GHz Peaked Spectrum (GPS) Radio Galaxies. The GPS galaxies have absolute magnitudes in the Cousins Rc band between -22 and -24.0, consistent with brightest cluster galaxies and the hosts of other powerful radio sources. The GPS Hubble diagram and the redshift distribution of $r-i$ colors are consistent with both no-evolution models and passive evolution models for elliptical galaxies. The GPS galaxies are in good agreement with the Rc band Hubble diagram for 3CR galaxies at low redshifts, $z<0.5$. At higher redshifts, there is a suggestion that the GPS galaxies are about 1 magnitude fainter than the 3CR galaxies. If real, this may be due to 3CR galaxies having an extra component of blue light (the aligned component?) which is not present in the GPS galaxies. We suggest that the presence or lack of the blue light may be related to the presence or lack of a powerful extended radio source.

B. Miller used Hα imaging and nebular spectroscopy to investigate the recent star formation histories of eight dwarf galaxies in the Sculptor Group. Only two of the eight galaxies have current star formation, and the oxygen abundances in their H II regions are 10–15% of solar. The general star formation activity of the Sculptor Group dwarfs is less than in dwarf galaxies in the Local Group or M81 Group. Since the mass density in the Sculptor Group is less than in either the Local or M81 Groups, large-range gravitational interactions may play a role in regulating star formation in dwarf galaxies. However, the O/H, M_B relation seems to hold for all environments so galaxy mass appears to be the primary factor governing a galaxy's chemical evolution.

Miller is working with Whitmore, Fall, and Schweizer (DTM) to find globular clusters in galaxy merger remnants using the *HST*. They have discovered a population of young, luminous clusters in NGC 3921. The effective radii are all less than 5 pc (cf. Milky Way globulars have $R_{eff}\sim 3$ pc) and the cluster luminosity function is described by a power law with slope -2.1. They estimate that the number of globulars has increased by about 40% during the merger and that the globular cluster specific will increase from 0.7 to 1.8 over the next 5 Gyr and that NGC 3921 will look like a normal field elliptical. They will also continue their work on new *HST* observations of the young merger remnants NGC 7252 and NGC 4038/39 and of the old merger remnants NGC 1700 and NGC 3610. Their goals are to see how cluster populations evolve with time and to use the clusters to date the merger.

Miller, Whitmore, Ferguson, and Stiavelli are working on preliminary analysis of a *HST* snapshot survey of dwarf elliptical (dE) galaxies. The goals are to compare the globular cluster populations of nucleated and non-nucleated dE's and to study the properties of the nuclei. With twelve galaxies observed to date, their preliminary finding is that nucleated dE's have higher globular cluster specific frequencies, S_N, than non-nucleated dE's. Also, both types seem to have values of S_N more like giant ellipticals than spirals or irregulars. Finally, many of the nuclei are offset from the geometrical centers of the galaxies.

Miller and Rubin (DTM) continue to obtain Hα spectroscopy of Virgo ellipticals and early-type spirals with kinematically distinct cores. The kinematical information from the specta will be compared with *HST* images of the cores of these galaxies in order to see the relationships between the stars, dust, and gas.

K. Sahu continued his efforts in frequent, round-the-clock monitoring of the Galactic microlensing events through the PLANET (Probing Lensing Anomalies NETwork) collaboration. One of the prime objectives of this project is to look for extra-solar planetary systems, the signature of which would be a sharp extra peak on the microlensing light curve. The data can also be used to look for anomalies caused by other factors such as binary sources/lenses, extended sources, etc.

The PLANET collaboration, which started in 1995 through the initiatives of Sahu and Sackett (Kapteyn Lab, Groningen), has collaborative astronomers from Groningen, South Africa, and Australia. It uses a network of 1m-class telescopes situated at Chile, South Africa, and Australia to achive an almost continuous coverage in the monitoring program.

The data analysis of the 1995 pilot campaign has been completed and a binary event was detected. In 1996, a new 1-m telescope at Hobart, Australia, was added to the collaboration. S. Kane, a joint graduate student from ST ScI and Tasmania University (Australia), joined the project and participated in the observing from Hobart. PLANET has completed the 1996 campaign and the data analysis is now in progress.

Sahu is also conducting a program of spectroscopic study of the microlensed sources towards the Galactic bulge.

M. Stiavelli and collaborators continues to work on an *HST* snapshot survey of the bulge properties of a sample of 107 nearby spiral galaxies. The observations carried out so far indicate the widespread and unexpected presence of structures down to very small radii.

The study of the core properties of elliptical galaxies continued with two additional observing runs at the 2.5m *Nordic Optical Telescope* at La Palma (Moeller & Stiavelli in preparation). Multicolor images with subarcsec seeing conditions are now available for more than 100 objects.

The Near-IR properties of the jet and hotspot in M87 were studied using data obtained at the *ESO* 2.2m telescope with

IRAC2 and at the 3.8m *UKIRT* telescope with *IRCAM3*. These very deep images show that the M87 radiolobe in the Near-IR has intermediate properties between the optical and the radio and allow for a more precise determination of the spectral break energy as a function of position along the jet and at the location of the hot spot (Stiavelli, Peletier, Carollo, 1996, MNRAS, in press).

A new project on the study of the evolution of the fundamental plane of elliptical galaxies with redshift was started. High quality data were obtained at the *ESO* 3.6m telescope and are being reduced (Stiavelli, Casertano, Moeller, in preparation).

A. Suchkov and a co-author, Marochnik, have published a monograph *The Milky Way Galaxy*. The book covers major issues of the structure and evolution of our Galaxy, including stellar populations, ISM, spiral structure, chemical and dynamical evolution, star formation and formation of the Galaxy.

B. Whitmore (1995a, 1995b) wrote two review articles summarizing recent *HST* observations of young star clusters in mergers and starbursting galaxies. These star clusters have the luminosities, colors, and spectra expected of proto-globular clusters. Hence, they may provide a natural explanation for why elliptical galaxies have a higher number of globular clusters per unit luminosity than spiral galaxies.

Schweizer (DTM), Miller (ST ScI/DTM), Whitmore and Fall completed a study of the recent merger remnant NGC 3921, using *HST* observations. A search for star clusters yielded 102 candidate globular clusters (GC) and 49 separate, more extended stellar associations (A) brighter than $V=26.0$ mag. The color indices of the GC's yield estimates of 250–750 Myr for the median age, depending on the adopted metallicity (1.0–0.2 solar), and suggest a prolonged formation period (several 100 Myr) roughly in agreement with the estimated duration of the merger. Since from their colors most of these clusters appear to be dozens of core crossing times old, they must be gravitationally bound. Schweizer *et al.* estimate that the total number of GC's in NGC 3921 has increased by $\geqslant 40\%$ during the merger, from about 270 ± 60 GC's before to $\geqslant 380$ GC's after the merger.

6. STARBURST GALAXIES AND AGN

H. Bushouse, L. Colina, R. Lucas (ST ScI), and K. Borne (Hughes STX) are obtaining a *WFPC2* snapshot survey of the ultraluminous *IRAS* galaxy sample. The survey images are being used to study the cores and starburst regions of the galaxies, with particular emphasis on searching for young stellar clusters, as have already been found in *HST* observations of similar objects. Nearly all of the galaxies in the survey show evidence from groundbased images for a very recent tidal interaction, thus a search is being made for evidence of the interaction progenitors by looking for multiple cores near the center of each system. These images also serve as a baseline for future *HST* observations designed to catch the type II supernovae that are expected to be produced at a prodigious rate in these strongly starbursting systems.

D. Calzetti, in collaboration with M. Giavalisco (OCIW) and A. P. Koratkar (ST ScI), analyzed *IUE* spectra of a sample of local, low-metallicity starburst galaxies to investigate the correlation between Ly-α emission, UV extinction, and the metal content. They find evidence that the transport of the Lyman-α photons is primarily controlled by the geometry of the highly inhomogeneous galaxy ISM, rather than by the amount of dust contained in the galaxy. Primeval galaxies with characteristics similar to those of the present low-metallicity galaxies would have been unnoticed in typical narrow-band surveys tuned to detect high-redshift Lyman-α emission. The spectral classification of high-redshift galaxies requires, for the zeroth-order comparison, UV and optical spectral energy distributions (SEDs) of present-day galaxies.

Calzetti, collaborating with A. L. Kinney, R. C. Bohlin, K. McQuade (ST ScI), T. Storchi-Bergmann, and H. Schmitt (UFRGS, Brazil), derived multiwavelength SEDs using aperture-matched *IUE* and optical spectra of local galaxies. For quiescent galaxies, the SEDs are separated according to the morphological classification of the galaxy; for starburst galaxies, according to color excess. The reddening-corrected SEDs of starburst galaxies have been used by Calzetti to investigate the star formation history of the starburst region. A large contribution from intermediate age population (age $\sim 100-500$ Myr) is found, suggesting that the starburst activity has proceeded through various episodes over a long timescale. In the same galaxies, there is no indication for a high-mass-truncated or a low-mass-deficient stellar Initial Mass Function.

E. Colbert is continuing his thesis work with S. Baum (ST ScI) and S. Veilleux (U. MD) on large-scale (galactic) outflows in edge-on Seyfert galaxies. Optical and radio surveys have been completed for galaxies selected from a distance-limited sample of 22 objects. There is evidence for large-scale outflows in about 50% of the objects surveyed. Evidence includes extended Hα nebulae along the minor axis of the galaxy disk, luminous Hα nebulae located $\sim 5-10$ kpc out of the disk, double-peaked Hα emission lines suggesting the presence of a wind blown bubble, and radiocontinuum emission extending one or more kpc from the nucleus. The three best candidates (NGC 2992, NGC 5506, and NGC 4438) show excellent evidence for an outflow in both the radio and optical regimes, and have extended soft X-ray nebulae which are roughly co-spatial. Follow-up work is being done to study in more detail the properties of the large-scale outflows in these three galaxies. The physics of these flows is fascinating. A plausible explanation of their origin is that they are larger scale extensions of sub-kpc nuclear outflows (*e.g.*, jets) that are known to be present in Seyfert galaxies. Starburst driven superwinds also remain a plausible explanation in some cases.

Colbert, S. Baum and C. O'Dea (ST ScI) have obtained very deep radio continuum observations of the Seyfert/starburst hybrid galaxy Mrk 231 in order to study properties of the radio outflow. This galaxy was already known to have a galactic outflow but its origin (starburst- or AGN-driven) is not known. Data were taken with the *VLA* at 6 and 20 cm in all array configurations. Preliminary results show the southern extended radio feature to be highly polarized (30–40%), steep-spectrum emission which is likely to be produced by a large-scale jet from the nucleus.

Colbert has won an NRC Research Associateship Award to do postdoctoral research at NASA/GSFC on X-ray imaging and spectroscopy of Seyfert galaxies.

M. Goad and his collaborators have an ongoing project to monitor the variable broad absorption lines in NGC 3516 (PI—A. Koratkar). They have four epochs of *HST/FOS* data so far and are awaiting the last observation in December. Meanwhile, Goad continued analysis of the archival NGC 5548 data. They have determined robust constraints on the physical conditions within the broad line region gas for this object, using the technique of Simulated Annealing.

Similar constraints are to be placed on several other objects which have moderately high resolution spectroscopic data available in the *HST* archive. This work was started with the aid of a very able summer student (M. Wang), who spent 10 weeks here as part of the summer student programme.

A. Koratkar's research has made use of UV variability, and UV spectropolarimetry to study AGN.

The nature of the powerful central engine in Active Galactic Nuclei (AGN) is related to the structure of the circumnuclear gas in these objects. Clues to the nature of activity can be found by studying the characteristic broad emission lines observed in AGN spectra, and comparing statistical properties of AGN at various wavelengths and luminosities.

One of the observational facts that favors the thermal disk models in AGN is the UV emission component of the quasar continuum. In addition to the above signature, there are other observational signatures of thermal accretion disks, such as discontinuity of the continuum at the Lyman edge both in polarized light and in total intensity. Koratkar and collaborators have observed with *HST* many AGN which are accretion disk candidates. The *FOS* data show polarized flux in emission contrary to the model predictions! (Koratkar, Antonnuci, Bushouse & Kinney 1995; Koratkar *et al.* 1997, in prep). They are presently developing models to explain the observed polarized flux in emission.

Along with strong UV emission lines, some AGN display intrinsic UV absorption lines. The origin and physical properties of the absorbing gas are not well understood. They have recently completed a study of the Seyfert 1 galaxy, NGC 3516, (Koratkar *et al.* 1996 in press) in which they have established that NGC 3516 has the most variable absorption lines. Dissipation of the variable absorption line gas implies a dynamic absorber, possibly the ionized surface layer of a molecular torus.

M. Livio, in collaboration with Pringle (Cambridge), examined models for the formation of double-peaked emission lines in AGN and proposed critical observations that can distinguish between the different models.

Livio, collaborating with Baum, O'Dea, de Koff, Sparks, Hayes, Golombek (all ST ScI), discovered obscuration rings in Hercules A, and examined their implications for energy transport in radio galaxies.

