Adler Planetarium & Astronomy Museum
Astronomy Department
Chicago, Illinois 60605

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Note: Due to a publication error last year, this report covers Astronomy Department activities over a two-year period, from October 2002 through October 2004.

1. FOREWORD

The primary missions of the Astronomy Department are: (1) to conduct forefront research in astronomy, astrophysics, and cosmology, while effectively integrating research programs with public outreach; (2) to be a leading resource in conveying the methodology, concepts and discoveries of astronomy to the public; (3) to provide content for Adler projects that convey the process of science; and (4) to be a leading center of highly skilled science interpreters, who can effectively bridge the gap between the research and educational communities, and help train other scientists to become more effective in their outreach efforts.

2. PERSONNEL

L. Ciupik rejoined Adler's Astronomy Department in November 2002; M. SubbaRao and M. Smutko joined the department in March and July 2003, respectively. G. Wolf-Chase was promoted to Senior Research Associate at the University of Chicago in June 2004. Former Adler postdoc, K. Coble, joined the faculty at Chicago State University in 2004, with adjunct status at Adler. D. Steele joined the Astronomy Department as a postdoc in Fall 2004. In October 2004, L. Fortson was promoted to Vice President for Research at Adler, and G. Gyuk was promoted to Director of the Astronomy Department. Current department personnel and research interests:

- L. Ciupik, Adler Astronomer; Adjunct Professor of Astronomy, Benedictine Univ.; Adjunct Professor of Astronomy, Indiana Univ. Northwest (M.S. Northwestern Univ. 1971) – *Supernovae, Visualization of Astronomical Data*
- K. Coble, Adjunct Adler Astronomer; Assistant Professor, Chicago State Univ. (Ph.D. Univ. of Chicago 1999) – *Cosmology, Cosmic Microwave Background*
- L. Fortson, Vice President for Research, Adler; Senior Research Associate, Dept. of Astronomy & Astrophysics, Univ. of Chicago; Associate Member, Univ. of Chicago Center for Cosmological Physics (Ph.D. Univ. of California, Los Angeles 1991) – *Cosmic Rays, Gamma Rays, High Energy Astrophysics, Active Galactic Nuclei*
- G. Gyuk, Director, Adler Astronomy Department; Research Scientist, Dept. of Astronomy & Astrophysics, Univ. of Chicago; Associate Member, Univ. of Chicago Center for Cosmological Physics (Ph.D. Univ. of Chicago 1996) – *Cosmology, Microlensing, White Dwarfs, Astrobiology*
- M. Hammergren, Adler Astronomer; Adjunct Professor of Astronomy, Benedictine Univ.; Participating Guest, Lawrence Livermore National Laboratory; External Collaborator, Sloan Digital Sky Survey (Ph.D. Univ. of Washington 1998) – *Solar System, Asteroids*
- D. Roberts, Adler Astronomer; Visualization Support Specialist, Northwestern Univ.; Adjunct Researcher, Physics & Astronomy Department, Northwestern Univ. (Ph.D. Univ. of Oklahoma 1992) – *Galactic Center, Masers, Radio Astronomy*
- J.F. Salgado, Adler Astronomer; Adjunct Professor of Astronomy, Benedictine Univ. (Ph.D. Univ. of Michigan 2000) – *Interstellar Medium, Radio Astronomy, Visualization of Astronomical Data*
- M. Smutko, Adler Astronomer; Lecturer, Dept. of Physics & Astronomy, Northwestern Univ. (Ph.D. Univ. of Chicago 1998) – *Adaptive Optics, Instrumentation, Star Formation*
- D. Steele, Adler Astronomer (Ph.D. Univ. of Wisconsin 2004) – *Cosmic Rays, Gamma Rays, Active Galactic Nuclei*
- M. SubbaRao, Adler Astronomer; Research Scientist, Dept. of Astronomy & Astrophysics, Univ. of Chicago (Ph.D. Johns Hopkins Univ. 1997) – *Cosmology, Large Scale Structure, Galaxy Evolution*
- G. Wolf-Chase, Adler Astronomer; Senior Research Associate, Dept. of Astronomy & Astrophysics, Univ. of Chicago (Ph.D. Univ. of Arizona 1992) – *Star Formation, Molecular Clouds, Infrared & Microwave Astronomy, Protostars, Jets & Outflows*

3. FACILITIES

The Adler Astronomy Department has the unique distinction of being located on the premises of the recently renovated Adler Planetarium & Astronomy Museum. Through joint appointments at the University of Chicago, the Adler Astronomy Department has access to the Apache Point Observatory 3.5-m telescope, which is owned and operated by the Astrophysical Research Consortium.

