New Mexico State University
Department of Astronomy
Las Cruces, New Mexico 88003

This report covers events and activities that occurred during the calendar year 1995.

1. PERSONNEL

The faculty of the Astronomy Department includes Professors Kurt S. Anderson, Reta F. Beebe, Jack O. Burns (Dept. Head), Bernard J. McNamara, and William R. Webber; Assistant Professors Nicholas A. Devereux, Jon A. Holtzman, Anatoly A. Klypin, Chris Loken, Mark S. Marley, and René Walterbos; and Emeritus Professors Herbert A. Beebe and Clyde W. Tombaugh.

Adjunct members of the faculty include Jonathan Brinkman (Apache Point), Roger E. Davis (Science & Technology Corp.), Richard B. Dunn (NSO), Nebojsa Duric (UNM), W. Miller Goss (NRAO), Hunt Guitar (Science & Technology Corp.), Virginia Gulick (NASA, ARC), John J. Keady (LANL), David Kuehn (Pittsburg State Univ.), Donald F. Neidig (NSO), Frazer N. Owen (NRAO), Richard A. Perley (NRAO), Richard R. Radick (NSO), George Simon (NSO, Sac Peak), Raymond N. Smartt (NSO), and John Stocke (Colorado).

The postdoctoral fellows are Tom Harrison, Micheal Ledlow, Jason Pinkney, and Alan Watson.

Twenty graduate students are enrolled for the Fall 1995 semester. They are Mark Bliton, Matthew Carlson, Nancy Chanover, Vanessa Galarza, Christopher Garasi, Marla Geha, Percy Gomez, Bruce Greenawalt, Salman Hameed, Charles Hoopes, Nichole King, Andrey Kravtsov, Kevin Marvel, Neal Miller, Elizabeth Rizza, Amy Simon, Clay Smith, Matthew Templeton, David Thilker, Charles Walter.

Observatory and departmental staff include Amy Cherryhomes, office manager; Lorraine Montes, accountant; David Summers, observing specialist; Lyle Huber, programmer.

2. OBSERVATORIES/INSTRUMENTATION

2.1 Apache Point Observatory

New Mexico State University is a member of the Astrophysical Research Consortium (ARC) and operates the Apache Point Observatory for the Consortium. Apache Point is located at an elevation of 2800m in the Sacramento Mountains of south-central New Mexico. Its principal instrument is the 3.5 meter ARC telescope. The 2.5 meter telescope of the Sloan Digital Sky Survey is presently under construction and an associated 0.6 meter monitoring telescope is now operating at the site. Also, NMSU has installed a new 1.0 meter imaging telescope at Apace Point.

Apache Point Observatory has three Observing Specialists responsible for 3.5 meter operations; Eddie Bergeron, Karen Gloria, and Dan Long. Other observatory site staff are Jon Brinkmann, Instrument Scientist; Jon Davis, telescope Engineer; Jim Fowler, Computer Systems Manager; Bruce Gillespie, Site Manager; Mark Klaene, Observatory Engineer; Madonna Reyero, Custodian; and Gretchen Van Doren, Records Specialist. Kurt Anderson is Site Director. Current instrumentation includes a 2048^2 CCD imaging camera, a 256^2 IR array, and a double-imaging spectrograph with 1–10 Å resolution.

Instrument development and research activities of the ARC facilities at Apache Point Observatory are described in greater detail elsewhere in these Observatory Reports. In brief, the 3.5 meter telescope has been fully operational for over a year, and has been used for a diverse variety of imaging and spectroscopic investigations at optical and infrared wavelengths. It is noteworthy that most of these observational programs, including several synoptic investigations, have been conducted remotely via INTERNET links. Work continues on the development of new capabilities and instruments, and on the upgrading of existing systems. These efforts address improvements in the pointing, tracking, and image quality of the telescope. The basic mechanical structures of the Sloan telescope were installed this summer; that telescope might see first light late in 1996.