In collaboration with Borne, Bushouse, and Colina, R. Lucas is investigating the nature of *IRAS* Ultraluminous Galaxies using the *HST WFPC2* in a SNAPshot program to obtain I-band images of several *IRAS* ULG samples, including the remainder of galaxies not yet imaged by *HST* from the samples of Sanders, and also of Melnick and Mirabel. Other subsamples in this program include those from Kim *et al.* and Clements, as well as the QDOT and NGW surveys of Lawrence *et al.*. At the time of this writing, it is still early in the observing Cycle, but new, previously unresolved, features have already been discovered in a number of the galaxies, and the majority seem to be part of apparently interacting pairs or groups, which is consistent with the view that these highly luminous systems are triggered and/or fueled by interactions and mergers. The SNAP allocation is for a sample of up to 160 galaxies. To date, images of about 45 galaxies have been obtained, and a paper describing the results seen in these initial observations is in preparation.

Lucas continued work on *HST WFPC2* images of the Cartwheel Ring Galaxy. Some new results are described in Struck, Appleton, Borne, and Lucas (accepted for publication in *The Astronomical Journal*) in which the dust lanes and cometary structures in the inner disk of the Cartwheel are described and analyzed. The previously undetected cometary structures may be explained in several ways, all of which raise still more questions. They may be supersonic orbit crossings of the inner ring by massive clouds, or cloud complexes radially mixed in the disk as a result of the collision; they may be formed from dense clouds raining down on the disk from a bridge which connects the Cartwheel to the intruder galaxy; or they may be disk clouds traversing a tenuous high-velocity accretion stream. More work is needed to better understand this very complex and fascinating galaxy, and the history of the interactions it shares with its companions. Lucas also presented results of these observations at the workshop on *Interacting Galaxies in Pairs, Groups, and Clusters* in Sant'Agata, Italy, in September 1995, and some initial results will be described in the published proceedings from this conference. Initial results are also described in Borne *et al.* in the proceedings of the Paris conference on *Science With HST: II*, which took place in December 1995. More papers are currently in preparation on these initial *HST* observations of the Cartwheel Galaxy and two of its three companions. (NOTE: It has recently been found by Higdon 1995 using the VLA that the third, more distant companion seems to be connected to the Cartwheel by a plume or bridge of H I gas, so we hope to follow up this result also if possible.)

J. E. Pesce, Urry, Scarpa, Falomo (Obs. Padua), and Treves (SISSA, Trieste) are working on a series of projects to study the host galaxies of BL Lac objects. The first set of *HST* data has been analyzed and more work is in progress. In particular, they continue to receive *HST WFPC2* images from their Cycle 6 Snapshot project. See Urry, below, for a description of the results obtained.

Pesce, with Urry, Scarpa, Falomo, Paske (Pomona, summer student), and Kim (Towson State, summer student) is completing a project using the digitized sky survey images to study the extended, Mpc-scale environments of low redshift ($z < 0.15$) BL Lac objects and radio galaxies (FR type I and II). This is the first study using a complete sample of FR I and II radio galaxies, and preliminary results indicate no great difference between the environments of FRI/II radio galaxies and BL Lac objects (papers are in preparation).

The *HST WFPC2* images of about 50 BL Lac fields (both

GO targets and Snapshot targets) are being analyzed by Pesce to determine the environmental properties of these objects. In addition to number counts of galaxies around the BL Lac targets, the high resolution of the *HST* allows morphological classification of these galaxies as well. A paper is in preparation.

Pesce, Pian, and Urry (along with a substantial fraction of the astronomical community!) have finished a series of papers describing the large multiwavelength campaign to observe PKS 2155−304 in May 1994 (see also below). The ground-based data show a correlation between the optical and ultraviolet; the optical flux and polarized flux seem to be well correlated with a flare seen in the ultraviolet and harder energies. Pesce continues to coordinate ground-based observations for various multiwavelength campaigns, in particular observations with *GRO*, collaborating with Hartman (GSFC).

E. Pian is investigating the continuum variability of blazars with the aim of clarifying the emission processes in these luminous sources and the mechanisms which convert matter into radiated energy. Multiwavelength monitorings of selected sources have led to a significant improvement in the interpretation of the emission and spectral variations. Particularly, the observing campaign of the BL Lac class prototype PKS 2155−304 in May 1994 from radio to hard X-ray frequencies detected a prominent flare of wavelength-dependent profile amplitude. This characteristic, together with the observation of a temporal lag, point to the evolution of a synchrotron flare within a shock or disturbance propagating down an inhomogeneous jet. A recent *EGRET* campaign on the gamma-ray bright blazar 3C 279, coordinated with observations with space- and ground-based facilities at lower frequencies, enabled mapping the development of an outburst at high energies, which seems consistent with an inverse Compton flare produced by scattering of relativistic electrons off high ionization emission lines (likely Lyman-α) photons.

Using ground spectrophotometric observations, R. Scarpa is studying the optical spectrum of a large sample of 73 blazars, investigating differences and similarities between radio-loud highly polarized quasars (HPQ) and BL Lacertae objects (BLL). This study is carried out as part of a larger collaboration with R. Falomo (Padova Obs.). The analysis of line luminosities shows that a continuum exists from BL Lacs to HPQ, indicating that, in spite of the classification criteria, they constitute a single class of object. This result puts strong constraints on the theoretical models for blazars.

In collaboration with C. M. Urry, A. Treves (SISSA, Trieste), R. Falomo, and J. E. Pesce, Scarpa is carrying out a detailed study of BL Lac host galaxies. This research is based on a large amount of *HST WFPC2* images. Results will permit better determination of the average morphological properties of the hosts, to be compared with those of the proposed parent population.

C. Simpson and collaborators finally obtained data for *HST* GO-5411, emission-line imaging of 8 Seyfert 2 galaxies using the Linear Ramp Filters, after a long delay. Papers based on the two most dramatic datasets are in press, and a paper is in preparation on the remaining objects.

The origin of the near-infrared [Fe II] emission in Seyfert galaxies has been a matter of debate for some time, and a thorough analysis of literature data and our own data (obtained with *CGS4* on *UKIRT*) came out strongly in favour of photoionization; a paper is in press for *MNRAS*.

In addition to projects which were finally completed and the results published, a number of new projects are underway. A combination of infrared data (from *ESO* and *UKIRT*) and X-ray spectroscopy (from the *ASCA* satellite) has revealed an extremely large gas-to-dust ratio (an order of magnitude greater than the canonical Galactic value) along the line-of-sight to the Seyfert nucleus of NGC 3281. Thermal infrared imaging of radio galaxies at $z \sim 1$ (from *UKIRT*) has indicated the existence of non-stellar contamination in the near-infrared Hubble diagram. A similar project (from the *ANU* 2.3m at *Siding Spring*) is turning up insights into the nature of the obscuring torus in low-redshift radio galaxies. Broad-band imaging of Seyfert galaxies (again from *UKIRT*) revealed the presence of a kpc-scale dust disk in Mrk 348, and follow-up Fabry-Perot imaging in a line of molecular hydrogen is scheduled for early next year.

H. Stockman continues to collaborate with Schmidt and B. Jannuzi (NOAO) on imaging polarimetry and spectropolarimetry of high redshift objects. The data for most of these objects appears consistent with obscured/lensed AGNs, rather than extended star forming regions. A good example is the $z = 1.82$ radio galaxy, 3C 256, which displays extended polarized radiation (P(0.19 μm rest = 16.4%) which is consistent with much of the light being scattered nuclear radiation.

A. Suchkov and Berman, collaborating with T. Heckman, have continued hydrodynamical simulations of galactic winds and modeling of the wind induced X-ray emission of starburst galaxies. They concluded that, in the case of M82, the galactic wind must be a strongly collimated mass-loading wind whose mass flux is 3–6 times higher than the mass deposition rate due to supernova ejecta, with almost all mass loading taking place in the very center of the galaxy (Suchkov *et al.* 1996). The X-ray emission was found to be due exclusively to the wind material: any substantial contribution from the wind-shocked halo gas appears to be incompatible with the observed data. Preliminary results from a model applicable to Arp 220 have shown that a putative superwind responsible for extended X-ray emission in this galaxy should also be a collimated wind with central mass-loading (Suchkov *et al.*, in preparation). The modeling suggests that, unlike the case of M82, the X-ray emission in this galaxy has a two-component structure, with an inner component (within $\sim 3-4$ kpc) being due to the wind material and an outer component (prominent beyond ~ 10 kpc) associated with the shocked material of the wind and the wind-evaporated gas of an extended cloudy component of the galactic ISM. The intermediate region appears to be void of emitting material at all.

C. M. Urry and Pesce continue their *HST WFPC2* imaging survey of BL Lac objects, investigating the properties of their host galaxies and environments. The first results, now in press (Falomo *et al.* 1997), describe the detection of two host galaxies at $z = 0.19$ and $z = 0.66$ and give interesting

limits on the host luminosity for a BL Lac at $z = 0.25$. Additional data for several dozen BL Lacs is now being analyzed, and will be used to understand the nature of BL Lac objects, their connection to radio galaxies, their evolution from $z = 0.1$ to $z = 1$, and the role of interactions in triggering nuclear activity.

Urry has continued multiwavelength monitoring of blazars, with Maraschi (U. Milan), Pesce, Pian, Wehrle (IPAC), and collaborators, carrying out radio-through-gamma-ray campaigns on the superluminal quasar 3C 279 and the UV-bright BL Lac object PKS 2155−304. For 3C 279, coordinated variations at gamma-ray through optical/UV wavelengths imply associated changes in both Compton-scattering electrons and seed UV photons, as may happen if the broad-line region is photoionized significantly by the jet radiation. A re-analysis of archival *IUE* spectra (Koratkar *et al.* 1996) suggests that this may well be the case.

For PKS 2155−304, two epochs of monitoring have demonstrated a close connection between UV and X-ray emission, but dramatic differences between the two epochs argue for multiple flare mechanisms. In the papers describing the second-epoch X-ray, UV, and optical data recently been submitted for publication, a variety of possible flare mechanisms are discussed, including acceleration and decay events intrinsic to a relativistic jet, microlensing events in intervening galaxy cores, and changes in Doppler beaming.

The relativistic jet paradigm for blazars implies that radio galaxies are fundamentally the same objects. Urry has written a review paper for *PASP* with P. Padovani describing the unification of blazars with radio galaxies and quasars (BL Lac objects with low-luminosity radio galaxies and quasars with high-luminosity radio galaxies). The review describes the kinds of anisotropic emission that lead to aspect-dependent AGN classification and details the aspect-independent properties that can be used to test these unified schemes. Urry and Padovani then discuss the statistical basis for this kind of unification, with quantitative analysis of both prevailing schemes. They investigate in some detail the nature of BL Lac objects, particularly the distinctions between X-ray-selected and radio-selected BL Lacs, and the connection to blazar-like quasars. Finally, they discuss the problems and complications for unified schemes and outline the ten most important questions for future research in this area.

Urry continues to study the X-ray properties of AGN with *ROSAT* and *ASCA*. She and Sambruna (NASA/GSFC) have completed a *ROSAT* survey of radio-selected BL Lac objects which suggests the onset of a Compton-scattered X-gamma-ray component typically occurs above 1−2 keV. Sambruna and she have completed a related paper demonstrating that the multiwavelength properties of BL Lac objects and flat-spectrum radio quasars show systematic trends with luminosity and line emission properties. This study rules out a simple orientation effect as the sole distinction between radio-selected and X-ray-selected BL Lac objects. With Sambruna, the *ASCA* spectrum of the high-redshift blazar 0528+134 has been used to constrain the activity of the gamma-ray component, and *ASCA*, *ROSAT*, and *BBXRT* spectra of the BL Lac object 1426+428 have been used to constrain the presence of hot, X-ray-absorbing gas.

M. Voit has begun to evaluate the potential of large infrared interferometers for studying active galaxies at high resolution. Instruments like the *VLTI* and *Keck* interferometers will be able to resolve the 10-micron thermal emission from AGN and will be excellent for studying the interface between the accretion-dominated nucleus and the ambient ISM of the host galaxy (Voit 1996b, 1996c).

7. CLUSTERS AND COSMOLOGY

S. Casertano used the distribution of faint galaxies in a large number of fields to measure their angular correlation function as a function of their magnitude, color and morphological type (Neuschaefer *et al.* 1996). The main result is that the fraction of galaxies in pairs does not increase strongly with redshift, in contrast with the conclusions of other, less deep studies.

In a related study, they have detected and measured the weak gravitational shear of the images of background galaxies around a relatively bright foreground object (Griffiths *et al.* 1996). The detected shear is larger around early-type galaxies, indicating a large mass-to-light ratio (about 100), and its radial variation is consistent with extended dark haloes around such galaxies.

M. Donahue is in the process of completing a suite of space-based observations of three distant ($z = 0.5$–0.9) clusters of galaxies selected from the Extended Medium Sensitivity Survey, including *ASCA* X-ray spectra, *ROSAT* HRI imaging, and *HST WFPC2* imaging. She is collaborating with M. Dickinson, M Postman (ST ScI), J. Stocke (U. CO), and P. Lee (ST ScI) on an optical survey of deep *ROSAT* pointed fields to find distant clusters and to compare optical and X-ray samples derived from the same fields. Donahue and M. Voit (ST ScI) have done a detailed case study of the emission line nebulae in the cooling flow cluster Abell 2597, deriving, for the first time for a cluster, cooling flow nebulae from model-independent assumptions, complete nebulae temperatures, gas densities, reddening, and elemental abundances. Knowing these gas properties allow Voit and Donahue to limit the physical mechanisms that can heat the nebular gas in cluster cooling flows.