The Doane Observatory is located on the site of the Adler Planetarium, on the shore of Lake Michigan in downtown Chicago, and houses a research-grade 0.5-m Cassegrain telescope by DFM Engineering. Instrumentation has recently been upgraded, and includes a 1Kx1K Finger Lakes Instrumentation CCD camera, a SBIG STV high-speed CCD camera, and several video cameras, with a standard complement of astronomical filters. The primary mirror was recoated in October 2003. The observatory is routinely used for public observing events, evening classes, and live sky shows.

Many webcasts and videoconferences have been implemented in CyberSpace − an interactive multimedia environment containing Vision Stations for virtual reality experiences, a distance learning classroom with state-of-the-art videoconferencing equipment, and a computer classroom for interactive learning activities. The fast time scale with which new content can be disseminated in CyberSpace opens new doors for effectively integrating research programs with educational outreach.

4. SCIENTIFIC ACCOMPLISHMENTS

4.1 Astroparticle Physics

4.1.1 Composition of Cosmic Rays

It is extremely important to understand the composition in the knee region of the all particle spectrum primarily because the knee is the only distinguishing feature of an otherwise impressively continuous power law extending over ~10 decades in energy. This break in the spectrum provides reason to believe that cosmic rays below and above the knee are produced by different astrophysical mechanisms. Current theories using supernova shock acceleration and galactic diffusion models predict that the composition should become increasingly iron-like just above the knee. Composition measurements at the knee are then one of the few directly measurable predictions that can be used to confirm this model.

As the P.I. of the BLANCA experiment, Fortson has recently led an effort to measure the composition of cosmic rays between 10^{14} eV and 10^{16} eV by studying the Cherenkov radiation associated with the air showers produced at these energies. The Broad Lateral Non-imaging Cherenkov Array operated in conjunction with the Chicago Air-Shower Array in Dugway, Utah through May, 1998. Results from this experiment generally agree with the model where a lighter composition is seen at energies below the knee changing to more iron-like composition above the knee. However, there is an intriguing feature in this composition trend which was not predicted and which has also been detected by competing experiments such as Kascade (Fowler *et al.* 2001). A workshop was hosted by Fortson and collaborators at the Adler Planetarium in 2000 to study this feature and review the recent results from many new experiments studying composition of cosmic rays at the knee. Fortson was a principal author on the paper resulting from this workshop, which was published in 2002 (Swordy *et al.* 2002). This paper has been cited in the Particle Physics Data Book on the section on Cosmic Rays as the reference paper for cosmic rays at the knee.

4.1.2 Ultra High Energy Gamma Rays

Toward the end of the last century, the Compton Gamma Ray Observatory detected hundreds of gamma ray sources up to 40 GeV. Today, only a handful of sources are known to emit at TeV energies. The detection of gamma rays above 300 GeV was first accomplished by the Whipple Telescope Atmospheric Cherenkov Technique telescopes. As the follow-on to Whipple, the VERITAS collaboration is set to build four ACTs to continue the discovery and study of ultra high-energy-gamma-ray emitting objects in the universe. The four telescopes will be located at the Kitt Peak National Observatory (Weekes *et al.* 2002). Fortson is an active member of this collaboration as a Senior Research Associate with the University of Chicago group. Apart from her work in the construction efforts for the first telescope (first light Fall 2003), Fortson is the Coordinator for Optical Campaigns for VERITAS. In this role, she is involved in monitoring the optical and gamma-ray bands of TeV selected Active Galactic Nuclei to study the correlations in hopes of understanding the gamma-ray emission mechanisms. Fortson is pursuing partnerships with optical astronomy colleagues at Western Kentucky University to use facilities at KPNO – in particular, the RTO. Fortson was co-chair of the conference organizing committee for the 2nd VERITAS Symposium on TeV Astrophysics of Extragalactic Sources, held at the Adler Planetarium in Spring 2003. She is co-editor of the proceedings from this conference (Fortson & Swordy 2003).