NMSUs 1.0 meter telescope is in place at Apache Point and is undergoing alignment and testing. This is an f/6 RC instrument intended for imaging; it is presently equipped with a CCD camera and filter system. The telescope is to be operated remotely and, eventually, will be programmed for robotic operation. Current alignment efforts have concentrated on improving the pointing and tracking capabilities of its alt-azimuth mounting. Instruments are placed at the Naysmith focus where compensation is provided for field rotation. An offset guider and autoguiding system for this telescope are under development. Kurt Anderson has been responsible for the design and construction of this telescope. David Summers, who joined the Department of Astronomy as an Observing Specialist this fall, will eventually assume principal responsibilities for its operation and maintenance.

2.2 Tortugas Mountain Planetary Observatory

The 0.6m Tortugas Mountain Observatory is used to monitor the temporal changes in the Jovian cloud deck and equatorial activity on Saturn. The data are collected with a CCD camera, archived at the NMSU astronomy department and made available to the Astronomical community through the NASA Planetary Data System Subnode. Images collected over the last 27 years are being used as a climatic data base to interpret the Hubble Space Telescope (HST), Galileo and Cassini data. Although funding has been reduced, simultaneous observations are scheduled when the 3.5 meter telescope is used for infrared imaging of Jupiter. Murrell and Chanover are carrying out this program and archiving the data.

3. RESEARCH ACTIVITIES

3.1 Planetary Astronomy

Chanover, Simon, Beebe and Murrell have continued a multispectral imaging program. The goals of this program are to understand the extent to which vertical cloud development and the east-west winds vary with time. Chanover has collaborated with D. Kuehn, Pittsburg State Univ., in modeling the vertical structure. Beebe has been Principal Investigator on Cycle 1, 2, 4, and 5 HST Wide Field Planetary Camera observing programs and the NMSU group participated in the Shoemaker-Levy 9 Campaign. Co- Investigators are directly involved in the NASA Galileo Mission and the NMSU group is charged with assisting in integrating the limited high resolution Galileo data with the HST, Voyager and Groundbased data. Beebe is a member of the Galileo Solid State Imaging Team and will interact with the Near Infrared Mapping Spectrometer and Photo Polarimeter Radiometer teams. Beebe and Huber are functioning in a data node for the Small Bodies Node of the NASA Planetary Data System to archive the Shoemaker-Levy atmospheric data.

Marley and Walter searched for the signature of seismic waves launched by the impact of fragment R of comet Shoemaker-Levy/9 into Jupiter. This project utilized 7.8 μm images taken after the impact from the IRTF in collaboration with Hunten, Sprague, and Witteborn (Univ. of Arizona) and other collaborators. No seismic waves were detected, but a very tight upper limit was placed on the impact energy that is comparable to those derived from other observations. A paper describing these results has been submitted to the special SL/9 issue of Icarus.

Marley and Geha initiated a program to search for p-mode oscillations of Jupiter excited by the impacts. Hundreds of 7.8 μm Jupiter images were acquired in the week after the impacts for this purpose. The quality of the dataset is expected to permit improvement upon the existing observational upper limits for these modes.

Marley concluded a substantial theoretical modeling effort to better understand the atmospheric thermal structure of Uranus. This work has constrained energy sources in the stratosphere and placed the first lower limits on the interior heat flow of the planet. A major paper describing these results will appear in Icarus. Walter and Marley obtained near infrared images of Uranus with the GRIM camera at Apache Point. These images show evidence for a substantial south polar haze. Early analysis suggests that this haze has brightened significantly since geometric albedo observations made in the late 1970's. This data will be further reduced to yield information on the vertical profile of the atmosphere.

Marley, Gómez, and Podolak (Tel Aviv U.) completed work on an innovative Monte Carlo method for modeling the interiors of giant planets. They discovered qualitatively new interior models for Uranus and Neptune. In the new models, the composition varies gradually throughout the outermost regions of the planet. Such composition gradients may play a substantial role in controlling the internal heat flow of these objects. Further modeling is planned to evaluate this possibility.

Marley initiated a program to calculate the emergent spectra of evolving giant planets. This work will proceed in collaboration with the U. Arizona brown dwarf group led by W. Hubbard. Such spectra can be directly compared to observations of extrasolar giant planets, when they are found. Preparations are underway to observe the occultation of ν_2 Sag by Jupiter in March from the 3.5-meter telescope with the infrared camera AMBER. This high time resolution instrument should allow for observation of fine structure in Jupiter's upper atmosphere.