M. Fall continued his work with Charlot (IAP, Paris) and Pei (JHU) on the global approach to star and galaxy formation. From observations of quasar absorption systems, it is possible to infer the global histories of gas consumption and metal production in galaxies from $z = 4$ to the present; and from this information it is possible to deduce the global history of star formation and hence to predict the cosmic emissivity and background intensity at various wavelengths from the far-UV to the far-IR. These predictions are in remarkably good agreement with a variety of measurements and observational upper and lower limits.

Fall and Kulkarni completed a study of the abundance patterns in damped Lyman-α galaxies at high redshifts. They found that the observed patterns are most compatible with nucleosynthesis in a mixture of type I and II supernovae and subsequent depletion onto dust grains. The inferred dust-to-metals ratios in the damped Lyman-α galaxies are similar to those in the Milky Way today, but the dust-to-gas ratios and metallicities are much lower than those in the Milky Way.

The Hubble Deep Field promises to provide new and important constraints on galaxy evolution. H. C. Ferguson was involved in the planning, data reduction, data distribution, and analysis of the images. A major focus of the initial analysis has been to identify high-redshift galaxies. Using computations of the opacity of the IGM, together with an extensive grid of galaxy spectral models Madau, Ferguson, Dickinson, Fruchter (ST ScI), Giavalisco (OCIW), and Steidel have identified 69 galaxies with likely redshifts $2<z<3.5$, and 14 with $3.5<z<4.5$. The metal-formation rate in the universe at these redshifts, calculated from the integrated UV fluxes of the galaxies, turns out to be larger than the present-day metal-formation rate, but less than the rate at $z\sim1$. Ferguson and Babul (NYU) compared a two models galaxy formation to the HDF observations. One model has pure luminosity evolution, with a deceleration parameter $q_0=0.01$. The other has $q_0=0.5$ but contains a large population of dwarf galaxies forming stars at $z\sim1$. Neither model reproduces simultaneously the observed counts, color distribution, or size distribution of the HDF galaxies. It is not yet clear whether the problems are in the detailed star-formation histories, or the underlying cosmological assumptions.

M. Livio, in collaboration with Giavalisco, Bohlin, Macchetto (ST ScI), and Stecher (LASP), showed how local galaxies observed at UV wavelengths would appear to *HST* if placed at cosmological distances. They have shown that the dependence of the galaxy morphology on star-formation activity and on wavelength must be understood before conclusions on the morphological evolution of galaxies can be reached.

Livio, with Ferrarese (ST ScI) and the H_0 key project team, discovered a nova in the Virgo galaxy M100 and derived a distance modulus to this galaxy which is consistent with the Cepheid distance modulus.

R. Lucas, in collaboration with Whitmore, Sparks, Macchetto, and Biretta, participated in a study of the globular cluster system of M87, from which a luminosity function was obtained and an estimate of the Hubble Constant was made. More than a thousand globular clusters were included in the sample, and the luminosity function was measured to a couple of magnitudes past the turnover point. Taking into account various other assumptions about the consistency of luminosity functions for both spiral and elliptical galaxies, etc., the Hubble constant was estimated to be 78 ± 11 in this case, using this method. The results were published in the 1 December 1995 ApJ Letters (Whitmore *et al.* 1995) and in the *Science With HST: II* conference proceedings from the December 1995 Paris meeting (Sparks *et al.*).

Lucas participated in the Hubble Deep Field experiment, from initial planning and field selection, through data reduction and the public release of the initial results. The data show a wealth of galaxies (several thousand) in an area that is nearly blank on the sky survey plates. The target area was chosen to meet the constraints of being as empty as possible on the optical sky survey plates, of having very low radio flux, and very low infrared cirrus, plus it was required to be in an area where good guide stars could be obtained within the *HST* Continuous Viewing Zone. These data are a rich ground for studying the formation and evolution of galaxies, and for testing new techniques of analysis (crude redshifts based on UV dropout for higher redshift galaxies, etc.), since all but the few hundred brightest galaxies are too faint even for the current capabilities of the *Keck* telescope to be able to obtain redshifts. The observations were carried out in December 1995 and were released to the community a few weeks later at the AAS Meeting in San Antonio after the first run-through of the data reduction had been completed. Two subsequent versions of the reduced data have been created, using more refined techniques, and these are available via the WWW from ST ScI's HDF page. The program and data are described in Williams *et al.* in the October 1996 *Astronomical Journal*.

In support of *HST* imaging of ten distant ($z>0.6$) clusters, M. Postman, Oke (DAO, Caltech), and Lubin (OCIW) have conducted a redshift survey using the *Low Resolution Imaging Spectrograph* (*LRIS*) on the *Keck I* 10m telescope. To date, 500 redshifts have been measured in these 10 fields. Close to 1000 redshifts are expected when the survey is completed next year. *BVRI* broad band photometry has already been obtained for all 10 clusters and JHK infra-red photometry is being acquired this year. The goal is to study the morphological and spectroscopic properties of the cluster members. Preliminary results suggest that there is significantly greater variance in the morphology-density relation at $z\sim1$ than compared to what is seen locally ($z<0.1$).

In a related project, Postman has completed a wide area ($4°\times4°$) deep *I* band survey. This is the largest, contiguous deep galaxy survey to date. The 4σ limit is $I=24$. The survey was conducted using the *KPNO* 4m prime focus camera. Co-investigators on the project include T. Lauer (KPNO), W. Oegerle (JHU), and J. Hoessel (U. WI). The goal of the survey is to constrain the evolution of large scale structure from $z\sim1$ to the present epoch. This will be done by studying the clustering properties of both the galaxies and galaxy clusters contained within this volume. There are over 500,000 galaxies mapped within this area and there are expected to be approximately 100 clusters at $z\sim1$. Analysis of the catalog is underway and preliminary results should be available next year. Spectroscopic follow-up to this imaging survey will begin in the fall of 1997.

Postman, Lauer, Strauss (Princeton), Colless (Mt. Stromlo), and Graham (Mt. Stromlo) continue to study the properties of brightest cluster galaxies (BCGs) and to use the galaxies as distance indicators. Some of this work is summarized in Graham *et al.* (1996) where it is found that there are significant departures from the $R^{1/4}$ law which are real features of BCG profiles (and are not due to observational errors). By fitting a generalized de Vaucouleurs profile of the form $R^{1/N}$, they find that BCGs typically have values of $N>4$. The shape parameter, N, is shown to correlate with the effective half light radius, such that brighter BCGs have larger N values. This continues a trend noticed among ordinary and dwarf elliptical galaxies. The extension of the original Lauer-Postman BCG sample out to $z=0.08$ is nearly complete (imaging is available for all 533 BCG in the extended survey, dispersions will be available for all of these galaxies by spring 1997). A revised measurement of the mo-

tion of the Local group relative to this cluster sample is expected by late 1997.

M. Voit has been investigating the impact of blastwaves on the evolution of the intergalactic medium. The low overall metallicity of intergalactic gas implies that the enriching stars originated in groups of one million or less and not in large galaxies (Voit 1996a).

With M. Donahue (ST ScI), Voit has continued to explore the goings-on in cooling-flow clusters of galaxies. They do not appear to contain much cold gas (Voit & Donahue 1995), but their emission-line nebulae indicate that some of these clusters sustain star formation at rates 10–100 times higher than that of the Milky Way (Donahue & Voit 1996; Voit & Donahue 1996).

B. Whitmore *et al.* (1995) used *HST* observations of over a thousand globular clusters in M87 to produce a new estimate of the Hubble constant. The limiting magnitude in V is 26 mag, more than two magnitudes beyond the turnover of the luminosity function. The distribution is well fit by a Gaussian profile with a mean of $<m_V^0>=23.72\pm0.06$ mag and a width of 1.40 ± 0.06 mag. The resulting estimate for the Hubble constant is $H_0=78\pm11$ km s^{-1} Mpc^{-1}. The $V-I$ color distribution is bimodal, with peaks at $V-I=0.95$ mag and 1.20 mag.

Whitmore (1996) reviewed the use of the globular cluster luminosity function (GCLF) as a distance indicator. The intrinsic dispersion in the turnover of the GCLF is ≈0.12 mag for bright ellipticals, making it competitive with the best distance indicators. The value of the turnover appears to be nearly universal, with only a weak second-order dependence on luminosity clearly demonstrated and other second-order dependencies possible at about the 0.1–0.2 mag level (*e.g.*, Hubble type, color, and environment). At present the best estimate of the Hubble constant based on the GCLF can be determined using seven galaxies in the Fornax cluster, yielding a value of $H_0=82\pm13$ km s^{-1} Mpc^{-1}.

8. INSTRUMENTAL RESEARCH, SOFTWARE, CATALOGS, AND SURVEYS

R. Allen continued his activities in furthering the Space Interferometer Mission (SIM) and accepted an appointment to the new SIM Science Working Group. A postdoctoral fellow has been engaged to assist with simulations of the imaging performance of SIM in rotational synthesis mode. A paper on SIM was presented at a conference on future optical telescopes (Allen, Peterson, & Shao 1996).

Ray completed the construction of drive electronics for the experimental membrane mirror project Allen is carrying out with Shao (JPL), and the hardware was shipped to JPL. Testing of the prototype device using the ST ScI electronics is expected to take place later this fall.

A new release of the *isophote* STSDAS package considerably improved on both its user interface and its internal algorithms. A detailed Monte Carlo study enabled for the first time to include in the algorithms a consistent, meaningful computation of isophote parameter errors. Results of this study can be found in Busko (1996a).

The STSDAS package *fitting* was also improved, with explicit computation of χ^2, more sophisticated noise model and improved user interface. A Monte Carlo study similar to the one done in *isophote* enabled to quantify biases found in function coefficient determination, as well as measure the accuracy of coefficient error bar computations. Results are reported in Busko (1996b).

A new set of STSDAS tasks for performing basic image processing with *NICMOS* images is undergoing development by Busko. These tasks provide the same basic functionality found in well-known existing tasks as IMARITH and IMSTAT, but with the added capability to access the extra pixel arrays contained in *NICMOS* ''images'' (errors, data quality, integration time). The tasks were developed in C language as part of the ongoing OpenIRAF project.

Instrumental work by C. Burrows has included the successful proposal of a coronagraph for the advanced camera (member of science team), optical verification by phase retrieval of *NICMOS*, and work on the science team with Lockheed for the NGST. Also a major effort to understand the *HST* wavefront and point spread function was published in Applied Optics, and is available to *HST* users through TinyTim.

J. Doggett, in collaboration with Lasker, Postman, and others, produced generic photometric calibrations for the three surveys used in the *DSS–I* (first *Digitized Sky Survey*). The overall accuracy is about 0.5 mag. The calibrations will be included in FITS extractions done by *GetImage* version 2.0 (for January 1997 release).

G. Greene, with McLean and Lasker, has developed a new object oriented database that are to be used both for evaluating the errors of *GSC 1.2* (see below; also Morrison, *et al.*, 1996) and for the initial production activities in *GSC–II*. This system is built on the Objectivity database management package. Important features of the new system include (1) ease of operation between catalog versions and with reference catalogs and overlapping plates, (2) speed and platform independence, and (3) extensibility to very large (Tbyte) catalogs. Thanks to liaison with R. Brunner (JHU), this work is being coordinated with similar developments in the SDSS archive. The possibility of sharing certain database features, *e.g.*, the partitioning of the sky, with other large database developers is also under exploration.

R. J. Hanisch and J. Mo are collaborating with D. Redding and A. Boden (JPL) on work to model optical systems and their response functions and apply these models to image restoration. In the past year they have refined optical models for *HST* and developed a massively parallel computer implementation for image restoration with a spatially-variant point spread function. This code was used to aid in the interpretation of the jets in the Herbig-Haro object HH47 in collaboration with J. Morse (U. CO).

Hanisch, R. L. White, and R. J. Gilliland completed a review of image restoration techniques for *HST*. This review will appear as one chapter in the new edition of *Deconvolution*, edited by P. Jansson and being published by Academic Press.

B. Lasker (SOC Chair) and Postman (LOC Chair) organized IAU Symposium 179, *New Horizons from Wide Field Imaging*. The host institutions were ST ScI and JHU. A Book of Abstracts was also contributed by the University of

Maryland. The main themes of the meeting were to bring together the various sky surveys (both existing and future) across the spectrum, to explore the relations between the surveys and the astrophysical opportunities, and to build strategies for working with the huge (multiple terabyte) databases associated with the surveys. The proceedings will be edited by McLean and published by Kluwer.

Lasker and his associates continued the digitization of the second generation sky surveys, *i.e.*, the *AAO Second Epoch R Survey* in the south and all three passbands of the *POSS–II* in the north. The scans have 15 μm sampling, and each plate is a 23050 square raster occupying approximately 1.1 Gbytes. As of this writing, the scanning is over half-completed. The scans are being compressed lightly (10X) and written to six sets of CD ROMs, called the *DSS–II* (*Digitized Sky Survey–II*). Highest priority is being given to an all-sky coverage in the *R*-band; this is now about 40% complete.