In addition to her science contributions to VERITAS, Fortson is the P.I. for the Education and Outreach program for the VERITAS collaboration.

4.2 Cosmology

4.2.1 Cosmic Microwave Background

Coble focuses on observations and analysis of the Cosmic Microwave Background (CMB) and the Sunyaev-Zel'dovich effect (SZE). The SZE is a signature in the CMB from the interaction of CMB photons and the hot x-ray gas associated with galaxy clusters. Combining SZE and x-ray observations of galaxy clusters can yield measurements of cosmological parameters and constrain galaxy cluster physics.

Coble has been analyzing radio point sources in 93 cluster fields and 18 non-cluster fields, in data taken by the SZE group at the University of Chicago. These data have deep sensitivity and can be used to model point source contamination in simulations for various CMB and SZE experiments.

For both CMB and SZE measurements, extra-galactic point sources can present an important foreground contaminant. For CMB experiments with increasingly high resolution, the contribution by point sources becomes an increasingly dominant source of confusion for CMB power. In SZE data, point sources are not just foreground contaminants, but are often associated with the clusters themselves. For upcoming SZE surveys, it will be especially interesting to know how elevated point source counts will be within a beamwidth in fields containing a cluster. It is critical to characterize the spatial distribution of point sources as well as source counts as a function of flux.

In order to characterize the point sources, Coble and her colleagues compute source counts as a function of flux (dN/dS) for cluster and non-cluster fields. They compare the point source distribution in the cluster fields as a function of angular radius with the point source distribution of non-cluster fields. They also compare the results with models and to extrapolations from other experiments. Number counts in non-cluster fields are about same as those expected from extrapolations of previous data. Number counts are high in the centers of cluster fields as expected, but number counts in the

outer regions of cluster fields are higher than expected from models and other experiments.

4.2.2 Microlensing in the Andromeda Galaxy (M31)

Although there is compelling evidence that spiral galaxies are embedded in extended non-luminous halos there is little direct information concerning halo composition. X-ray observations rule out a hot, gaseous halo, and the Hubble Space Telescope has placed tight limits on the contribution of faint stars. The most promising candidates for the halo dark matter are cold dark matter (CDM) particles and baryons in the form of MACHOs (Massive Astrophysical Compact Halo Objects). Observation of microlensing events towards the Large Magellanic Cloud (LMC) over the last few years has posed very intriguing questions about the baryonic content of the Milky Way's halo. Recent microlensing experiments suggest that perhaps 20% of the Galactic halo may be composed of compact objects (MACHOs) with masses roughly in the range 0.1 – 1 $M_{\odot}$. Astrophysical candidates for MACHOs – white dwarfs, neutron stars, and black holes – each present serious challenges for stellar formation and evolution theories.

Unfortunately, the paucity of lines of sight and the low event rate make studying the structure of our galactic halo through LMC microlensing very difficult. Furthermore, there is the question whether the Milky Way is a typical galaxy. Microlensing towards M31 (Andromeda) address all three of these concerns. By looking at the variation of the optical depth across the face of M31, MEGA (Microlensing Exploration of the Galaxy and Andromeda) probes a wide variety of lines of sight through its halo. Because of the high inclination of M31 (77°), the optical depths to the disk are considerably higher than for the LMC. Finally, microlensing observations will directly address the question of the uniqueness of the LMC measurements: finding a MACHO halo around the Andromeda galaxy would demonstrate that baryonic halos are a generic consequence of galaxy formation and evolution (at least for spirals).

Geza Gyuk continues as an active member of the MEGA collaboration, a long-term project to search for microlensing events in Andromeda. MEGA uses an innovative image subtraction technique that radically increases the experimental sensitivity to changes in the flux due to microlensing. On the theoretical front, along with A. Crotts (Columbia), Gyuk has shown that with observation of M31 over a period of a few years we should expect hundreds of events and a clear halo signal for halo fractions greater than 0.1. MEGA is focusing on completion of its data pipeline and analysis of its data. The result should be strong limits not only on the total M31 mass in MACHOs, but also on some of the halo's structural parameters such as the core radius, flattening and radial distribution. As a sideline, MEGA expects to collect a vast database on Andromeda, including variable stars, bulge and disk profiles, luminosity functions, etc.