3.2 High Energy Astrophysics

McNamara and Harrison continue to be funded under the COMPTON Gamma-Ray Observatory (CGRO) Guest Investigator program to provide ground-based follow-up to gamma-ray bursts (GRBs) detected by the COMPTEL instrument on CGRO. Substantial changes in the localization and dissemination of GRB positions have been implemented within the last year to increase the response time of the network to COMPTEL GRBs. Two years ago, it took COMPTEL about two hours to localize a GRB. This time is now down to 15 minutes, with further improvements expected. This has led us to use alternative notification methods, including the use of alphanumeric pagers, to speed-up our response time. While no strong COMPTEL bursts have occurred during the first 10 months of 1995, we have tested these advancements on BATSE bursts. We have imaged the fields of BATSE bursts (to V=17) within three hours of their occurrence (our previous best effort had been V=16 in 7 hours). Given optimum conditions, response times on the order of 15 to 20 minutes should be attainable.

McNamara has also been funded under the CGRO Guest Investigator program for continuing a long-term study of the Low-Mass X-ray Binary (LMXB) Sco X-1. A four year light curve containing more than 17,000 measurements of the 7 to 15 keV X-ray flux of Sco X-1 is being readied for publication. In addition, 100,000 optical photometric measurements obtained over two months are being combined with the X-ray data to search for correlated behavior. A preliminary analysis shows that the optical and X-ray fluxes of Sco X-1 are anticorrelated.

Harrison has been funded under the CGRO Guest Investigator program to analyze the 7 to 15 keV lightcurves and fluxes of GRBs. The 7 to 15 keV fluxes will be used to determine the spectra energy distributions of 100 GRBs. These data will provide important constraints on models that predict the energy spectra of GRBs.

3.3 Normal Galaxies

Walterbos and Braun (NFRA) wrote a review paper for the Minnesota Lectures on Extragalactic Neutral Hydrogen, in which they discuss recent results on the temperature of hydrogen gas in nearby spiral galaxies, the distribution of warm and cold HI, and the possible relation with the warm ionized medium. Greenawalt and Walterbos are continuing their study of the diffuse ionized gas in nearby spiral galaxies. Narrow-band images in Hα and [SII] of the galaxies M81 and M51 show that a similarly large fraction (30 to 40%) of the total Hα luminosity in these galaxies is contrib-

uted by diffuse ionized gas as found for M31 by Walterbos and Braun. Together with Charles Hoopes, the Sculptor group galaxies were studied as well, with again similar results. In all cases, the [SII] signal is characteristically stronger in the diffuse medium than in the HII regions, but it appears that the [SII]/Hα ratio in the diffuse gas is not the same in all galaxies. Greenawalt and Walterbos also analyzed long-slit spectra of the diffuse gas, obtained with the ARC 3.5-m and KPNO 4-m telescopes. The first detection of forbidden oxygen lines in the truly diffuse medium was made, confirming the expected strength of the [OII] lines, and the weakness of [OIII].

Walterbos and Thilker completed a study of the ionized gas in the spiral NGC4258. The anomalous arms were imaged in [SII] and Hα. The ratio of these two lines is in agreement with shock ionization of the gas. The galaxy also contains widespread diffuse ionized gas, especially in the central region. It is not yet clear what the ionization mechanism for this gas is, or if it is related to the anomalous arms.

Walterbos, Bothun (University of Oregon), Schommer (CTIO) and Smith (NASA/GSFC) have started a project aimed at constraining the spectral type of the stars responsible for ionizing the diffuse interstellar medium in spiral galaxies. Ultraviolet images from UIT are compared with deep exposures in Hα of the HII regions and diffuse medium for a sample of nearby spirals, to determine the ratio of Lyman continuum to UV and optical flux across galactic disks. This ratio is very different for stars of different spectral types and provides an important constraint on ionization models of the diffuse medium.