Lasker, in collaboration with Meakes, Doggett, and Postman, also completed a CD set of heavily compressed (100X) images of the *POSS–I* (E) plates for centers in $+90° > \delta > -12°$. (This is the same plate material that was previously published with 10X compression in the 102-volume *DSS–I* set.) This eight-volume set, which is being distributed as *RealSky* by the ASP is supported by *GetImage* software (from ST ScI) on UNIX and VMS systems and on PC and MAC systems by *RealSkyView* (produced for ASP by Software Bisque). The constituency for *RealSky* are the amateur and educational communities, and another version directed to K–12 classroom use will be produced in 1997.

Lasker and Lattanzi (Torino), in collaboration with McLean, Hawkins, Greene, and White (ST ScI) and Spagna, Massone, Morbidelli, and Zacchei (Torino) are continuing with the development of a second *Guide Star Catalog* (*GSC–II*), which is to provide all-sky coverage to at least 18 mag with colors and proper motions. The input data are the scans of the *DSS–I* and *–II*, with calibrations from the *GSPC–II* and (when possible) from *TYCHO*. Details may be found in *ESA SP* 379, and production will begin early in 1997.

A collaborative effort by Morrison and Röser (Heidelberg), Bucciarelli (Torino), and Lasker and Mclean has produced a recalibration of the *GSC–I*. This catalog, *GSC 1.2*, is on the astrometric system of the *PPM*; and corrections for field-dependent errors and magnitude effects have been included. A preliminary release of *GSC 1.2* has been made on the ST ScI WWW server; and a general distribution of the full catalog will be considered after a complete study of its errors has been completed.

M. Postman, Borgman (JHU student), Bucciarelli (Torino), Sturch, and Lasker continued work on the second *Guide Star Photometric Catalog* (*GSPC–II*), the goal of which is to provide a deep photometric sequence (*V*,*R* to 20 mag, also *B* whenever possible) for every Schmidt plate in the *DSS–I* and *–II*. At present, most fields in the north and over half in the south have at least one observation. An error analysis and a preliminary (FTP) data release are in preparation, and future efforts will be directed both towards in incomplete fields and towards increasing reliability by obtaining multiple observations as resources permit.

In 1995, H. Stockman and J. Mather (GSFC) were appointed study scientists for a feasibility study for a *Next Generation Space Telescope* (*NGST*), a large, passively cooled telescope to detect the earliest galactic structures at high redshift in the near infrared. As part of that study, they have organized a volunteer Science Working Group to define the science mission and capabilities for *NGST*. The initial portion of the study has recently been completed and an interim report will be issued in January 1997.

PUBLICATIONS

This list includes papers published or submitted between October 1995 and September 1996 by ST ScI staff (or by visitors, if a substantial portion of the work was done at ST ScI). Some papers published in this period may have been included as ''submitted'' or ''in press'' in the previous annual report.

Allen, R. J. 1996, ''Molecular Gas in Spiral Galaxies,'' in *New Extragalactic Perspectives in the New South Africa; Changing Perceptions of the Morphology, Dust Content, and Dust-Gas Ratios in Galaxies*, eds. D. Block & P. Grosbol (Kluwer: Dordrecht) in press

Allen, R. J., Peterson, D., & Shao, M. 1996, ''Space Interferometer Mission: Taking the Measure of the Unvierse,'' in *Optical Telescopes of Today and Tomorrow*, ed. A. Ardeberg (SPIE) in preparation

Armitage, P. J., & Livio, M. 1996, ''Accretion Disks in Interacting Binaries: Simulations of the Stream-Disk Impact,'' ApJ, 470, 1024

Artymowicz, P., & Lubow, S. H. 1996, ''Mass Flow Through Gaps in Circumbinary Disks,'' ApJ, 467, L77

Artymowicz, P., & Lubow, S. H. 1996, ''Binary/Disk Interactions,'' *Disks and Outflows Around Young Stars*, eds. Beckwith, *et al.*, (Berlin: Springer), p. 115

Babul, A., & Ferguson, H. C. 1995, ''Faint Blue Galaxies and the Epoch of Dwarf Galaxy Formation,'' ApJ, 458, 100

Ballester, G., Clarke, J., Trauger, J., Harris, W., Stapelfeldt, K., Crisp, D., Evans, R., Burgh, E., Burrows, C., Casertano, S., Gallagher, J., Griffiths, R., Hester, J., Hoessel, J., Hotzman, J., Krist, J., Meadows, V., Mould, J., Sahai, R., Scowen, P., Watson, A., & Westphal, J., 1996, ''Time-Resolved Observations of Jupiter's Far-Ultraviolet Aurora: Comparison of WFPC2 and IUE,'' Science, in press

Baum, S. A., O'Dea, C. P., de Koff, S., Sparks, W., Hayes, J. J. E., Livio, M., & Golombek, D. 1996, ''Hubble Space Telescope Observations of Obscuration Rings in Hercules A: Implications for Energy Transport in Powerful Radio Galaxies,'' ApJ, 465, L5

Belton, M. J. S., Mueller, B. E. A., D'Amario, L. A., Byrnes, D. V., Klaasen, K. P., Synnott, S., Breneman, H., Johnson, T. V., Thomas, P. C., Veverka, J., Harch, A. P., Davies, M. E., Merline, W. J., Chapman, C. R., Davis, D., Denk, T., Neukum, G., Petit, J.-M., Greenberg, R., Storrs, A., & Zellner, B. 1996, ''The discovery and orbit of 1993 (243)1 Dactyl,'' Icarus, 120, 185

Blair, W. P., Long, K. S., & Raymond, J. C. 1996, ''A

Search for Fe III in SN1006 Using the Hopkins Ultraviolet Telescope,'' ApJ, 468, 871

Blair, W. P., Raymond, J. C., Long, K. S. & Kriss, G. A. 1995, ''A Far Ultraviolet Spectrum of the Puppis A Supernova Remnant Using the Hopkins Ultraviolet Telescope,'' ApJ, 454, L35

Boffi, F. R., & Sparks, W. B. 1996, ''In Search of the Light Echoes around Historical Supernovae,'' in preparation

Boffi, F. R., Sparks, W. B., Panagia, N., & Macchetto, D. 1996, ''The Search for Light Echoes from Historical Supernovae as a New Geometric Method to Determine Extra-Galactic Distances,'' in *The Extragalactic Distance Scale*, ST ScI May Symposium

Branch, D., Livio, M., Yungelson, L. R., Boffi, F. R., & Baron, E. 1995, ''In Search of the Progenitors of Type Ia Supernovae,'' PASP, 107, 1019

Brown, T. M., Ferguson, H. C. & Davidsen, A. F. 1995, ''Hopkins Ultraviolet Telescope Observations of Six Elliptical and S0 Galaxies,'' ApJ, 454, L15

Brown, T., Ferguson, H. C., & Davidsen A. F. 1996, ''A Grid of Model Atmospheres and Synthetic Spectra for the Far Ultraviolet Analysis of Old Stellar Populations,'' ApJ, in press

Burrows, C. J. Krist, J. Hester, J. Sahai, R., Trauger J., Stapelfeldt, K., Gallagher, J., Ballester, G., Casertano, S., Clarke, J., Crisp, D., Evans, R., Griffiths, R., Hoessel, J., Holtzman, J., Mould, J., Scowen, P., Watson, A., & Westphal J. 1995, ''HST Observations of the SN1987A Triple Ring Nebula,'' ApJ, 452, 680

Burrows, C., Stapelfeldt, K., Watson, A., Krist, J., Ballester, G., Clarke, J., Crisp, D., Gallagher, J., Griffiths, R., Hester, J., Hoessel, J., Holtzman, J., Mould, J., Scowen, P., Trauger, J., & Westphal, J., 1996, ''HST Observations of the Disk and Jet of HH30,'' ApJ, in press

Busko, I. C. 1996a, ''Error Estimation in Elliptical Isophote Fitting,'' in *Astronomical Data Analysis Software and Systems V*, ASP Conference Series, eds. George H. Jacoby and Jeannette Barnes, 101, p. 139

Busko, I. C. 1996b, ''Error and Bias in the STSDAS FITTING Package,'' in *Astronomical Data Analysis Software and Systems VI*, Charlottesville, September 1996

Buss, R. H., Kruk, J. W. & Ferguson, H. C. 1995, ''New Far-Ultraviolet Intrinsic Spectral Fluxes of Hot Stars and their Photospheric Temperatures,'' ApJ, 454, L55

Calzetti, D. 1996, ''Reddening and Star-Formation in Starburst Galaxies,'' AJ, submitted

Calzetti, D., Kinney, A. L., Ford, H., Doggett, J., & Long, K. S. 1995, ''An Atlas of Hα-Emitting Regions in M 33: a Systematic Search for SS433 Star Candidates,'' AJ, 110, 2739

Canzian, B., & Allen, R. J. 1996, ''Spiral Density Wave Theory, Corotation Resonance, and the Velocity Field of NGC 4321,'' ApJ, submitted

Caon, N., Pastoriza, M., Macchetto, F. & Sparks, W. B. 1995, ''A Survey of the Interstellar Medium in Elliptical Galaxies: The Ionized Gas,'' BAAS, 27, 1407

Casertano, S., Ratnatunga, K. U., Griffiths, R. E., Im, M., Neuschaefer, L. W., Ostrander, E. J., & Windhorst, R. A. 1995, ''Structural Parameters of Faint Galaxies from Pre-refurbishment Hubble Space Telescope Medium Deep Survey Observations,'' ApJ, 453, 599

Charbonnel, C., 1995, ''Non-standard mixing on the red giant branch: Influence on carbon isotopic ratio, lithium abundance and stellar production of ^{3}He,'' in *Proceedings of ''From Stars to Galaxies: The Impact of Stellar Physics on Galaxy Evolution,''* ASP Conf. Series, Vol 78, eds. C. Leitherer, U. Fritze-von Alvensleben, & J. Huchra, Crete, Greece, p. 213

Charbonnel, C. 1995, ''Non-standard mixing on the red giant branch: Influence on chemical anomalies,'' in *Proceedings of the 9th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun*, (Florence, Italy, October 1995), in press

Charbonnel, C. 1996, ''Primordial abundances of ^{7}Li and ^{3}He: the stellar point of view,'' in *Proceedings of the Fourth International Conference on Nuclei in the Cosmos*, (University of Notre Dame: Indiana, June 1996), in press

Charbonnel, C., Dappen, W., Bernasconi, P. A., Maeder, A., Meynet, G., & Schaerer, D. 1996, ''Grids of stellar models. VII. From 0.4 to 1.0 M at $z=0.020$ and $z=0.001$, with an adequate equation of state,'' A&AS, in preparation

Ciotti, L., Stiavelli, M., & Braccesi, A. 1995, ''Recovering the intrinsic metallicity distribution of elliptical galaxies,'' MNRAS, 276, 961

Clarke, J., & WFPC2 IDT, 1995, ''HST Far-Ultraviolet Imaging of Jupiter During the Impacts of Comet Shoemaker-Levy-9,'' Science, 267, 5202

Colbert, E. J. M., Baum, S. A., Gallimore, J. F., O'Dea, C. P., & Christensen, J. A. 1996, ''Large-Scale Outflows in Edge-on Seyfert Galaxies. II. Kiloparsec-Scale Radio Continuum Emission,'' ApJ, 467, 551

Colbert, E. J. M., Baum, S. A., Gallimore, J. F., O'Dea, C. P., Lehnert, M. D., Tsvetanov, Z. I., Mulchaey, J. S., & Caganoff, S. 1996, ''Large-Scale Outflows in Edge-on Seyfert Galaxies. I. Optical Emission-line Imaging and Optical Spectroscopy,'' ApJS, 105, 75

Colina, L., & Koratkar, A. 1997, ''The Nature of the Energy Source in LINERs,'' in *Emission Lines in Active Galaxies: New Methods and Techniques,* eds. B. M. Peterson, F.-Z. Cheng, & A. S. Wilson (San Francisco: Astronomical Society of the Pacific), in press

Crenshaw, D. M., *et al.* 1996, ''Multiwavelength Observations of Short-Timescale Variability in NGC 4151. I. Ultraviolet Observations,'' ApJ, 470, 322

Cuillandre, J.-C., Lequeux, J., Mellier, Y., & Allen, R. J. 1996, ''Dust and star formation in the outermost parts of M31,'' A&A, submitted

De Bruyn, A. G., O'Dea, C. P., & Baum, S. A. 1996, ''WSRT Detection of HI Absorption in the z=3.4 Damped Lyman Alpha System in PKS 0201+113,'' A&A, 305, 450

Della Valle, M., & Livio, M. 1996, ''Are Microlensing Events Contaminated by Dwarf Nova Eruptions?'' ApJ, 457, L77

Dempsey, R. C., Neff, J. E., O'Neal, D., & Olah, K. 1996, ''Multiwavelength Observations of Two Moderate Rota-

tion RS CVn Systems: V815 Herculis and IM Pegasi,'' AJ, 111, 1356

Dempsey, R. C., Neff, J. E., Thorpe, M., Linsky, J. L., Brown, A., Cutispoto, G., & Rodonó, M. 1996, ''Goddard High Resolution Spectrograph Observations of Variability in the RS CVn System V711 Tau (HR 1099),'' ApJ, 470, in press