4.2.3 SDSS Research: Spectroscopic Supernova Search, Large Scale Structure, Galaxy Classification

SubbaRao continues to work as a developer for the Sloan Digital Sky Survey (SDSS) spectroscopic pipeline. To date, the SDSS has acquired over half a million redshifts. SubbaRao is also involved in a project to do real-time identification of supernovae in the SDSS Spectra. To date nearly 30 type Ia supernovae have been identified within a day or two of observation. SubbaRao is also investigating the nature of the three dimensional distribution of galaxies. With D. Smith (SCSU), he is testing methods for correcting for redshift distortions such as the fingers-of-god. The SDSS provides a large enough sample to test the relative merits of various correction schemes. With D. Surendran (U. of Chicago) he is exploring Lapacian Eigenmaps as a tool for automated galaxy classification.

4.2.4 White Dwarf Search in the Sloan Survey

E. Gates (Univ. of Chicago) and Gyuk have been studying an ancient, very cool, white dwarf population on both the theoretical and observational fronts. They have proposed a new component of the Galaxy, a very thick disk-like ''shroud'' which reduces the required mass while at the same time maintaining the observed LMC microlensing. While many newly observed ancient white dwarfs appear to have kinematics halfway between halo objects and disk objects, unfortunately the number of such ancient white dwarfs known is still very small.

Gates, Gyuk, SubbaRao and H. Harris (USNO) are searching for more white dwarf candidates in the Sloan Digital Sky Survey (SDSS) spectral database. Very cool white dwarfs have colors similar to high-redshift quasars and may be selected for SDSS spectroscopic fibers. Over the past year Gates, Gyuk, Harris and SubbaRao have found five new very cool white dwarf candidates, potentially doubling the number of such objects known.

The known examples and theoretical models indicate that these very cool white dwarfs should be quite blue, far bluer than previously expected. Since the Sloan Survey images in five colors, selecting out only those objects that meet the criteria for white dwarfs is straightforward. Further removing all objects that are astrometrically fixed (quasars, blue galaxies, etc.) yields a sample small enough to confirm with follow-up spectroscopy. By the time the SDSS is finished, Gates, Gyuk and SubbaRao expect to have discovered somewhere between 10 and 100 very cool white dwarfs.

4.3 Galactic Astrophysics

4.3.1 Galactic Center

Roberts, working with Yusef-Zadeh (Northwestern Univ.) has used the Very Large Array to observe the radio continuum emission of the ionized gas at the center of the Galaxy at 1.2, 2 and 3.6 cm. Comparing these images with those taken years before, Roberts and collaborators have determined the proper motion of ionized gas near Sagittarius A*, the radio point source coincident with the supermassive black hole at the center of the Galaxy.

In addition to continuum proper motion measurement, Roberts and Yusef-Zadeh have made new radial velocity measurements of the ionized emission from Sgr A West. These observations are compared with the radial velocities determined at two earlier epochs to derive the change in

radial velocity due to acceleration of the gas along the line of sight. These radial velocity changes are compared with proper motion velocities of Sgr A West made in the radio continuum.

4.3.2 Masers

Roberts, working with Yusef-Zadeh (Northwestern Univ.), has used the Very Large Array and Green Bank Telescope to observe OH (1720 MHz) masers in regions where supernova remnants are interacting with molecular clouds. In these regions, the detection of OH (1720 MHz) masers and *non-detection* of masers from the main lines at 1665 and 1667 MHz are evidence of supernova-molecular cloud interactions. In this case, the characteristics of the OH (1720 MHz) maser lines and the absorption at the OH main lines (1665 and 1667 MHz) can be used to understand the conditions in the molecular clouds and in the supernova remnants.

4.3.3 Star Formation: Protostars, Jets & Outflows

One of the present outstanding questions in star formation is whether high-mass stars form – and drive outflows – in a similar manner to low-mass stars, but the answer to this question is poorly constrained observationally. In confused regions, it is virtually impossible to correlate the properties of individual, deeply-embedded, young stellar objects (YSOs) with the properties of associated jets and outflows. Wolf-Chase has employed observational and modeling techniques to help isolate the properties of YSOs and outflows. With colleagues Moriarty-Schieven (JAC, Hilo), Fich (Univ. of Waterloo), and Barsony (Space Science Institute), she showed that using Submillimetre Common-User Bolometer Array (SCUBA) observations acquired at the James Clerk Maxwell Telescope (JCMT) on Mauna Kea to help model resolution enhanced (HIRES-processed) *IRAS* data is a powerful technique that can be used to place much better limits on the contribution of individual star-forming cores to the far-infrared flux in clustered regions. This work established that many previously noted source–outflow correlations reflect the overall properties of protoclusters rather than properties of individual sources, and particularly called into question the relationship between the properties of outflows and high-luminosity driving sources.