Thilker, Braun, and Walterbos developed a new method to detect expanding HI shells in the HI data cubes of nearby spirals. The method is fully computer-based, providing for the first time a repeatable, robust search method for finding these structures. The goal is to make a detailed comparison of the properties of the expanding HI shells in a variety of galaxies and conditions, to better test evolutionary models of superbubbles created by supernovae and stellar winds in galactic disks. A crucial aspect of the project will be a study of the stellar populations inside the HI shells, to estimate ages of the associations, and the integrated energy input into the ISM over the life time of the association. Together with Wang (Northwestern University) they are also studying the correlation between the overall properties of HI holes and soft X-ray emission in galactic disks.

Walterbos and Greenawalt finished the first paper on a new method to model the FIR emission in galaxies. The results show that a non-negligible role for the ISRF continues to be a likely option. Together with Hoopes they are expanding their study to produce two-dimensional model images, based on the observed HI and optical light distributions in galaxies. The model images should prove instructive for analysis of forthcoming ISO images.

Walterbos and King obtained long-slit spectra with the ARC 3.5-m telescope of a new sample of massive stars with high mass loss rates in M31. The objects were discovered from an Hα imaging survey published earlier by Walterbos and Braun. It is possible that at least some of the stars are related to Luminous Blue Variables. All objects studied so far show broad wings on the Balmer lines, no forbidden nebular lines and compact ionized gas nebulae surrounding them.

Holtzman, assisted by Watson, continued to work primarily with data from the Wide Field Planetary Camera 2 of the Hubble Space Telescope. The performance of WFPC2 and methods for data reduction were described by Holtzman and collaborators on the WFPC2 Instrument Definition Team in a paper published in the PASP in February. In addition, Holtzman took the lead in establishing the photometric calibration for WFPC2 based on on-orbit observations as well as ground observations made at the Siding Springs Observatory during April 1994. In collaboration with D. Hunter (Lowell), E. Shaya (Univ. of Maryland.) and R. Light (IPAC), analysis of the cluster R136 in the Large Magellanic Cloud was performed. It was found that even in this extremely dense cluster, the initial mass function down to around two solar masses is remarkably normal. Initial results from a program to look for young globular clusters in several interacting and cooling flow galaxies were presented at the January 1995 AAS meeting. These data show a population of young compact star clusters in the interacting galaxy NGC 3597, but no large population of compact objects in either of the two cooling flow galaxies which were observed. Further analysis is in progress to determine accurate sizes for the NGC 3597 objects to determine whether they are comparable in compactness to old globular clusters. Watson analyzed images of the starburst galaxy NGC 253; a remarkably bright dense stellar cluster was discovered in this galaxy.

Holtzman characterized the variations in the PSF of the WFPC2 using phase retrieval on in-focus images. This work enables fairly accurate model PSFs to be generated for any observation. In conjunction with generalized stellar photometry software which simultaneously fits brightnesses of stars in multiple exposures, this should provide a powerful tool for extracting information from crowded field exposures.

The first tests of this technique were made on observations of a field in the Large Magellanic Cloud. Excellent photometry was obtained showing a well-defined main sequence down to an absolute V magnitude of around 8. These data are being used to determine the initial mass function in the field and to constrain star formation histories in the LMC. An initial paper on the star formation history was submitted to the Astrophysical Journal by Gallagher *et al.*, and additional work on the initial mass function is nearing completion.

Holtzman continued his project to study the effects of dust in spiral galaxies, in collaboration with S. Courteau (NOAO). Data collection continued, with a concentration on increasing the number of infrared observations. This was accomplished with observing runs at KPNO and using the OSIRIS camera on the Lowell 72‘‘. A paper describing the data reduction and surface brightness measurements is in preparation.

Devereux, Duric (Univ. of New Mexico) and Scowen (Arizona State Univ.) continue to obtain $H\alpha$ and $H\beta$ images of large nearby spiral galaxies using the Case Western Burrell Schmidt telescope at Kitt Peak National Observatory. So far, Hα images have been obtained for the two early-type spirals M31 & M81, and the two late-type spirals M33 &

IC342. Additional time has been secured for $H\beta$ imaging of M33, M81 and IC342. The primary goal of the research, funded under the NASA Long Term Space Astrophysics Program, is to compare the Hα images with high resolution far infrared images, obtained with the Infrared Astronomical Satellite (IRAS), in order to constrain the origin of the far infrared luminosity. A secondary goal is to measure the extinction to the ionized gas using the balmer decrement and the thermal radio continuum. The correspondence between the Hα and far infrared morphology is striking when the H α images are convolved to the same resolution as the IRAS data. Additionally, the far infrared luminosity agrees quantitatively with that expected from the O and B stars which are required to ionize the hydrogen gas. The new results indicate that the far infrared luminosity is as a reliable measure of the current high mass star formation rate as the Hα luminosity. New results for M81 were published this year and the M33 data is expected to be published early in 1996.