Dixon, W. V. D., Davidsen, A. F., Dorman, B., & Ferguson, H. C. 1995, ''Constraints on the Horizontal-Branch Morphology of the Globular Cluster M79 (NGC1904) from Optical and Far-UV Observations,'' AJ, 111, 1936

Dixon, W. V. D., Davidsen, A. F., & Ferguson, H. C. 1995, ''Observations of Far-UV Emission from NGC1275 with the Hopkins Ultraviolet Telescope,'' AJ, 111, 130

Dixon, W. V. D., Davidsen, A. F. & Ferguson, H. C. 1995, ''Observations of the UV-Bright star in 47 Tucanae with the Hopkins Ultraviolet Telsecope,'' ApJ, 454, L47

Dixon, W. V. D., Davidsen, A. F., & Ferguson, H. C. 1995, ''Discovery of OVI Emission from the Galactic Corona with the Hopkins Ultraviolet Telescope,'' ApJ, 465, 288

Dixon, W. V. D., Hurwitz, M., & Ferguson, H. C. 1996, ''Limits on Far-Ultraviolet Emission from Warm Gas in Clusters of Galaxies with the Hopkins Ultraviolet Telescope,'' ApJ, 496, L77

Doggett, J., Postman, M., Lasker, B. M., & Meakes, M. 1996, ''Photometric Calibration of the Digitized Sky Survey,'' in *Proc. ADASS V, ASP Conf. Series*, eds. G. Jacoby & J. Barnes, ASP Conf. Series, 101, 159

Donahue, M. 1995, ''Distant ($z>0.5$) Clusters of Galaxies,'' in *Clusters, Lensing, and the Future of the Universe*, (A. S. P. Conference Series, College Park, MD, invited talk), p. 76

Donahue, M. 1996, ''Temperature and Metallicity of a Massive X-ray Cluster at Redshift 0.5,'' ApJ, 468, 79

Donahue, M., Aldering, G. L., & Stocke, J. T. 1995, ''Low Surface Brightness Observations of Integalactic HI Clouds,'' ApJ, 450, 45L

Donahue, M. & Stocke, J. T. 1995, ''ROSAT Observations of Distant Clusters of Galaxies,'' ApJ, 449, 554

Donahue, M. & Voit, G. M. 1997, ''Emission Lines in Cluster Cooling Flows,'' to be published in *Cluster Cooling Flows*, (Workshop in Haifa, Israel, August, 1996)

Dopita, M. A ., Koratkar, A., Allen, M., Bicknell, G. V., Sutherland, R. S. , Evans, I., Hawley, J. F., & Sadler, E., 1996, ''Shock Excitation of LINERs,'' in *The Physics of LINERs in View of Recent Observations*, eds. M. Eracleous, A. Koratkar, C. Leitherer, & L. Ho (San Francisco: Astronomical Society of the Pacific), p. 44

Downes, R. A., Anderson, S. F., & Margon, B. 1996, ''The Diverse Optical/Ultraviolet Spectra of the Globular Cluster X-ray Sources in NGC 7078 and NGC 6712,'' PASP, 108, 688

Drissen, L., Moffat, A. F. J., Walborn, N. R., & Shara, M. M. 1995, ''The Dense Galactic Starburst NGC 3603. I. HST/FOS Spectroscopy of Individual Stars in the Core and the Source of Ionization and Kinetic Energy,'' AJ, 110, 2235

Eck, C., Cowan, J. J., , Boffi, F. R., & Branch, D. 1996, ''A Deep Search for Radio Emission from the Type II SNe 1984E and 1986E,'' ApJL, in press

Edelson, R. A., *et al.* 1996, ''Multiwavelength Observations of Short-Timescale Variability in NGC 4151. IV. Analysis of Multiwavelength Continuum Variability,'' ApJ, 470, 364

Eracleous, M., Koratkar, A., Leitherer, C., & Ho, L. 1996, editors *The Physics of LINERs in View of Recent Observations*, ASP Conference Proceedings Vol 103

Evans, I., Koratkar, A., Storchi-Bergmann, T., Kirkpatrick, H., Baldwin, J., Heckman, T., & Wilson, A. 1996, ''An Atlas of HII Regions in Nearby Seyfert Galaxies,'' ApJS, 105, 93

Falcke, H., Wilson, A. S., Simpson, C., & Bower, G. A. 1996, ''Helical strands in the jet-like narrow line region of ESO 428−G14,'' ApJL, in press

Fall, S. M. 1996, ''A Global Approach to Star and Galaxy Formation,'' in *The High-Redshift Universe with the VLT*, ed. J. Bergeron (Berlin: (Springer), in press

Fall, S. M., Charlot, S., & Pei, Y. C. 1996, ''Cosmic Emissivity and Background Intensity from Damped Lyman-Alpha Galaxies,'' ApJ, 464, L43

Fall, S. M., & Pei, Y. C. 1995, ''Consequences of Dust in Damped Lyman-Alpha Systems,'' in *QSO Absorption Lines*, ed. G. Meylan (Berlin: Springer), p. 23

Falomo, R., Scarpa, R., Pesce, J., Urry, C. M., & Treves, A. 1996, ''Optical Ground-Based Images of BL Lac Objects Scheduled for HST Observations,'' in *Science with the Hubble Space Telescope II*, eds. P. Benvenuti, F. D. Macchetto, & E. J. Schreier (Space Telescope Science Institute), p. 226

Falomo, R., Urry, C. M., Pesce, J. E., Scarpa, R., Treves, A., & Giavalisco, M. 1997, ''Observations of Host Galaxies in Three Radio-Selected BL Lacertae Objects,'' ApJ, 476, in press

Ferguson, H. C., Brown, T. M., & Davidsen, A. F. 1995, ''Far-UV Line Strengths in Elliptical Galaxies,'' in *From Stars to Galaxies: The Impact of Stellar Physics on Galaxy Evolution*, eds. C. Leitherer, U. Fritze-von Alvensleben, & J. Huchra (ASP,San Francisco), 486

Ferguson, H. C., Dixon, W. V. D., Davidsen, A. F. & Dettmar, R.-J. 1995, ''A Search for Far-UV Emission Lines from Diffuse Hot Gas in the Halo of NGC4631,'' ApJ, 454, L23

Ferrarese, L., Livio, M., Freedman, W., Saha, A., Stetson, P. B., Ford. H. C., Hill, R. J., & Madore, B. F. 1996, ''Discovery of a Nova in the Virgo Galaxy M100,'' ApJ, 468, L95

Forestini, M., & Charbonnel, C. 1996, ''Nucleosynthesis of light elements inside thermally pulsing AGB stars,'' A&AS, in press

Gallagher, J. S., Mould, J. R. De Feijter, E., Holzman, J., Stappers, B., Watson, A., Trauger, J., Ballester, G., Burrows, C. J., Casertano, S., Clarke, J. T., Crisp, D., Griffiths, R., Hester, J., Hoessel, J., Krist, J., Matthews, L., Scowen, P., Stapelfeldt, K., & Westphal, J., 1996, ''Main-Sequence Stars and the Star Formation History of the Outer Disk in the Large Magellanic Cloud,'' ApJ, 466, 732

Gallimore, J. F., Baum, S. A., & O'Dea, C. P. 1996, ''The Sub-arcsecond Radio Structure in NGC 1068: II. Implica-

tions for the Central Engine and Unifying Schemes,'' ApJ, 464, 198

Gallimore, J. F., Baum, S. A., O'Dea, C. P., Brinks, E., & Pedlar, A. 1996, ''H2O and OH Masers as Probes of the Obscuring Torus in NGC 1068,'' ApJ, 462, 740

Gallimore, J. F., Baum, S. A., O'Dea, C. P., Pedlar, A., & Brinks, E. 1996, ''The Sub-arcsecond Radio Structure in NGC 1068: I. Observations and Results,'' ApJ, 458, 136

Gäng, Th., Leitherer, C., Wolf, B., Stahl, O., Kaufer, A., Rivinius, Th., Gummersbach, Ch., Jankovics, I., Kovacs, J., Mandel, H., Peitz, J., & Szeifert, Th. 1996, ''Analysis of the line variations in the wind of HD 160529,'' BAAS, 187, 1902

Gäng, Th., Wolf, B., Stahl, O., Leitherer, C., Kaufer, A., Rivinius, Th., Gummersbach, Ch., Jankovics, I., Kovacs, J., Mandel, H., Peitz, J., & Szeifert, Th. 1996, ''Spectral analyses from long-term monitoring of HD 160529,'' A&A, in preparation

Gaskell, M., & Koratkar, A. 1996, ''The Nature of Fe II Emitting Clouds in Quasars: Ultraviolet Observations of Extreme Fe II Emitting Quasars Mrk 42 and Mrk 957,'' ApJ, submitted

Giavalisco, M., Koratkar, A., & Calzetti, D. 1996, ''Obscuration of Lyman-alpha Photons in Star-Forming Galaxies,'' ApJ, 466, 831

Giavalisco, M., Livio, M., Bohlin, R. C., Macchetto, F. D., & Stecher, T. P. 1996, ''On the morphology of the HST faint galaxies,'' AJ, 112, 369

Goad, M. R., & Wanders, I. 1996, ''The Effect of a Variable Anisotropic Continuum Source upon the Broad Emission Line Profiles and Responses,'' ApJ, 469, 113

Gondhalekar, P. M., Goad, M. R., & O'Brien, P. T. 1996, ''The Broad Emission Line Region in AGNs and Quasars: The Impact of Variability Studies,'' Ap&SS, 237, 207

Graham, A., Lauer, T. R., Colless, M., & Postman, M. 1996, ''Brightest Cluster Galaxy Profile Shapes,'' ApJ, 465, 534

Grandi, P., Sambruna, R., Maraschi, L., Urry, C. M., & Mushotzky, R. F. 1996, ''The High Energy Spectrum of the Radio Galaxy 3C 120,'' in *X-Ray Imaging and Spectroscopy of Cosmic Hot Plasmas*, (Tokyo, March 1996)

Grandi, P., Urry, C. M., Maraschi, L., Wehrle, A. E., Madejski, G. M., Aller, M. F., Aller, H. D., Bailyn, C. D., Balonek, T. J., Bock, T. H., Glass, I. S., Litchfield, S. J., McHardy, I. M., Mulchaey, J. S., Reuter, H.-P., Robson, E. I., Sadun, A. C., Sherry, W., Steppe, H., Steven, J. A., Terasranta, H., Tornikoski, M., & Wagner, S. J. 1995, ''3C279 Multiwavelength Monitoring. II. Ground-Based Campaign,'' ApJ, 459, 73

Greeley, B. W., Blair, W. P., & Long, K. S. 1995, ''Hopkins Ultraviolet Telescope Observations of Nova Circini 1995 and Nova Aquilae 1995,'' ApJ, 454, L43

Greene, G., McLean, B., Morbidelli, R., Lasker, B., & Wolfe, D. 1996, ''The GSC-I and GSC-II Databases: An Object Oriented Approach,'' in *IAU Symposium 179, New Horizons from Wide-Field Imaging*, ed. B. McLean, in press

Griffiths, R. E., Casertano, S., Im, M., & Ratnatunga, K. U. 1996, ''Weak Gravitational Lensing around Field Galaxies in HST Survey Images,'' MNRAS Letters, in press

Hau, G. K. T., Ferguson, H. C., Lahav, O., & Lynden-Bell, D. 1995, ''Visual Search fo Galaxies near the Northern Crossing of the Supergalactic Plane and by the Milky Way,'' MNRAS, 277, 125

Heath-Jones, D., Mould, J., & WFPC2 IDT, 1996, ''Visible and Far Ultraviolet WFPC2 Imaging of the Nulceus of the Galaxy NGC 205,'' ApJ, 466, 732

Hester, J., Stone, J., Scowen, P., Byung, J., Gallagher, J., Norman, M., Ballester, G., Burrows, C., Casertano, S., Clarke, J., Crisp, D., Griffiths, R., Hoessel, J., Holtzman, J., Krist, J., Mould, J., Sankrit, R., Stapelfeldt, K., Trauger, J., Watson, A., & Westphal, J., 1995, ''WFPC2 Studies of the Crab Nebula: III Magnetic Rayleigh-Taylor Instabilities and the Origin of the Filaments,'' ApJ, 456, 225

Hester, J., & WFPC2 IDT, 1995, ''WFPC2 Studies of the Crab Nebula I: HST and Rosat Imaging of the Synchrotron Nebula,'' ApJ, 448, 240

Holtzman, J. 1996, ''Star Clusters in Interacting and Cooling Flow Galaxies,'' AJ, 112, 416

Holtzman, J. A., Burrows, C. J., Casertano, S., Hester, J. J., Trauger, J. T., Watson, A. M., & Worthey, G. 1995, ''The Photometric Performance and Calibration of WFPC2,'' PASP, 107, 1065

Holtzman, J., Hester, J., Casertano, S., Trauger, J., Watson, A., Ballester, G., Burrows, C., Clarke, J., Crisp, D., Evans, R., Gallagher, J., Griffiths, R., Hoessel, J., Matthews, L., Mould, J., Scowen, P., Stapelfeldt, K., & Westphal, J., 1995, ''The Performance and Calibration of WFPC2 on the Hubble Space Telescope,'' PASP, 197, 156

