

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

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This report covers events and activities that occurred during the calendar year 1997.

1. PERSONNEL

The faculty of the Astronomy Department includes Professors Kurt S. Anderson, Reta F. Beebe, Bernard J. McNamara, and William R. Webber; Associate Professor René Walterbos (Dept. Head); Assistant Professors Jon A. Holtzman, Anatoly A. Klypin, and Mark S. Marley; College Assistant Professors Nicholas Devereux, Chris Loken, Tom Harrison, and Sarah Maddison; and Emeritus Professor Herbert A. Beebe.

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).

Lisa Young joined our department as the Tombaugh Fellow. Paul Mason is a postdoctoral fellow. J. Johnson is an adjunct research associate. Twenty five graduate students are enrolled for the Fall 1997 semester. They are Mark Bliton, Matthew Carlson, Laurianne Flynn, Vanessa Galarza, Christopher Garasi, Marla Geha, Chris Gelino, Percy Gomez, Bruce Greenawalt, Salman Hameed, Jennifer Hoffman, Charles Hoopes, Nichole King, Andrey Kravtsov, Dawn Leeber, Neal Miller, Jason Peterson, Shannon Pelkey, Elizabeth Rizza, Amy Simon, Denise Stephens, Tom Stephens, Matthew Templeton, David Thilker, and Charles Walter.

Observatory and departmental staff include Mendy Fowler, secretary; Cheryl Beer, office manager; Dacia Pacheco, accountant; MerriLee Saige, accounting assistant; David Summers, observing specialist; Lyle Huber, programmer analyst; Steven Duran, research assistant.

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 Apache Point.

Apache Point Observatory has three Observing Specialists responsible for 3.5 meter operations; they are Charles Corson,

Karen Gloria, Tia Hoyes, Dan Long, and Russet McMillian. Other observatory site staff are Norm Blythe, Project Aide; Jon Brinkmann, Scientific Instruments Engineer; Jon Davis, Telescope Systems Engineer; Bruce Gillespie, Site Manager; Mark Klaene, Deputy Site Manager; Madonna Reyero, Records Technician; Gretchen Van Doren, Technical Writer; John Wagoner, Carpenter; and Dave Woods, Electronics Technician. On-campus support staff include Dacia Pacheco and Marilee Sage. Dr. Kurt Anderson is the observatory's Site Director.

Instrument development and research activities of the ARC facilities at Apache Point Observatory are detailed in a separate Observatory Report. The 3.5 meter telescope has been fully operational for over three years, and used for a variety of imaging and spectroscopic investigations at optical and infrared wavelengths. It has seen daytime use for missile-tracking and intercept experiments as part of a collaboration with White Sands Missile Range. Most of the observational programs, including several synoptic investigations, have been conducted remotely and routinely via INTERNET links. New capabilities and instruments are under development; we also undertook a number of major upgrade efforts in 1997. Mechanical structures of the Sloan telescope are in place, its optics are on-site awaiting installation, and the survey camera has been mounted. The instrument will see "first light" early next year.

Significant progress has been made on NMSU's 1.0 meter telescope at Apache Point. This is an f/6 Ritchey-Chretien instrument on an alt-azimuth mounting; it is presently equipped with a CCD camera and filter system at its Nasmyth focus. Significant work was done on the telescope drive system and the computer control system; the latter was almost entirely rewritten. A simple offset guider and auto-guiding software was added in the past year, allowing accurate tracking for long exposures. Current effort is underway to improve the image quality through optical collimation. Scientific testing of the telescope is in progress, and we anticipate scheduling of regular scientific programs by the end of calendar 1997. The telescope is operated remotely and will eventually be programmed for robotic operation. All of the recent work on the 1m has been performed in house by Professor Jon Holtzman and Observing Specialist David Summers. Professor Kurt Anderson was responsible for the supervision of the original design and construction of this telescope.