Devereux, Ford (Johns Hopkins) and Jacoby (NOAO) secured time on the Hubble Space Telescope to obtain UV (1590Å) and Hα images of the central 1 kpc of M81 with WFPC2. The images are expected to provide new insight into the origin and excitation of the nuclear Hα spiral. A high angular resolution V band image will also be obtained with the FOC to search for a multiple nuclei in M81.

Devereux and Hameed have compiled reliable IRAS far infrared fluxes for galaxies in the *Nearby Galaxies Catalog* (NBG). The combined catalogs are used to construct far infrared luminosity functions for lenticular and spiral galaxies of different Hubble type. As a result of our efforts, the number of galaxies in the NBG catalog with reliable IRAS fluxes has been increased by about 30% allowing the far infrared luminosity functions to be extended to luminosities that are an order of magnitude lower than previously determined. Both the catalog of IRAS fluxes and the far infrared luminosity functions are expected to be published early in 1996.

Devereux is planning the New Mexico Extragalactic Hα Imaging Survey (NExHIS) of 500 nearby galaxies. The survey is to be conducted using the recently commissioned New Mexico State University 1m telescope located at Apache Point. The goal of the survey is to determine the first Hα luminosity functions for spiral galaxies of different Hubble type. Devereux & Davies (Univ. of Wales) and collaborators will be using the Infrared Space Observatory to obtain far infrared (160 and 200 μm) maps of nearby spiral galaxies. The goal of the research is to measure the far infrared luminosity and estimate the opacity of spiral galaxy disks.

Watson, in collaboration with Coil (Princeton University), Churchwell and Shepherd (University of Wisconsin), and Hofner (Universität Köln) conducted a survey of ultracompact HII regions in the near infrared with the OSIRIS camera on Lowell Observatory's 72 inch telescope. They were able to identify about a dozen candidates for more detailed study and are beginning this additional work by analyzing comprehensive data on two ultracompact HII regions with the aim of identifying the location, spectral type, and evolutionary stage of the ionizing star, and placing these quantities in the context of models of the nebulae.

Watson, Gallagher, Sparke (University of Wisconsin) and Cox (NRAO) began a study of polar ring galaxies to constrain the age of the ring stars and thereby investigate ring stability. By using optical and near infrared colors in conjunction with optical spectroscopy of ring HII regions, they hope to break the age-metallicity-reddening degeneracy. Spectroscopy of these regions will be obtained in spring 1996 with the ARC 3.5m telescope.

3.4 Active Galaxies

Ledlow and F. Owen (NRAO) are completing optical observations of 170 non-cluster B2 and 3CR radio galaxies. These data are being used for isophotal surface photometry to examine the relationships between the host galaxy properties, the radio source, and the external large-scale environment. In particular, the bivariate luminosity functions (radio/optical) and the dependence of the FR I/II break on optical luminosity will be verified for radio galaxies outside rich cluster cores.

Ledlow, Owen, and W. Keel (Alabama) are analyzing near IR (J,H,K) and optical (U,B) images of 6 low radio-luminosity BL Lac candidates. These objects show evidence of possible non-thermal optical nuclear emission which may be related to a beamed component from an active nucleus. This idea will be tested via multicolor high resolution imaging to sort out possible contributions from star formation, dust scattering, or to confirm the non-thermal nature of these sources. If confirmed, these objects will be the least luminous BL Lacs discovered to date, and will make an important connection to FR I/BL-Lac unification models.