Holtzman, J., & WFPC2 IDT, 1995, ''The Photometric Performance and Calibration of WFPC2,'' PASP, 107, 1065

Holtzman, J., & WFPC2 IDT, 1997, ''Stellar Populations in the Large Magellanic Cloud. Out with New and in with the Old?'' AJ, in press

Jannuzi, B. T., Elston, R., Schmidt, G. D., Smith, P. S., & Stockman, H. S. 1995, ''Detection of Extended Polarized Ultraviolet Radiation from the z = 1.82 Radio Galaxy 3C 256,'' ApJ, 454, L111

Johnson, W., Benetti, S., Turatto, M., Garnavich, P., Riess, A., Kirshner, R., & Moehler, S. 1996, ''Supernova 1996Z in NGC 2935,'' IAUC 6401, 1

Kaufer, A., Stahl, O., Wolf, B., Gäng, Th., Gummersbach, C. A., Jankovics, I., Kovacs, J., Mandel, H., Rivinius, Th., Szeifert, Th. 1996, ''Long-term spectroscopic monitoring of BA-type supergiants. II: High-velocity absorptions in beta Ori and HD 96919,'' A&A, in press

Kidger, M. R., Gonzalez-Perez,J. N., De Diego, J. A., Zapatero-Osorio, M. R., Hammarseley, P. C., Cepa, J., Devaney, N., Sahu, K. C., & Vidal, I. 1995, ''A large optical and Ir outburst in OJ 287,'' A&A, 303, 973

Kinney, A. L., Calzetti, D., Bohlin, R. C., McQuade, K., Storchi-Bergmann, T., & Schmitt, H. R. 1996, ''Template Ultraviolet to Ner-Infrared Spectra of Star-forming Galaxies and their Application to K-Corrections,'' ApJ, 467, 38

Koratkar, A., Goodrich, R., & Antonucci, R., 1997, ''Below the Lyman Edge: UV Polarimetry of Quasars,'' in *Accre-*

tion Phenomenon in Astrophysics, ed. G. Bicknell (San Francisco: Astronomical Society of the Pacific), in press

Koratkar, A., Pesce, J. E., Urry, C. M., & Pian, E. 1996, ''Variability of the Ly-alpha Emission Line in 3C 279,'' ApJ, submitted

Koratkar, A., Pesto, S., & Evans, I. N., 1997, ''A Detailed Comparison of HST FOS and IUE UV Spectra of Selected Seyfert Nuclei,'' in *Emission Lines in Active Galaxies: New Methods and Techniques*, eds. B. M. Peterson, F.-Z. Cheng, & A. S. Wilson (San Francisco: Astronomical Society of the Pacific), in press

Koratkar, A. P., *et al.* 1996, ''The Disappearing Broad Absorption Lines and Variable Emission Lines in NGC 3516,'' ApJ, 470, 378

Krist, J., & Burrows, C., 1995, ''Phase Retrieval Analysis of Pre and Post Repair Hubble Space Telescope Images,'' Applied Optics, 34, 4951

Kulkarni, V. P., & Fall, S. M. 1995, ''Implications of Non-Thermal Motions for Statistics of Lyman-Alpha Forest Systems,'' ApJ, 453, 65

Laidler, V. G., Sturch, C. R., Greene, G. R., Lasker, B. M., McLean, B. J., White, R. L., Bucciarelli, B., Lattanzi, M. G., Spagna, A., & Zacchei, A. 1996, ''New Surveys at ST ScI: Scanning, Distribution, and Cataloging,'' BAAS, 28, 907

Lasker, B. M., Doggett, J., McLean, B., Postman, M., Sturch, C., Djorgovski, S., De Carvalho, R., & Reid, I. N. 1996, ''The Palomar–ST ScI Digitized Sky Survey: Preliminary Data Availability,'' in *Proc. ADASS V*, eds. G. Jacoby & J. Barnes, ASP Conf. Series, 101, 88

Lasker, B. M., McLean, B. J., Jenkner, H., Lattanzi, M. G., & Spagna, A. 1996, ''Potential Applications of the GSC–II for GAIA Operations,'' in *ESA/RGO Workshop on Future Possibilities for Astrometry in Space*, (Cambridge, June 1995) eds. M. A. C. Perryman & F. van Leeuven, ESA Conference Proceedings, ESA SP 379, p. 137

Lasker, B. M., Sturch, C., Doggett, J., Greene, G., Laidler, V., Loomis, C., & Wolfe, D. 1996, ''The ST ScI Digitized Sky Surveys,'' in *IAU Symposium 179, New Horizons from Wide-Field Imaging*, ed. B. McLean, in press

Lebre, A., Charbonnel, C., & De Medeiros, J. R. 1995, ''On the relation between rotation and lithium abundance on the sub-giant branch,'' in *Proceedings of the 9th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun*, (Florence, Italy, October 1995), in press

Leitherer, C., Ferguson, H. C., Heckman, T. M. & Lowenthal, J. D. 1995, ''The Lyman Continuum in Starburst Galaxies Observed with the Hopkins Ultraviolet Telescope,'' ApJ, 454, L19

Leitherer, C., *et al.* 1996, ''A Database for Galaxy Evolution Modeling,'' PASP, in press

Livio, M., & Pringle, J. E., 1996, ''The Formation of Point-symmetric Nebulae,'' ApJ, 465, L55

Livio, M., & Pringle, J. E. 1996, ''On the origin of double-peaked emission lines in active galactic nuclei,'' MNRAS, 278, L35

Lloyd, C., Stickland, D. J., & Walborn, N. R. 1995, ''The Variable Velocity of Theta Carinae,'' PASP, 107, 1030

Loinard, L., Allen, R. J., & Lequeux, J. 1996, ''CO Emission Associated With Dust Clouds in the Inner Disk of M31,'' A&A, 310, 93

Loinard, L., Dame, T. M., Koper, E., Lequeux, J., Thaddeus, P., & Young, J. S. 1996, ''Molecular Spiral Arms in M31,'' ApJ, 469, L101

Long, K. S. 1995, ''The Hopkins Ultraviolet Telescope Observations of Dwarf Novae,'' Journal of the AAVSO, 23, 94

Long, K. S. 1996, ''The EUVE Observations of Dwarf Novae,'' in IAU Colloq. 152 *Astrophysics in the Extreme Ultraviolet*, eds. S. Bowyer & R. F. Malina (Dordrecht: Kluwer), p. 301

Long, K. S., Blair, W. P., Hubeny, I., & Raymond, J. C. 1996, ''Observations of the Dwarf Nova VW Hydri in Quiescence with the Hopkins Ultraviolet Telescope,'' ApJ, 466, 964

Long, K. S., Blair, W. P., & Raymond, J. C. 1995, ''Hopkins Ultraviolet Telescope Observations of U Geminorum Far from Outburst,'' ApJ, 454, L39

Long, K. S., Charles, P. A., Blair, W. P., & Gordon, S. M. 1996, ''A Deep X-ray Image of M33,'' ApJ, 466, 750

Long, K. S., Mauche, C. W., Raymond, J. C., Szkody, P., & Mattei, J. A. 1996, ''EUVE Observations of U Gem in Outburst,'' ApJ, 469, 841

Long, K. S., Mauche, C. W., Szkody, P., & Mattei, J. A. 1995, ''EUVE Observations of U Gem,'' in *Cataclysmic Variables*, eds. A. Bianchini, M. Della Valle, & M. Orio (Holland: Kluwer), p. 133

Lubin, L. M., & Postman, M. 1996, ''The Palomar Distant Cluster Survey—II. The Cluster Profiles,'' AJ, 111, 1795

Lubow, S. H., & Artymowicz, P. 1996 ''Young Binary Star/Disk Interactions,'' in *Evolutionary Processes in Binary Stars*, eds. Wijers, Davies, & Tout, NATO ASI vol. 477, p. 53

Macchetto, F., Caon, N., Pastoriza, M. & Sparks, W. B. 1996, ''The Ionized Gas in Early-type Galaxies,'' in *Changing Perceptions of the Morphology, Gas Content and Gas-Dust Ratios in Galaxies*, (Johannesburg, South Africa, January 1996)

Macchetto, F. D., Pastoriza, M., Caon, N., Sparks, W. B., Giavalisco, M., Bender, R. & Capaccioli, M. 1996, '' A Survey of the Interstellar Medium in Elliptical Galaxies. I. The Ionized Gas,'' A&ASS, in press

Madau, P., Ferguson, H. C., Dickinson, M. E., Giavalisco, M., Steidel, C. C., & Fruchter, A. S. 1996, ''High Redshift Galaxies in the Hubble Deep Field. I. Color Selection and Star Formation History to $z\sim4$,'' MNRAS, in press

Mahdavi, A., Geller, M. J., Fabricant, D., Kurtz, M. J., Postman, M., & McLean, B. 1996, ''The Lumpy Cluster Abell 1185,'' AJ, 111, 64

Makino, F., Edelson, R., Fujimoto, R., Kii, T., Idesawa, E., Makishima, K., Takahashi, T., Sasaki, K., Kamae, T., Kubo, H., Mathis, D., Tashiro, M., Terasranta, H., & Urry, C. M. 1996, ''Observations of Blazars with ASCA,'' in *Roentgenstrahlung in the Universe*, p. 413

Maraschi, L., Sambruna, R., Urry, C. M. 1996, ''On the

Spectral Energy Distributions of Blazars,'' in *Roentgenstrahlung in the Universe*, p. 473

Marochnik, L. S., & Suchkov, A. 1996, ''The Milky Way Galaxy,'' Gordon and Breach Publishers

McLean, B., Hawkins, G., Spanga, A., Lattanzi, M. G., Lasker, B., & Jenkner, H. 1996 ''The Second Guide Star Catalogue,'' in *IAU Symposium 179, New Horizons from Wide-Field Imaging*, ed. B. McLean, in press

Mighell, K. J., Rich, R. M., Shara, M., & Fall, S. M. 1996, ''WFPC2 Observations of Star Clusters in the Magellanic Clouds. I. The Large Magellanic Cloud Globular Cluster Hodge 11,'' AJ, 111, 2314

Miller, B. W. 1996, ''The Star Formation Histories of Sculptor Group Dwarf Galaxies I. Current Star Formation Rates and Abundances,'' AJ, 112, 991

Miller, B. W. & Hodge, P. 1995, ''Spectroscopy of HII Regions in M81 Group Dwarf Galaxies,'' ApJ, 458, 467

Miller, B. W., & Rubin, V. C. 1995, ''Near Nuclear Velocities in NGC 5907: Observations and Mass Models,'' AJ, 110, 2692

Miller, B. W., Whitmore, B., Schweizer, F., & Fall, M. 1996, ''Star Clusters in the Merger Remnant NGC 7252,'' BAAS, 28

Ming-Sheg H., Hoessel, J., & WFPC2 IDT, 1997, ''Stellar Populations in the Dwarf Elliptical Galaxy NGC 147,'' ApJ, in press

Moehler S. 1996, ''Hot stars in globular clusters,'' in *Proceedings of Formation of the Galactic Halo—Inside and Out*, eds. H. Morrison & A. Sarajedini, ASP Conf. Ser. 92, p. 281

Moehler, S., Heber, U., & Durrell, P. 1996, ''Hot HB stars in globular clusters—Physical parameters and consequences for theory. IV. sdB candidates in M 15,'' A&A Letters, submitted

Moehler, S., Heber, U., & Rupprecht, G. 1997, ''Hot HB stars in globular clusters—physical parameters and consequences for theory. III. NGC 6752 and its long blue vertical branch,'' A&A, in press

Moehler, S., Heber, U., Saffer, R., & Thejll, P. 1995, ''Hot Subdwarfs in Globular Clusters,'' BAAS, 27, 1704

Moeller, P., Stiavelli, M., & Zeilinger, W. W. 1995, ''Core properties of elliptical galaxies—I. A northern hemisphere sample at high resolution,'' MNRAS, 276, 979

Morse, J. A., Blair, W. P., Dopita, M. A., Hughes, J. P., Kirshner, R. P., Long, K. S., Raymond, J. C., Sutherland, R. S., & Winkler, P. F. 1996, ''Hubble Space Telescope Observations of Oxygen-Rich Supernova Remnants in the Magellanic Cloud. I. Narrow-band Imaging of N132D in the LMC,'' AJ, 112, 509

Morrison, J. E., Röser, S., Lasker, B. M., Smart, R. L., & Taff, L. G. 1996, ''A Schmidt Plate Magnitude Term,'' AJ, 111, 1405

Mould, J. R., Watson, A. M., Gallagher, J. S., Holtzman, J. A., Hester, J. J., Ballester, G. E., Burrows, C. J., Casertano, S., Clarke, J. T., Crisp, D., Evans, R. E., Griffiths, R. E., Hoessel, J. G., Scowen, P. A., Stapelfeldt, K. R., Trauger, J. T., & Westphal, J. A., 1996, ''Far-Ultraviolet Imaging of the Globular Cluster NGC 7099 with WFPC2,'' ApJ, 461, 762