2.2 Tortugas Mountain Planetary Observatory

A limited monitoring program is continuing at the Tortugas Mountain Observatory. Multicolor CCD observations obtained with the 0.6 m telescope are reduced, archived and made available to the Planetary community through the Atmospheres Discipline Node of the NASA Planetary Data System, maintained at NMSU. Images collected over the last

29 years are on file and accessible as a climatic data base. Although NASA funding has been reduced, simultaneous observations are obtained when the 3.5 meter Apache Point telescope is scheduled for near-IR observations of Jupiter. Murrell and Chanover are carrying out this program and are archiving the data.

3. RESEARCH ACTIVITIES

3.1 Planetary Science

Simon, Beebe and Murrell have continued efforts to sustain a climatological data base containing a multispectral imaging data. This includes aggressive use of Hubble Space Telescope WFPC2 images of both Jupiter and Saturn, near IR imaging with GRIM at Apache Point and 0.4 to 1.0 micron observations at Tortugas Mountain Observatory.

A major part of our efforts this year has involved support of the Galileo mission, both probe and orbiter. Our Hubble Space Telescope data provides the global context for interpreting the limited high resolution atmospheric imaging that can be obtained with the Solid State Imaging system and has higher spatial resolution than a major portion of the infrared data. Our access to Voyager and ground-based data provides the temporal framework for interpretation.

A third major thrust has been related to our assumption of operation and improvement of the Atmospheres Discipline Node of the NASA Planetary Data System (DS). Online access to the data sets maintained by the Atmospheres Node is available through <http://atmos.nmsu.edu/> or via FTP to the same site. Huber and Duran are maintaining the node and undergraduate assistants Washburn, Chilton and Reinke provide support for ingestion of data and other data handling tasks. This archive includes all atmospheric data that has been obtained with NASA spacecraft as well as some supporting ground-based data. Current data sets that are being prepared for ingestion are the SL-9 data, Galileo Probe, and Mars Pathfinder data.

Maddison is working on gravitational instabilities in disks around young stellar objects. She has developed a 3D two-phase SPH code with Monaghan (Monash, Australia) to investigate the dynamical effect of dust in protostellar environments. Maddison and Barge (LAS, Marseille) are working on the evolution of the solar nebula perturbed by Jupiter-like bodies. Maddison and Monin (Grenoble, France) are working on the dynamics of circumbinary disks.

Marley continued to model the atmospheres of extra-solar giant planets and brown dwarfs. Model temperature profiles derived using a radiative-convective equilibrium code were used to synthesize the spectra of objects of varying masses and ages. Theoretical spectra reproduce the near-infrared observations and constrain the effective temperature and mass of the known brown dwarf Gliese 229 B. Observations by K. Noll (STScI) and T. Geballe (JAC) combined with a project model atmosphere led to the first detection of CO in Gl 229B. Model atmospheres for the recently-discovered extra-solar giant planets provide guidance for efforts to detect the new planets directly. Current research focuses on the reflected component of extra-solar planet spectra and the role of clouds. This work continues in collaboration with W.

Hubbard, T. Guillot, J. Lunine, and A. Burrows (U. Arizona), D. Saumon (Vanderbilt), and R. Freedman (NASA/Ames-Sterling Software).

Walter completed his Ph.D. thesis on the vertical structure of Uranus' atmosphere. Analysis was completed on images obtained at APO by Walter and Marley and at the IRTF by project collaborator Hammel (MIT).

3.2 Variable Stars

Harrison continued his HST GO program using the Fine Guidance Sensors to measure the first precise parallaxes to three dwarf novae. Included in this project is an effort to calibrate the technique of infrared spectroscopic parallax. Moderate resolution ($R \approx 1300$) infrared J and K-band spectroscopy of the program dwarf novae (and spectral-type template stars) have been (or will be) obtained using the infrared spectrograph CRSP on the KPNO 2.1 m. These data, combined with high precision parallaxes, will allow us to determine the accuracy of the technique of infrared spectroscopic parallax as applied to dwarf novae.

Mason is using the ARC 3.5m telescope to perform phase-resolved spectroscopy of magnetic cataclysmic variables to determine whether the spin and orbital periods of the systems remain locked in phase over long periods. Mason published his multi-wavelength study of BY Cam, firmly establishing it as the prototype of the asynchronous polars.