Wolf-Chase and collaborators O'Linger (Spitzer Science Center), Cole (JPL), and Ressler (JPL) have been conducting surveys of low- and high-mass protostellar regions using the high-sensitivity mid-infrared camera, MIRLIN, at the NASA Infrared Telescope Facility (IRTF). These observations are being used to isolate the highest-luminosity sources in regions containing High Mass Protostellar Objects (HMPOs) and to determine the physical properties and evolutionary states of YSOs in these regions.

With colleagues Mike Smutko (Adler/Northwestern Univ.), Al Harper (Univ. of Chicago) and Rhodri Evans (Univ. of Wales), Wolf-Chase has been conducting a survey for near-infrared jets near HMPOs, using the GRIM II near-infrared camera and low resolution spectrograph on the Astrophysical Research Consortium (ARC) 3.5-meter telescope at Apache Point Observatory (APO). Since protostars are deeply embedded objects suffering from high extinction, many jets in these regions are better observed at near-infrared, rather than optical, wavelengths. The H_2 2.122 and [Fe II] 1.644 μm lines are particularly useful tracers of the shocked gas in protostellar jets, and can help elucidate differences and similarities between jets driven by low- and high-mass YSOs. Combined with the MIRLIN images, these data help clarify whether objects producing the bulk of the luminosity are also driving jets. Smutko & Wolf-Chase are supervising two students from the Illinois Math and Science Academy (IMSA), who are assisting in the data reduction. This project will be continued with the new NIC-FPS instrument at APO. Along with colleagues O'Linger, Moriarty-Schieven, and R. Redman (NRC Canada), Wolf-Chase has begun a complimentary search for SiO emission from the HMPOs at the JCMT. SiO is an excellent tracer of outflow shocks. Results will be used to compile a list for early targeted observations with HAWC, SOFIA's facility far-infrared camera, which is being built by Harper's team at the Univ. of Chicago.

Since the dominant mode of star formation probably lies between the isolated low-mass star-forming and rich cluster-forming modes, a clearer observational picture of the intermediate mode, small groups, is essential to our overall understanding of star formation. To further our understanding of star formation in small groups, Wolf-Chase and colleagues O'Linger and Moriarty-Schieven are conducting continuum (SCUBA) and spectral-line surveys of selected molecular clouds at the JCMT, including one observed in the Spitzer Galactic First Look Survey (GFLS), in order to study both global and small-scale properties of these regions. HIRES-processing of *IRAS* data and large-scale millimeter-wave mapping at the Arizona Radio Observatory 12-m telescope provide ancillary data to study the properties of outflows and protostars in these regions.

4.4 Solar System

4.4.1 Asteroids

Hammergren is examining the Sloan Digital Sky Survey (SDSS) for pre-discovery images of near-Earth asteroids and comets. Unlike other pre-discovery archives currently being searched, the SDSS reaches a considerably fainter magnitude than the discovery surveys themselves, and provides multi-color photometry that can help determine the taxonomic type (and thus rough surface composition) of such objects. A preliminary effort has serendipitously rediscovered more than a dozen comets, and found cometary activity in an object previously thought to be an asteroid.

Along with colleagues B. Macintosh (LLNL), S. Gibbard (LLNL), C. Max (LLNL), and D. Gavel (LLNL), Hammergren is investigating the size and shape of asteroid (216) Kleopatra through speckle interferometric imaging obtained with the Keck I telescope. They find that this unusual dog-bone-shaped asteroid is significantly longer than a radar-derived shape model (Ostro *et al.* 2000), which has implications for formation scenarios.

Hammergren is conducting a program of astrometric follow-up of near-Earth asteroids that are in urgent need of observations, using the ARC 3.5-m telescope at the Apache

Point Observatory. This program is one component of a weekly transient observing effort organized in conjunction with colleagues at the Adler and Univ. of Chicago.