Loken and Burns, along with M. Norman & G. Bryan (NCSA), have begun an effort to numerically simulate the onset of turbulence in an extragalactic jet. A sophisticated hydrodynamical code implemented on the massively-parallel Connection Machine (CM5) at NCSA has allowed them to carry out the highest-resolution simulation to date of the disruption of an equilibrium jet. The entrainment properties of this jet and a series of similar ones run at lower resolution are being studied and compared in order to determine whether the turbulence has been adequately resolved. The results can help to test the hypothesis that an initially supersonic FRII jet may undergo a transition to a transonic FRI-type jet by entraining ambient material.

Loken, Owen, & J. Eilek (NNIMT) completed a set of sensitive, low-frequency radio observations of several FRI radio sources using the VLA. The data are being reduced and detailed maps of the radio tails will be produced in order to determine whether their morphologies and properties are consistent with them being turbulent, entraining flows.

Anderson, as part of a large collaborative effort, as been monitoring the temporal behavior of the broad-lined radio galaxy 3C390.3. Images in Gunn g and r, plus low resolution (7) blue and red spectra, have been obtained at intervals of roughly 10 days throughout the year. These observations were made using the double imaging spectrograph on the ARC 3.5 meter telescope at Apache Point Observatory. Almost all observations were conducted remotely. The same instrumentation and approach will now be used to monitor the Seyfert 1 galaxy Markarian 335. The intention, in both instances, is to use reverberation mapping techniques to un-

derstand the spatial and kinematic geometry of the broad emission line regions. A related program, based upon optical imaging and spectroscopy of samples of Seyfert galaxies and broad-lined radio galaxies, attempts to describe and understand both the great similarities and large differences between these two classes of AGN.

3.5 Galaxy Clustering and Cosmology

Burns, F. Owen (NRAO), Ledlow, and W. Voges (MPE) are continuing their correlation analysis of the X-ray and radio properties of a statistically complete sample of rich Abell clusters (Ledlow & Owen, 1995). They are comparing the X-ray morphologies and luminosities from the ROSAT all-sky survey (RASS) with the radio properties from the 20-cm VLA cluster survey. Ledlow & Burns have examined a subsample of these clusters that appear to have a strong correlation between X-ray peaks and the position of the radio galaxies using images from the *Einstein* & ROSAT archives. They also have made multi-fiber redshift measurements of galaxies in these clusters at Steward Observatory in collaboration with J. Hill. About 50% of these clusters have significant velocity substructure and the subsample shows a possible correlation between the X-ray and radio luminosities. Bliton, Roettiger, & Burns are analyzing another subsample of Abell clusters with steep radio spectra observed by the VLA & ROSAT.

Gómez, Pinkney, Burns, & Owen completed a study of ROSAT X-ray images of clusters that contain wide-angle tailed (WAT) radio galaxies at the cluster centers. They found that 90% of the clusters show some form of substructure and none contain cluster cooling flows. They also found a highly significant correlation between the orientation of the WAT tails and the major axes of elongations in the central X-ray emission. These properties are consistent with WAT clusters undergoing a merger with groups or subclusters.

Roettiger, Loken, & Burns finished their hybrid hydro/N-Body numerical simulations of merging subclusters. They conducted a parameter study of different initial colliding cluster masses and gas densities, and computed synthetic X-ray images that can be compared directly with ROSAT & ASCA observations. In particular, they combined X-ray and galaxy velocity data with numerical simulations to constrain the details of a merger model for Abell 2256.

Burns, Ledlow, Voges, Loken, Klypin, & R. White (GSFC) have constructed the first X-ray Luminosity Function for poor clusters of galaxies. They selected a complete, volume-limited sample of 50 clusters with a surface density enhancement of ≈ 50 and $z \leqslant 0.03$ for correlation with the RASS. About 50% of the poor clusters were detected by ROSAT. The resulting luminosity function matches well with that for Abell clusters, suggesting that these groups are low mass extensions of rich clusters. Ledlow, Loken, & Burns completed redshift observations of all these groups principally using slit-masks on the ARC 3.5-m telescope. They are in the process of comparing the mass function of these groups with numerical simulations in an effort to constrain Ω.