Mould, J., & WFPC2 IDT, 1996, ''Low Mass Stars in an Outer Field in NGC 6397,'' PASP, 108, 682

Mould, J., & WFPC2 IDT, 1996, ''Wide-Field and Planetary Camera 2,'' ApJ, 461, 762

Neff, J. E., Brown, A., Dempsey, R. C., Fox, T., Linsky, J. L., Pagano, I., Rodono, M., Bromage, M., & Kürster, M. 1996, ''Rotational Modulation and Flares on RS CVn and BY Dra Stars. BH. Simultaneous IUE, ROSAT, VLA, and Visual Observations of TY Pyxidis,'' A&A, 31, 173

Neuschaefer, L. W., Im, M., Ratnatunga, K. U., Griffiths, R. E., & Casertano, S. 1996, ''Evidence for Galaxy Interactions/Mergers from Medium-Deep Survey WFPC2 Data,'' ApJ, in press

Neuschaefer, L. W., Ratnatunga, K. U., Griffiths, R. E., Casertano, S., & Im, M. 1995, ''Galaxy Clustering Statistics of Hubble Space Telescope Medium Deep Survey WF/PC Images,'' ApJ, 453, 559

Nota, A., Pasquali, A., Clampin, M, Pollacco, D., Scuderi, S., & Livio, M. 1996, ''The Nebula Around HD 168625: Morphology, Dynamics and Physical Properties,'' ApJ, in press

O'Dea, C. P., Stanghellini, C., Baum, S. A., & Charlot, S. 1996, ''On the Host Galaxies of the GHz Peaked Spectrum Radio Sources,'' ApJ, 470, 806

O'Dea, C. P., Worrall, D. M., Baum, S. A., & Stanghellini, C. 1996, ''A ROSAT Search for Clusters Around Three Powerful Radio Galaxies at Redshifts $0.1<z<0.25$,'' AJ, 111, 92

Oudmaijer, R. E., Groenewegen, M. A. T., Matthews, H. E., Blommaert, J. A. D. L., & Sahu, K. C. 1996, ''The spectral energy distribution and mass-loss history of IRC +10420,'' MNRAS, 280, 1062

Panagia, N., Romaniello, M., Scuderi, S., & Kirshner, R. P., 1996, in preparation

Pei, Y. C., & Fall, S.M. 1995, ''Cosmic Chemical Evolution,'' ApJ, 454, 69

Perlman, E. S., Stocke, J. T., Schachter, J. F., Elvis, M., Ellingson, E., Urry, C. M., Potter, M., Impey, C. D., & Kolchinsky, P. 1996, ''The Einstein Slew Survey of BL Lacs,'' ApJS, 104, 251

Pesce, J. E., Falomo, R., Fasano, G., Kim, J., Scarpa, R., & Urry, C. M., ''The Environments of Low-Redshift Radio Galaxies,'' in preparation

Pesce, J. E., Falomo, R., Fasano, G., & Scarpa, R. 1995, ''The Environments of Low Redshift Radio Galaxies,'' in *IAU 175th Symposium, Extragalactic Radio Sources*, Bologna, Italy

Pesce, J. E., Paske, A., Urry, C. M., & Falomo, R. 1996, ''The Environments of Low-Redshift BL Lac Objects,'' in preparation

Pesce, J. E., Urry, C. M., Falomo, R., Scarpa, R., Treves, A., & Giavalisco, M. 1996, ''High Resolution HST Imaging of Radio-Selected BL Lacertae Objects,'' High Energy Astrophysics Division of the American Astronomical Society meeting, San Diego, May 1996

Pesce, J. E., Urry, C. M., Falomo, R., Scarpa, R., & Treves, A. 1997, ''Environments of BL Lacertae Objects Observed with the HST,'' in preparation

Pesce, J. E., Urry, C. M., Maraschi, L., Treves, A., Grandi,

P., Kollgaard, R I., Pian, E., Smith, P. S., Aller, H. D., Aller, M. F., Barth, A. J., Buckley, D. A. H., Covino, E., Filippenko, A. V., Hooper, E. J., Joner, M. D., Kedziora-Chudczer, L., Kilkenny, D., Knee, L. B. G., Kunkel, M., Layden, A. C., Magalhães, A. M., Marang, F., Margoniner, V. E., Palma, C., Pereyra, A., Rodrigues, C. V., Schutte, A., Sitko, M. L., Tornikoski, M., van der Walt, J., van Wyk, F., Whitelock, P. A., & Wolk, S. J. 1996, ''Multiwavelength Monitoring of the BL Lacertae Object PKS 2155−304 in May 1994. I. The Ground-Based Campaign,'' ApJ, in press

Pesce, J. E., Urry, C. M., *et al.*, 1996, ''Multiwavelength Observations of PKS 2155−304 during May 1994: The Ground-based Campaign,'' in *Blazar Variability*, eds. H. R. Miller & J. R. Webb (San Francisco: ASP), in press

Pesto, S., Koratkar, A., Blitz, E., & Evans, I. 1997, ''Complete Atlas of Recalibrated Archival HST FOS Spectra of Quasars and AGN,'' in *Emission Lines in Active Galaxies: New Methods and Techniques*, eds. B. M. Peterson, F.-Z. Cheng, & A. S. Wilson (San Francisco: Astronomical Society of the Pacific), in press

Pian, E., Treves, A., Webb, J., Kazanas, D., Maraschi, L., McCollum, B., Shrader, C., & Wamsteker, W. 1996, ''IUE Observations of OJ 287 in November 1994,'' in *Proc. of the OJ-94 Project Meeting*, Tuorla Observatory Report N. 176, ed. L. O. Takalo, p. 26

Pian, E., Urry, C. M., Pesce, J. E., Maraschi, L., Treves, A., Penton, S., & Shull, J. M. 1996, ''Multiwavelength Monitoring of the BL Lac Object PKS 2155−304. The May 1994 IUE Campaign,'' in *Blazar Variability*, eds. H. R. Miller & J. R. Webb (San Francisco: ASP), in press

Pian, E., Urry, C. M., Treves, A., Maraschi, L., Penton, S., Shull, J. M., Pesce, J. E., Grandi, P., Kii, T., Kollgaard, R. I., Madejski, G., Marshall, H., Wamsteker, W., Celotti, A., Courvoisier, T. J.-L., Falomo, R., Fink, H. H., George, I., & Ghisellini, G. 1996, ''Multiwavelength Monitoring of the BL Lacertae Object PKS 2155−304 in May 1994. II. The IUE Campaign,'' ApJ, in press

Pinkney, J., Holtzman, J., Garasi, C., & WFPC2 IDT, 1996, ''HST Observations of the Cooling Flow Elliptical in Abell 1795,'' ApJ, 468, L13

Postman, M., Bucciarelli, B., Sturch, C., Borgman, T., Casalegno, R., & Doggett, J. 1996, ''The Second Generation Guide Star Photometric Catalog: Calibrators for the GSC-II,'' in *IAU Symposium 179, New Horizons from Wide-Field Imaging*, ed. B. McLean, in press

Postman, M., Lubin, L. M., Gunn, J. E., Oke, J. B., Hoessel, J. G., Schneider, D. P., & Christensen, J. 1996, ''The Palomar Distant Cluster Survey—I. The Cluster Catalog,'' AJ, 111, 615

Rasio, F. A., & Livio, M. 1996, ''On the Formation and Evolution of Common Envelope Systems,'' ApJ, in press

Rasio, F. A., Tout, C. A., Lubow, S. H., & Livio, M. 1996 ''Tiday Decay of Close Planetary Orbits,'' ApJ, 470, 1187

Raymond, J. C., Blair, W. P., & Long, K. S. 1995, ''Detection of Ultraviolet Emission Lines in SN1006 with the Hopkins Ultraviolet Telescope,'' ApJ, 454, L31

Richard, O., Vauclair, S., Charbonnel, C., & Dziembowski, W. A. 1996, ''New solar models including helioseismological constraints and light elements depletion,'' A&A, 312, 1000

Rivinius, Th., Stahl, O., Wolf, B., Kaufer, A., Gäng, Th., Gummersbach, C. A., Jankovics, I., Kovacs, J., Mandel, H., Peitz, J., Szeifert, Th., & Lamers, H. J. G. L. M. 1996, ''Variations of the stellar wind in early B hypergiants,'' A&A, in press

Sahu, K. C. 1996, ''PLANET collaboration,'' BAAS, 27, 1449

Sahu, K. C. 1996, ''PLANET: spectroscopic observations and a perspective based on the first campaign,'' in *Proc. of the 2nd International workshop on Gravitational Microlensing Surveys*, p. 270

Sambruna, R., George, I. M., Madejski, G. M., Urry, C. M., Turner, T. J., Weaver, K. A., Maraschi, L., & Treves, A. 1996, ''An X-Ray Absorption Feature in the BL Lacertae Object H1426+428,'' ApJ, submitted

Sambruna, R., Madejski, G. M., Urry, C. M., George, I. M., & Maraschi, L. 1996, ''The ASCA Spectrum of the X-Ray-Bright BL Lac 1426+428,'' in *Blazar Variability*, eds. H. R. Miller & J. R. Webb (San Francisco: ASP), in press

Sambruna, R. M., Maraschi, L., & Urry, C. M. 1996, ''On the Spectral Energy Distributions of Blazars,'' ApJ, 463, 444

Sambruna, R. M., Urry, C. M., Maraschi, L., Ghisellini, G., Mukherjee, R., Pesce, J. E., Wagner, S. J., Wehrle, A. E., Hartman, R. C., Lin, Y. C., & von Montigny, C. 1997, ''The High-Energy Continuum Emission of the Gamma-Ray Blazar PKS 0528+134,'' ApJ, 474, in press

Sambruna, R., Urry, C. M., Maraschi, L., *et al.*, 1996, ''ASCA Observations of the Gamma-Ray-Loud Blazar 0528+164,'' in *Blazar Variability*, eds. H. R. Miller & J. R. Webb (San Francisco: ASP), in press

Scarpa, R., Falomo, R., & Pesce, J. E. 1996, ''Redshifts of Southern Radio Galaxies,'' A&AS, 116, 295

Schaerer, D. 1996, ''About the initial mass function and He ii emission in young starbursts,'' ApJ, 467, L17

Schaerer, D. 1996, ''Massive Star Evolution in Different Environments,'' in *Active Galactic Nuclei, Dense Stellar Systems, and their Environments*, eds. S. A. Lamb & J. J. Perry, ASP Conf. Series, in press

Schaerer, D. 1996, ''About the initial mass function and He ii emission in young starbursts,'' in *Starburst Activity in Galaxies*, Rev. Mex. Astr. Astrof., eds. J. Franco, R. Terlevich, & G. Tenorio-Tagle, in press

Schaerer, D., & Vacca, W. D. 1996, ''WR Population in Starbursts: WN and WC subtypes and the Role of Binaries,'' in *WR stars in the Framework of Stellar Evolution*, 33rd Liège Int. Astroph. Coll., eds. J. M. Vreux *et al.*, in press

Schmidt, J. H. K., de Boer, K. S., Heber, U., & Moehler, S. 1996, ''PG 0009+036—a rapidly rotating normal B-star in the galactic halo,'' A&A, 306, L33

Schweizer, F., Miller, B., Whitmore, B. C., & Fall, S. M. 1996, ''Hubble Space Telescope Observations of Candidate Young Globular Clusters and Stellar Associations in the Merger Remnant NGC 3921,'' AJ, 112, in press

Scuderi, S., Capetti, A., Panagia, N., Romaniello, M., Lamers, H. G. J. L. M, & Kirshner, R. P., 1996, in preparation

Simpson, C. 1996, ''A method of probing the torus geometry?'' VA, 40, 57

Simpson, C., Forbes, D. A., Baker, A. C., & Ward, M. J. 1996, ''Forbidden Fe+ emission from active galaxies,'' MNRAS, in press

Simpson, C., Mulchaey, J. S., Wilson, A. S., Ward, M. J., & Alonso-Herrero, A. 1996, ''An ionization cone and dusty disk in Markarian 348: The obscuring torus revealed?'' ApJ, 457, L19

Simpson, C., & Ward, M. 1996, ''A dynamical model for the narrow-line region of AGN,'' MNRAS, in press

Simpson, C., Ward, M., Clements, D. L., & Rawlings, S. 1996, ''Emission line ratios in a radio-selected sample of AGN,'' MNRAS, 281, 509

Simpson, C., Ward, M. J., & Wilson, A. S. 1995, ''Evidence for an obscured quasar in the giant radio galaxy PKS 0634−205,'' ApJ, 454, 683

Simpson, C., Wilson, A. S., Bower, G. A., Heckman, T. M., Krolik, J. H., & Miley, G. K. 1997, ''A one-sided ionization cone in the Seyfert 2 galaxy NGC 5643,'' ApJ, in press

Soria, R., Mould, J., & WFPC2 IDT, 1996, ''Detection of the Tip of the Red Giant Branch in NGC 5128,'' ApJ, 465, 79

Southwell, K. A., Livio, M., Charles, P. A., O'Donoghue D., & Sutherland, W. 1996, ''The Nature of the Supersoft X-Ray Source RXJ0513-69,'' ApJ, 470, 1065