4.5 Visualization of Astronomical Data

Salgado has been working on techniques for the visualization of astronomical data for professional science journals as well as for disseminating science research to the public via different kinds of media (e.g., science books, sky shows, gallery exhibits, web publishing).

Roberts and SubbaRao have worked on various scientific visualizations of astronomical data. SubbaRao created a program that displays an immersive view of the Milky Way in different wavelengths. This can be displayed on any of four 1-meter domes (VisionStations) in the Adler CyberSpace gallery. The user can select the wavelength of the Milky Way that is presented. Roberts has been working with Economou (Univ. of Chicago) on an interactive program that allows visitors at Adler to drive the Mars Exploration Rover (MER) around the real 3-D terrains of the surface of Mars and to explore the surface using the tools on the rover itself.

Roberts and SubbaRao have setup a GeoWall (3-D stereoscopic projection/computer system) in a small theater at Adler. Stereoscopic images from the MER rovers were projected in 3D in this theater during the mission early in 2004. Most of the Adler Astronomy department have given 3D presentions to the public using this GeoWall system on various topics from Mars (MER rovers) to cosmology (Sloan Digital Sky Survey).

5. OUTREACH & EDUCATION

General Astronomy Department educational & outreach activities include:

- Providing the content presented in exhibits, shows, and programs; including delineating the scope of the content and working with other departments to develop the content in the relevant media
- Presenting lectures to staff and to the public
- Developing and providing astronomy on the web, including in-depth content, inquiries, and news
- Writing popular articles
- Mentoring gifted high school students
- Establishing mutually beneficial connections with other research and academic institutions
- Interfacing with colleagues to identify opportunities for collaboration, including, for e.g., grant proposals, course instructors, and lecturers
- Interacting with the media, including responding to requests for radio, print, and television interviews, as well as helping to identify and develop topics of potential interest to the media
- Keeping staff apprised of news and discoveries in Astronomy
- Leading a dynamic program of public observing events and opportunities

5.1 Highlights

In 2003, the Adler hosted public viewing of the May 15 and November 8 total lunar eclipses, and Mars telescope viewings for over 15,000 people at the end of August and beginning of September, necessitating a huge involvement by members of the Astronomy Department. In 2004, Adler hosted public viewing of the June 8 transit of Venus and the October 27 total lunar eclipse.

Ciupik has written articles for the members' newsletter, the Adler Star, the Adler web site, and CyberSpace. He coordinates public observing events and monthly *Far Out Friday* telescope viewing. In 2003 and 2004, Ciupik helped coordinate the Center for Cosmological Physics Short Course for Planetarians. He represents the Astronomy Department on the Adler Publications Committee, which primarily develops the Adler members' newsletter, and the Program Committee, which develops the course program for adults and children. Ciupik is on the teaching faculty of Indiana University Northwest and Benedictine University. He wrote the Astronomy module for the cohort program at Benedictine University.

Coble has focused on bringing cosmology and Antarctic science to the public, through courses, lectures, outreach, print and electronic media. She has led several tours of Adler's facilities for various groups, and has participated in ''Sisters4Science,'' an outreach program for middle school girls in the Chicago Public Schools. Coble leads ''Ask the Astronomer'' sessions amd Doane Observatory tours during Adler's ''Far Out Friday'' events. She is also co-authoring an introductory cosmology book, suitable for continuing education or liberal arts students. Coble has presented research and education results at several invited talks and meetings.

In her current role as Vice President for Research, Fortson oversees and guides expansion of all of Adler's research efforts. She represents the Astronomy Department on the CyberSpace Steering Committee, which sets the direction for content and educational programming in the CyberSpace Gallery. Fortson is an Adler liaison to the Jet Propulsion Laboratory's Mars Visualization Alliance and advisor to their Museum Liaison. She is also a member of the Education and Outreach Committee for the Center for Cosmological Physics, involved in determining their EPO programs. Fortson was recently asked to serve on the National Science Foundation's Math and Physical Science Advisory Committee for a three-year term. NASA's Office of Space Science held an Education and Public Outreach Conference in 2001 where Fortson was a member of the final overview panel. Her paper from this conference is in press (Fortson 2003).