Johnson, Harrison, and Mason have used the ARC 3.5m telescope to obtain spectra of recent classical novae (e.g., Nova Cas 1995 and Nova Sco 1997). Johnson is combining high resolution optical spectroscopy with outburst spectropolarimetry of Nova Cas 1995 to create a 3D model of the nova ejecta.

Graduate student Leeber, with Harrison, is reducing infrared and optical observations of classical novae that erupted in 1991. These objects are targets of an ISO program of mid-, and far-infrared spectroscopy of recent classical novae. To better understand the ISO data, data taken during the outbursts of the target novae (including the modeling of the formation of dust in their ejecta) must be fully analyzed.

Harrison, Mason, and Johnson have begun a program of optical (CCD) monitoring of cataclysmic variables using a Meade 16 inch telescope that was installed on campus in 1997 September. Targets of this program are highly variable dwarf novae, such as the ER UMa stars, and classical novae.

McNamara, Harrison, Mason, graduate student Templeton, and undergraduates supported by the NSF and the New Mexico AMP completed the calibration and reduction of the multi-year BATSE (10-20 keV) light curve of Sco X-1. Fourier transform and Gabor transform analysis was used to search for periodicity and quasi-periodicity in the data. Mason, McNamara and Harrison have used the RXTE ASM data archive to study the class of Low Mass X-ray Binaries known as Z-sources and determined their galactic distribution.

3.3 High Energy Astrophysics

McNamara, Harrison, Mason, and Johnson have continued their CGRO program to follow up Gamma-ray bursts

with optical observations through the BATSE /COMPTEL /NMSU rapid response network. This network has provided limits on the appearance of optical counterparts to gamma-ray bursts by providing both deep and rapid images of burst error boxes. Mason, McNamara, and Harrison found that a significant excess of Gamma-ray bursts originate from the direction of the X-ray binaries Cygnus X-1 and Scorpius X-1. They find a significant probability that some of the BATSE cataloged Gamma-ray bursts originate from these sources.

3.4 Normal Galaxies

Greenawalt and Walterbos are continuing their study of diffuse ionized gas in nearby spiral galaxies. Together with Braun (NFRA) they published a paper describing long slit spectroscopy of diffuse ionized gas in M31. The observed line ratios of [OII], [OIII], and [SII] to H-alpha are consistent with photo ionization models in which radiation from OB stars is the source of ionization. The conditions in the spiral arms in M31, however, reflect a less diluted radiation field than found for solar neighborhood ionized gas. The analysis of diffuse ionized gas in several other nearby spirals including M33, NGC 628, NGC 925, NGC 2366, and NGC 2403 is continuing. Walterbos published a review paper on the properties of the diffuse ionized medium in spiral galaxies. Hoopes and Walterbos are testing the photo ionization model for diffuse ionized gas, by determining whether field OB stars can ionize the DIG, or if ionizing photons have to leak out of HII regions. As part of this project they are analyzing HST and UIT images of these galaxies to investigate the ionization on global and local scales. A first paper, which shows that field OB stars may play an important role in M33, was published. Collaborators on this project are Bothun (University of Oregon), Schommer (CTIO) and Smith (NASA/GSFC).

Galarza, Walterbos, and Braun (NFRA) have analyzed optical spectra of M31 supernova remnants, HII regions, and diffuse ionized gas. Results include discovery of three Wolf-Rayet candidates and corroborating evidence for a previously known Wolf-Rayet star in M31. The comparison between HII region spectra and regions of diffuse ionized gas shows important differences, in that radial trends in HII region spectra, consistent with abundance gradients, are present, but such trends are not seen in the spectra of diffuse ionized gas. It is possible that excitation effects for the diffuse ionized gas produce substantial scatter in the various line ratios, obliterating any potential radial variations related to abundance gradients.

Walterbos, King, and Braun (NFRA) published the first papers on the discovery of new candidate luminous blue variables in M31. Spectra obtained with the ARC 3.5-m telescope have so far resulted in 7 candidates, more than double the number known previously. King, Gallagher (UWisc) and Walterbos have started a program to study the stellar and gaseous environments of known and candidate LBVs to try to constrain the evolutionary stage and progenitors of these objects.