Spagna, A., Lattanzi, M. G., Lasker, B. M., McLean, B. J., Massone, G., & Lanteri, L. 1996, ''Galactic Structure alone the Main Meridional Section of the Galaxy. I. The North Galactic Pole (N321) Field,'' A&A, 311, 758

Spagna, A., Lattanzi, M. G., Massone, G., McLean, B., & Lasker, B. M., 1996, ''Galactic Structure with GSC-II Material,'' in *IAU Symposium 179, New Horizons from Wide-Field Imaging,* ed. B. McLean, in press

Stahl, O., Kaufer, A., Rivinius, Th., Szeifert, Th., Wolf, B., Gäng, Th., Gummersbach, C. A., Jankovics, I., Kovacs, J., Mandel, H., Pakull, M., & Peitz, J. 1996, ''Phase-locked photospheric and stellar-wind variations of Θ^1 Orionis C,'' A&A, 312, 539

Stapelfeldt, K. R., Burrows, C. J., Krist, J. E., Trauger, J. T., Hester, J. J., Holtzman, J. A., Ballester, G. E., Casertano, S., Clarke, J. T., Crisp, D., Evans, R. W., Gallagher, J. S., Griffiths, R. E., Hoessel, J. G., Mould, J. R., Scowen, P. A., Watson, A. M., & Westphal, J. A., 1995, ''WFPC2 Imaging of the Circumstellar Nebulosity of HL Tauri,'' ApJ, 449, 888

Stasińska, G., & Schaerer, D. 1996, ''Combined stellar structure and atmosphere models for massive stars. IV. The impact on the ionization structure of single star H II regions,'' A&A, in press

Stocke, J. T., Shull, J. M., Penton, S., Donahue, M., & Carilli, C. 1995, ''The Local Ly-Alpha Forest: Association of Clouds with Superclusters and Voids,'' ApJ, 451, 24

Stocke, J. T., Wang, Q. D., Perlman, E. S., Donahue, M. E., & Schachter, J. F. 1995, ''Discovery of a Candidate Old, Isolated Neutron Star in the Field of a Galactic Cirrus Cloud,'' AJ, 109, 1199

Stockman, H. S. 1995, ''Shock Structures and Geometries of Magnetic Cataclysmic Variables,'' in *Cape Workshop on Magnetic Cataclysmic Variables,* ASP Conf. Series 85, eds. D. A. H. Buckley, & B. Warner, 153

Stockman, H. S., & Schmidt, G. D. 1996, ''Hubble Space Telescope Time-resolved Ultraviolet Spectroscopy of ST Leonis Minoris and UZ Fornacis: Resolving the Accretion Stream,'' ApJ, 468, 883

Storrs, A. D. 1996, ''Dust outflow velocity and the gas-to-dust ratio in comets,'' Earth, Moon, and Planets, 72, 99

Suchkov, A., Berman, V., Heckman, T., & Balsara, D. 1996, ''Mass Loading and Collimation of Galactic Superwinds,'' ApJ, 463, 528

Suchkov, A., Berman, V., & Heckman, T. 1996, ''Model of the Dynamics and X-ray emission of the galactic wind in Arp 220,'' in preparation

Szkody, P., Long, K. S., Sion, E. M., & Raymond, J. C. 1996, ''ASCA Observations of U Geminorum during Quiescence,'' ApJ, 469, 834

Szkody, P., Silber, A., Sion, E., Downes, R. A., Howell, S. B., Costa, E., & Moreno, H. 1996, ''IUE and Optical Spectra of AL Com During a Rare Superoutburst,'' AJ, 111, 2379

Thejll, P., Flynn, C., Williamson, R., & Saffer, R. 1997, ''Proper Motions of the Hot Subdwarfs,'' A&A, in press

Treves, A., Falomo, R., Pesce, J., Scarpa, R., & Urry, C. M. 1996, ''Host Galaxies of Three Radio Selected BL Lac Objects: Comparison of HST and Ground Based Imaging,'' in *Blazars (Proc. Meeting in Girona, Spain, September 1996),* ed. M. Kidger, in press

Treves, A., Jetzer, Ph., Rovetti, F., & Urry, C. M. 1996, ''Achromatic Variability in the BL Lac Object PKS 2155−304. A Case for Microlensing?'' in *Blazars (Proc. Meeting in Girona, Spain, September 1996),* ed. M. Kidger, in press

Urry, C. M. 1996, ''An Overview of Blazar Variability,'' in *Blazar Variability,* ed. J. Webb & H. R. Miller (San Francisco: ASP), in press

Urry, C. M., & Padovani, P. 1995, ''Unified Schemes for Radio-Loud Active Galactic Nuclei,'' PASP, 107, 803

Urry, C. M., & Padovani, P. 1996, ''The Unification of Radio-Loud Active Galactic Nuclei,'' in *Extragalactic Radio Sources (IAU Symp. 175),* in press

Urry, C. M., Pesce, J. E., Falomo, R., Scarpa, R., Treves, A., & Giavalisco, M. 1996, ''HST Imaging of BL Lac Objects,'' BAAS, 28, 828

Urry, C. M., Sambruna, R., Maraschi, L., Makino, F., Wehrle, A., Pesce, J., Mukherjee, R., Madejski, G. M., Hartman, R. C., Lin, Y. C., & von Montigny, C. 1996, ''High Energy Spectra of the Gamma-Ray-Loud Blazar 0528 +164,'' High Energy Astrophysics Division of the American Astronomical Society meeting, San Diego, May 1996

Urry, C. M., Sambruna, R. M., Worrall, D. M., Kollgaard, R. I., Feigelson, E., Perlman, E. S., & Stocke, J. T., 1996, ''X-Ray Properties of a Complete Sample of Radio-Selected BL Lacertae Objects,'' ApJ, 463, 424

Urry, C. M., Treves, A., Maraschi, L., Marshall, H., Kii, T., Madejski, G., Penton, S., Pesce, J. E., Pian, E., Celotti, A., Fujimoto, R., Makino, F., Otani, Sambruna, R. M., Sasaki, K., Shull, J. M., Smith, P., Takahashi, T., & Tashiro, M. 1996, ''Multiwavelength Monitoring of the BL Lacertae Object PKS 2155–304 in May 1994. III. Probing the Inner Jet through Multiwavelength Correlations,'' ApJ, in press

van Albada, T. S., Bertin, G., & Stiavelli, M. 1995, ''Estimating distances to elliptical galaxies with a mass-luminosity relation,'' MNRAS, 276, 1255

Van de Steene, G. C., Sahu, K. C., & Pottasch, S. R. 1997, ''Optical observations of southern planetary nebula candidates,'' A&A, in press

von Montigny, C., Aller, H., Aller, M., Bruhweiler, F., Collmar, W., Courvoisier, T. J.-L., Edwards, P. G., Fichtel, C. E., Fruscione, A., Ghisellini, G., Hartman, R. C., Johnson, W. N., Kafatos, M., Kii, T., Kniffen, D. A., Lichti, G. G., Makino, F., Mannheim, K., Marscher, A. P., McBreen, B., McHardy, I., Pesce, J. E., Pohl, M., Ramos, E., Reich, W., Robson, E. I., Sasaki, K., Terasranta, H., Tornikoski, M., Urry, C. M., Valtaoja, E., Wagner, W., & Weekes, T. 1996, ''Multi-Wavelength Observations of 3C 273 in 1993–1995,'' ApJ, in press

Voit, G. M. 1996a, ''Cosmological Blastwaves and the Intergalactic Medium,'' ApJ, 465, 548

Voit, G. M. 1996b, ''Infrared Interferometery of AGNs,'' Astro. & Space Sci., in press

Voit, G. M. 1996c, ''AGNs at VLTI Scales,'' in *Science with the VLTI*, ed. F. Paresce, in press

Voit, G. M., & Donahue, M. 1995, ''Problems with Cold Clouds in Cooling Flows,'' ApJ, 452, 164

Voit, G. M., & Donahue, M. 1996,''A Deep Look at the Emission-Line Nebula in Abell 2597,'' in preparation

Walborn, N. R., & Bohlin, R. C. 1996, ''An Atlas of OB Spectra from 1000 to 1200 Å,'' PASP, 108, 477

Walborn, N. R., Long, K. S., Lennon, D. J., & Kudritzki, R. 1995, ''A Reconnaissance of the 900–1200 Å Spectra of Early O Stars in the Magellanic Clouds,'' ApJ, 454, L27

Walborn, N. R., MacKenty, J. W., Parker, J. Wm., Saha, A., & White, R. L. 1996, ''HST Images of Massive, Compact Multiple Systems in the LMC Giant Shell H II Region N11,'' in *The Interplay between Massive Star Formation, the ISM, and Galaxy Evolution,* 11th IAP Astrophysics Meeting, ed. D. Kunth *et al.*, p. 61

Walsh, J. R., Lasker, B. M., Garnett, D. R., Chu, Y.-H., Meaburn, J., Holloway, A. J., Meylan, G., Azzopardi, M., Heydari-Malayeri, H., Lequeux, J., & Meysonnier, N. 1996, ''HST Parallel Imaging in the Magellanic Clouds—First Results,'' in *Sciene with the Hubble Space Telescope–II,* eds. P. Benvenuti, F. D. Macchetto, & E. J. Schreier, p. 355

Wanders, I., *et al.* 1995, ''The Geometry and Kinematics of the Broad-Line Region in NGC 5548 from HST and IUE Observations,'' ApJ, 453, L87

Watson, A. M., Gallagher, J. S., Holtzman, J. A., Hester, J. J., Mould, J. R., Ballester, G. E., Burrows, C. J., Casertano, S., Clarke, J. T., Crisp, D., Evans, R. E., Griffiths, R. E., Hoessel, J. G., Scowen, P. A., Stapelfeldt, K. R., Trauger, J. T., & Westphal, J. A., 1996, ''The Discovery of Young, Luminous, Compact Stellar Clusters in the Starburst Galaxy NCG 253,'' AJ, 112, 534

Webb, J. R., Shrader, C., Nair, D., Balonek, T., Aller, M., Aller, H., Bonnell, J., Heinamaki, P., Hewit, N., Hughes, P., Jenkins, P., Kidger, M., Lehto, H., McCollum, B., McHardy, I., Okyuda, Pursimo, T., Pian, E., Poyner, G., Del Rio, L., Sadun, A., Sillanpää, A., Smith, A., Robson, I., Takalo, L., Teräsranta, H., Treves, A., Valtaoja, E., & Worraker, W. 1996, ''Target of Opportunity Multifrequency Observations of BL Lac and OJ 287,'' in *Proc. of the OJ–94 Project Meeting*, Tuorla Observatory Report N. 176, ed. L. O. Takalo, p. 20

Wehrle, A. E., & the Blazar Multiwavelength Consortium (incl. C. M. Urry), 1996, ''Preliminary Report on the January 1996 Outburst of 3C279,'' High Energy Astrophysics Division of the American Astronomical Society meeting, San Diego, May 1996

Wehrle, A. E., Unwin, S. C., Zook, A. C., Urry, C. M., & Marscher, A. P. 1996, ''VLBI Imaging and Multiwavelength Variability of 3C279,'' in *Blazar Variability,* eds. H. R. Miller & J. R. Webb (San Francisco: ASP), in press

Whitmore, B. C. 1995a, ''Globular Cluster Formation in Mergers and in Cluster Ellipticals,'' in *Clusters, Lensing, and the Future of the Universe* ed. V. Trimble (ASP, San Francisco), in press

Whitmore, B. C. 1995b, ''The Formation of Young Star Clusters in Merging Galaxies,'' in *Interacting Galaxies: Pairs, Groups, and Clusters*, ed. G. Longo, Astrophysical Letter and Communications, in press

Whitmore, B. C. 1996, ''Globular Clusters as Distance Indicators,'' in *The Extragalactic Distance Scale*, eds. M. Donahue, M. Livio (ST ScI, Baltimore)

Whitmore, B. C., Sparks, W. B., Lucas, R. A., Macchetto, F. D., & Biretta, J. A. 1995, ''Hubble Space Telescope Observations of Globular Clusters in M87 and an Estimate of H_0,'' ApJ, 454, L73

Wilcots, E. M., Lehman, C., & Miller, B. 1996, ''HI Observations of Barred Magellanic Irregulars I: Global Properties,'' AJ, 111, 1575

Williams, R. E., Blacker, B., Dickinson, M., Van Dyke Dixon, W., Ferguson, H. C., Fruchter, A. S., Giavalisco, M., Gilliland, R., Heyer, I., Katsanis, R., Levay, Z., Lucas, R. A., McElroy, D. B., Petro, L., Postman, M., Adorf, H. M., & Hook, R. N. 1996, ''The Hubble Deep Field: Observations, Data Reduction, and Galaxy Photometry,'' AJ, 112, 1335

Wood, B. E., Harper, G. M., Linsky, J. L., & Dempsey, R. C. 1995, ''Goddard High Resolution Spectrograph Observations of Procyon and HR 1099,'' ApJ, 458, 783

Yungelson, L., Livio, M., Truran, J. W., Tutukov, A., & Fedorova, A. 1996, ''A Model for the Galactic Population of Binary Supersoft X-Ray Sources,'' ApJ, 466, 890

M. Livio
J. Pesce
S. Toolan