As director of the Astronomy Department, Gyuk oversees the outreach efforts of the department in specific relation to their duties at Adler, such as development of theater shows and exhibitions, as well as other educational programming. Apart from this managerial role, he continues as P.I. for Astro-Science Workshop, a NSF funded summer outreach program for high school students interested in Astronomy. The ASW program is in its 41st year and includes such distinguished alumnae as Astronaut John Grunsfeld. Over the past year Gyuk has also guided the Adler's teacher training

and distance learning efforts as lead of the Astronomy Connections program.

Hammergren is Academic Director of the Summer Science Program (SSP) in Socorro, New Mexico. SSP is an intensive, residential summer program in math, physics, and astronomy for gifted high school students. SSP has been held every summer since 1959 in Ojai, California. In 2003, the program expanded to a second site on the campus of New Mexico Tech in Socorro. Hammergren has made presentations to the AAS on Adler's E/PO partnership process, and to the DPS on an Adler program that includes public observing of potentially hazardous asteroids. He is also on the teaching faculty of Benedictine University.

Roberts has given several public lectures, such as the ending of the Galileo mission, at Adler, and at several venues in the Chicago community. The entire Astronomy Department was involved in organizing observational events around the close opposition of Mars in late August 2003. The department organized a lecture series on the search for extrasolar planets and life, as well as a series on Mars, which coincided with the Mars opposition. Roberts, Gyuk, and Hammergren visited an elementary school in Glencoe, Illinois to participate in ''Readers are Leaders,'' a program in which professionals talk to students about how their careers were motivated by reading as youth.

Roberts and Smutko organized and presented a professional development workshop for Northwestern and Evanston-area secondary educators and students on electronic resourses for astronomy education in January 2004. Roberts gave a public lecture on the Mars Exploration Rover Mission as part of the Spring 2004 Northwestern Physics & Astronomy Public Lecture series.

Salgado, the designer of Adler's web site, continues to develop astronomy content (text and graphics) for the public that includes news, celestial events and skywatching information. He is developing partnerships with planetaria and observatories in Latin America and Spain. These partnerships will provide Adler astronomy material in Spanish for the web site and other educational programs. The latter is part of Adler's efforts to reach and serve the Spanish-speaking community of Chicago. Salgado has recently discussed these efforts in two fora, the 17th International Planetarium Society Conference in Valencia, Spain (4-8 July 2004) and the 2004 Society for Advancement of Chicanos and Native Americans in Science Conference in Austin, Texas (21-24 October 2004).

Salgado is a member of the El Universo a Sus Pies (Spanish version of the Astronomical Society of the Pacific's The Universe at Your Fingertips) Board of Advisors and, along with Wolf-Chase, a member of the NASA JPL Navigator program Peer Review Panel. Salgado is also on the teaching faculty of Benedictine University.

Smutko is Adler's representative to the Illinois Space Grant Consortium, coordinates speakers for public events, and supervises research work done by students from the Illinois Math and Science Academy (IMSA). The 2003-2004 IMSA students won ''Best of Category'' for their project. Currently, he (with Wolf-Chase) supervises two IMSA students who are working with near-infrared data acquired at the APO. At Northwestern, Smutko is a member of the Lecturer Faculty, a Freshman Adviser, and oversees all operations of the historic Dearborn Telescope.

SubbaRao leads the all-electronic CyberSpace gallery, whose mission is to present the latest space-science information to the public. He also develops content for the 3D theater such as Mars images, a 3D flythrough of the galaxy distribution, particle airshowers, and virtual visits to telescopes. Much of this work was done in collaboration with the education and outreach branch of the Kavli Institute of Cosmological Physics at the University of Chicago.

In 2003, Wolf-Chase helped to develop Adler's *Search for Alien Worlds* sky show, which explores the discoveries of extrasolar planets and plans to search for earth-like worlds in a novel, family-friendly fashion. She coordinated the ''Aliens'' public lecture series that helped launch Adler's 2003–2004 Astrobiology theme. Wolf-Chase continues to be very active in outreach through presentations to various communities, such as public schools, astronomy organizations, and churches, as well as participation in ''Career Day'' events. She presented a poster on the recent history of Adler's Astronomy Department, with emphasis on the role of women in creating the astronomy research positions, at the Women in Astronomy II meeting, which was organized by the Committee on the Status of Women in Astronomy and held in Pasadena in June 2003. She is currently developing plans for a quarterly workshop for women in science in the Chicago area.

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