Thilker, Braun (NFRA), and Walterbos completed development of an automated technique for the systematic detec-

tion and characterization of expanding gaseous shells in HI data cubes of spiral galaxies. The method produces statistically robust expanding shell catalogs. The algorithm is equally suited to optical emission-line data obtained using Fabry-Perot imaging spectrometers. They are able to determine catalog completeness as a function of shell size and expansion velocity. In collaboration with Mashchenko (National Academy of Sciences of Ukraine), they have incorporated realistic hydrodynamic numerical models to derive predicted observational supershell signatures. A first paper, presenting the method and results for the spiral galaxy NGC 2403, will be published in *Astronomy and Astrophysics*.

Thilker, Walterbos, and Flynn are analyzing archival HST WFPC2 broad-band multi-color optical images of regions coinciding with expanding HI shells in M101 and M33. The goal is to test if the embedded stellar populations are consistent with model predictions for the massive stars needed to form the shells. Wang (NWU), Walterbos, and Thilker obtained a very deep (180-ksec) ROSAT HRI observation of M101. The data show a spectacular correlation between diffuse X-ray emission and spiral arms. They are correlating the distribution of hot gas with the distribution of M101's HI supershell population, to test predictions of supershell formation. Observations of NGC 300 with ROSAT will be obtained in AO8 for a similar study of this closer galaxy.

Holtzman continued to work primarily with data from the Hubble Space Telescope as a member of the Investigation Definition Team for the Wide Field Planetary Camera 2. Work concentrated on understanding the stellar populations in nearby stellar systems and on studying several young globular cluster systems around other galaxies.

In the LMC, earlier HST observations suggest that a significant fraction of stars were formed more than several Gyr ago or that the IMF is steeper than that found in the solar neighborhood. This conclusion was strengthened by the observation of two additional fields in the LMC, which show comparable color-magnitude diagrams and stellar luminosity functions. These data were combined with ground-based observations of brighter stars, and the complete data set suggests that the star formation history may be better modelled with more older stars than with a steeper IMF. In addition, there is no strong evidence for any difference in the star formation history between the three different fields observed in the outer LMC. A significant portion of this work was done by graduate student Marla Geha.

Analysis of HST images in the Draco dwarf spheroidal were analyzed in collaboration with C. Grillmair (JPL) and J. Mould (MSSSO). Draco is composed primarily of an old, metal-poor population, and the HST data show no strong evidence for age spread in the population. Observations of the fainter stars were used to place constraints on the initial mass function, and it was found that the IMF is consistent with that observed in the solar neighborhood.

In the Galactic Bulge, HST observations reach to stars fainter than $V=27$, corresponding to masses of 0.3 solar masses or less. This allows measurements of the initial mass function which are largely independent of the star formation history. The HST observations suggest, again, that the initial mass function is similar to that observed in the solar neigh-

borhood. In particular, there is evidence for a significant flattening of the IMF for stars with masses less than 0.5 solar masses.

With graduate student Matt Carlson, deep observations of the globular cluster system in NGC 1275 were analyzed. Two systems of clusters were found: a young, blue system, and an older, redder, system. The lack of scatter in the colors of the blue clusters suggests that they are a single-age population, likely formed during a merger event in the galaxy a few hundred million years ago. The luminosity function of these young clusters rises towards fainter magnitudes, and is inconsistent with the presently observed luminosity function of old globular cluster systems, even after correction for evolutionary effects in the stellar populations. This suggests that globular clusters may be destroyed as galaxies evolve. It also suggests that the use of globular cluster systems as distance indicators may be problematical. The specific frequency of the young globular cluster system was estimated and found to be significantly higher than that of the old population, even after correction for evolution and cluster destruction. This suggests that mergers may form clusters with relatively high efficiency, and consequently, that the overall specific frequency of a galaxy may change as a result of a merger. However, probably not enough clusters were formed during the particular merger event in NGC 1275 to significantly affect the specific frequency as it will appear in the future. Similar analysis is in progress for the isolated merger remnant NGC 3597.