Ledlow, Burns, Loken, F. Owen, W. Voges & Klypin are continuing their program to study distant Abell clusters in the redshift range $0.2 < z < 0.4$. They are using the ARC 3.5-m telescope to obtain spectra for cluster galaxies and radio sources within these clusters. These data will be combined with RASS X-ray images and optical colors to study cluster, galaxy, and radio source evolution by comparing these properties to that for their existing statistical sample of $\sim$ 300 Abell clusters at lower redshift. Results will also be compared to numerical simulations of rich cluster evolution in different cosmologies. Rizza, Ledlow, Burns, & Owen are analyzing ROSAT HRI observations of 3 of these distant Abell clusters.

Loken, Burns and Klypin began a detailed analysis of a high-resolution simulation of the development of large-scale structure in a CHDM universe. The simulation self-consistently evolved both dark matter and gas enabling X-ray luminosities (including both bremsstrahlung and line emission) to be directly evaluated. In addition, the evolution of individual clusters is being followed in order to estimate merger rates, to assess the importance of mergers on the development of substructure, and to estimate the prevalence of substructure at various epochs.

Garasi, Loken and Burns completed a numerical study of the evolution of rotating, cluster cooling flows. Spherically-symmetric, steady-state cooling flows with varying mass drop-out rates were perturbed by imposing rotation profiles of differing shape and strength. Thin, dense, cold disks were shown to form on timescales inversely related to the mass drop-out rate. Synthetic X-ray maps were generated for comparison with ROSAT data while the spatial distribution and density of material that dropped from the flow were used to predict possible optical and infrared signatures of rotating cooling flows.

Klypin, Borgani (Perugia, Italy), Holtzman and Primack (UCSC) made analysis of formation of damped Lyman-alpha systems at high redshifts. It was determined that cosmological models with a small fraction of mass in the form of neutrino are still marginally consistent with observations. The models became significantly more interesting with the possible detection of a neutrino mass in an experiment performed at Los Alamos. Detailed discussion of different possibilities is given by Primack (UCSC), Holtzman, Klypin, and Caldwell (UCSB).

Klypin, Primack (UCSC), and Holtzman have presented results of numerical simulations of models with a cosmological constant. They have shown that the nonlinear power spectrum predicted by some of the models is at least twice larger than the power spectra of galaxies in the CfA and APM catalogs, which presents a serious problem for the models.

Campos (Durham, England), Yepes (Madrid, Spain), Carlson, Klypin, Moles (Granada, Spain), and Joergensen (Copenhagen, Denmark) have estimated the angular correlation function of faint field galaxies. CCD photometry of about 30,000 galaxies in R band has allowed them to detect the correlation function at 1 degree scale. Results show consistency with the much shallower APM catalog.

4. EDUCATION

The Astronomy Center at Sunspot is a collaborative venture of the Department of Astronomy, Apache Point Observatory, the Sacramento Peak Solar Observatory, and the United States Forest Service. This facility, to be located on the solar observatory campus at Sunspot, N.M., will serve as a visitor center for the growing complex of astronomical facilities in the Sacramento Mountains. Approximately half of the 4000 square foot area of the main building will be devoted to instructional and interactive exhibits related to the astronomical instruments and research at Apache Point and Sacramento Peak. Additional space includes a meeting room/ auditorium area, office spaces, and other visitor facilities. A system of trails will join the Center facilities to those of the observatories.

The Center is funded by a combination of grants from the New Mexico State Legislature and matching funds from the Federal Highway Administrations ISTEA program. Kurt Anderson represents the Department of Astronomy and Apache Point Observatory in this venture. Facility design is essentially complete. Certain difficulties associated with the Mexican Spotted Owl have delayed the start of Center construction, originally planned for fall of 1995. However, an opening of the facility in fall of 1996 remains likely.

Kurt Anderson edited the 1995 Journal of Science, the annual publication of the New Mexico Academy of Science. Intended for an educated lay audience, this special issue is entitled ''Astronomy in New Mexico: Past, Present and Future.'' In addition to papers on current research of New Mexico astronomers, it features articles on observatories and research facilities, astronomy education, archeoastronomy, and public facilities for astronomy. NMSU astronomers were strongly represented among the contributors.

Beebe, a member of the Space Sciences Advisory Committee, is serving as Co-Chair of the NASA Office of Space Sciences Education Implementation Task Force with Jeff Rosendhal from NASA Headquarters.

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