Holtzman continued his project to study the effects of dust in spiral galaxies, in collaboration with S. Courteau (NOAO). A project to understand the stellar populations in late type bulges was initiated at the CFHT in collaboration with Courteau, J. Gonzalez (UNAM), and S. Charlot (IAP), and a related project to study early type bulges was initiated with graduate student Salman Hameed.

Anderson, in collaboration with W. Baggett (Computer Sciences Corporation) and S. Baggett (STScI) has completed an imaging study for a large sample of disk and lenticular galaxies. Images of a large and homogeneous sample of galaxies have been examined and their surface brightness profiles in V represented by the superposition of a de Vaucouleurs law bulge and an inner-truncated exponential disk. Surprisingly, this succeeds for more than 94% of the 659 disk and lenticular galaxies in the sample. There are no significant trends in fitability with morphological type or inclination. At least 25% of disk profiles are best fit with an inner-truncated exponential, suggesting that such truncations are both real and relatively common. The truncated disk galaxies also seem to form a group distinct from other systems in that they have systematically brighter (by about 1.5 mag/sas) central surface brightness parameters.

A selected subsample of 218 galaxies was drawn from the above sample to investigate the possible connection between inner truncations and bars. We find that while about 28% of all disk systems exhibit inner truncations the incidence arises to nearly 50% for barred systems. This confirms a similar result drawn from a much smaller sample.

3.5 Active Galaxies

Anderson has been monitoring the temporal behavior of the broad-lined radio galaxy 3C390.3. Images in Gunn g and r, plus low resolution (7A) 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. The intention is to use “reverberation mapping” techniques to understand the spatial and kinematic geometry of the broad emission line regions.

AGN monitoring efforts are part of a larger collaborative program which will use optical imaging and spectroscopy of Seyfert and broad-lined radio galaxies to describe and understand both the great similarities and large differences between these two classes of AGN. Program results for the Seyfert galaxy NGC7469 were published this year; results for the 3C390.3 effort have been submitted for publication.

Loken and Burns, along with colleagues at the National Center for Supercomputing Applications (NCSA), ran the highest-resolution simulation to date of the disruption of a 3D equilibrium jet. The entrainment and stability properties were investigated and compared with previous, lower resolution simulations. They also began a self-convergence study of entrainment rates in an effort to determine the resolution required to properly characterize turbulent entrainment by jets.

3.6 Galaxy Clustering and Cosmology

Klypin, Loken, and Burns were awarded a NASA Astrophysics Theory grant to numerically investigate the evolution of the cluster X-ray luminosity function. The simulations will employ an advanced adaptive-mesh refinement code and include additional physics such as radiative cooling and galaxy feedback. The goal of the research is to resolve the discrepancy between theoretical predictions and observational results concerning the evolution of the X-ray luminosity function.

A. Klypin and A. Kravtsov, in collaboration with A. Khokhlov (NRL) have developed a new N -body method for cosmological simulations (ART). The method is the most efficient and fast N -body code available at present. The code is built on the Fully Threaded Tree (FTT) structure for adaptive mesh refinement simulations (Khokhlov 1997), with some important modifications required by cosmological simulations. To solve the Poisson equation for gravity, an adaptive, multilevel relaxation technique has been developed, as well as a special technique to advance particle positions on a non-uniform, adaptively refined mesh. At comparable resolution, the gravity solver vastly outperforms a Fast Fourier Transform solver.

Using the code Kravtsov *et al.* (1997) found that density profiles of small halos with rotational velocities 100-200 km/s may have shallower cusps $\rho(r) \propto r^{-0.2}$. This implies that there is no contradiction with the observed rotational curves. We collaborate with J. Navarro (Steward Obs.) and J. Primack (UCSC) on the subject.

Using both analytic estimates and high resolution numerical simulations Klypin *et al.* (1997) argue that the overmerg-

ing problem (erasure of substructures in groups and clusters of galaxies in numerical simulations) is mainly due to the lack of numerical resolution. We find that the force and mass resolution required for a simulated halo to survive in galaxy groups and clusters is extremely high and was almost never reached before: $\sim 1-3$ kpc and $10^8-10^9 M_\odot$, respectively. We use the high-resolution Adaptive Refinement Tree (ART) N -body code to follow the evolution of $\approx 2 \times 10^6$ dark matter particles with dynamic range in spatial resolution of 32,000. We show that in these simulations the halos do survive in regions that would appear overmerged with lower force resolution.

Gomez, Loken & Burns carried out a series of high-resolution (20 kpc) hydro+N-body simulations of galaxy cluster mergers to determine their effect on cluster cooling flows. The parameter space investigated included the mass ratio of the two clusters, the cluster baryon fraction and the strength of the primary cooling flow. Some mergers were found to destroy the original cooling flow while others left it intact. For a given primary-secondary mass ratio, the disruption of the primary cluster cooling flow was shown to depend on the strength of the cooling flow and the amount of gas in the subcluster. The main mechanism responsible for cooling flow disruption appears to be heating of the primary cluster core by the sudden inflow of hot gas from the subcluster. The results are being applied to explain puzzling observations in which substructure (believed to indicate merging activity) is associated with some cooling flows but not others.

Loken, Klypin & Burns, in collaboration with G. Bryan (Princeton) and M. Norman (NCSA), are assembling the first statistically-complete catalogs of simulated clusters with reliable X-ray luminosities through a series of high-resolution, gas+N-body cosmological simulations. A random sample of ~ 100 clusters spanning a mass range of almost 2 orders of magnitude has been chosen from an initial low-resolution simulation of a volume $256h^{-1}$ Mpc on a side. These clusters are currently being evolved at high spatial and mass resolution ($\sim 15h^{-1}$ kpc and $10^{10}h^{-1} M_\odot$, respectively) using an adaptive mesh-refinement code. This numerical catalog will result in definitive predictions for the evolution of the cluster X-ray luminosity function (XLF) and temperature function. The results will also be used to determine the amount and frequency of cluster substructure as well as the numbers and strengths (or even existence) of cluster cooling flows. The simulated cluster catalogs will be placed in a digital archive under construction at the National Center for Supercomputing Applications where they will be available to other researchers via the Internet/WWW.

Ledlow, Burns, Loken, Owen (NRAO) & Voges (MPE, Germany) analyzed X-ray images from the ROSAT All-Sky-Survey of a complete sample of 294 Abell clusters with $z < 0.09$ and 49 poor galaxy clusters from $0.01 < z < 0.03$. From these samples, they calculated the x-ray luminosity function for low- z clusters. Given the large size of this sample, this produced the most tightly constrained estimate of the local X-ray luminosity function to date. From a comparison of the rich and poor clusters in these samples, a remarkable power-law extrapolation in the XLF over nearly 4 orders of magnitude in X-ray luminosity was found. Com-

parison with Press-Schechter theory was used to interpret the XLF and put constraints on the formation history of poor clusters as well as cosmological parameters.

4. EDUCATION

The Sunspot Astronomy Center, a collaborative venture of the NMSU Department of Astronomy, Apache Point Observatory, the Sacramento Peak Solar Observatory, and the United States Forest Service, opened in July of this year. In the four months since that opening the Center has had approximately 18,000 visitors. Adjacent to the National Solar Observatory facilities at Sunspot, NM, and to Apache Point Observatory, the Center serves as a visitor center for the growing complex of astronomical facilities in the Sacramento Mountains. Approximately half of the 5000 square foot area of the main building is an exhibit area, devoted to instructional and interactive exhibits with astronomical themes. Emphasis is on the instruments and research at Apache Point and Sacramento Peak. An auditorium or meeting room/auditorium area is of comparable size. Office space and other visitor facilities occupy the remainder of the area. A system of walking trails joins the Center building to the telescopes and other features of the observatories.

The Sunspot Astronomy 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.

5. MISCELLANEOUS

Kurt Anderson has served as the Vice President for the New Mexico Academy of Sciences during 1997; he is now the President-elect of the organization.

6. SAMPLE OF PUBLICATIONS

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