National Astronomy and Ionosphere Center
Cornell University, Ithaca, New York 14853
Arecibo Observatory
Arecibo, Puerto Rico 00612

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The following report covers the period July, 2000 through June, 2001.

1. FACILITIES

The Arecibo Observatory is the primary research facility of the National Astronomy and Ionosphere Center (NAIC). The NAIC is operated as a visitor-oriented national research center by Cornell University under a cooperative agreement with the National Science Foundation (NSF). Partial support for the planetary radar program is provided by the National Aeronautics and Space Administration (NASA). Typically about 85% of the available observing time has gone to astronomical research programs, the remaining 15% going to research programs in atmospheric sciences (aeronomy).

The Arecibo Observatory is located about 12 km south of Arecibo, a city on the north coast of Puerto Rico about 80 km west of San Juan. The principle instrument of the observatory is a 305-m-diameter spherical radio reflector antenna. Radio sources can be tracked within 20 degrees of the zenith using moveable feeds suspended above the stationary reflector. The observatory latitude of $18°21'$N gives a declination coverage of about $-1°39'$ to $+38°21'$. Depending upon their declinations, celestial objects may be within view at Arecibo for up to 2h40m each day.

Besides the main antenna, the observatory maintains an optical facility for passive airglow and lidar observations. This facility can be used independently or in conjunction with ionospheric radar experiments using the main antenna.

Operational support at Arecibo includes a scientific staff, an electronic maintenance and development shop, mechanical engineering and maintenance services, computing facilities, technical library, living accomodations for visiting scientists, and a cafeteria. Additional support is provided by the NAIC staff at Cornell University in Ithaca, New York, where some administrative and business functions, a small electronics development group, and a small scientific group are located.

2. INSTRUMENTATION

Most of the telescope's receivers are mounted on a Gregorian subreflector system, which was recently installed as part of a major telescope upgrade. Multiple feed horns at the Gregorian focus will eventually provide continuous frequency coverage between 300 MHz and 12 GHz. Receiving systems currently available on the Gregorian include 327-MHz, 430-MHz, 610-MHz, L-band (consisting of two separate systems: an ''L-narrow'' receiver for 1.37–1.45 GHz and an ''L-wide'' receiver for 1.15–1.73 GHz), S-band (consisting of two separate systems: an ''S-low'' receiver for 1.7–3.0 GHz and an ''S-radar'' receiver for 2.33–2.43 GHz), and C-band (3.95–5.85 GHz). The current sensitivities for these Gregorian systems are 9 K/Jy (430 MHz), 10 K/Jy (610 MHz and L-band), 8–9 K/Jy (S-band), and 5–8 K/Jy (C-band). In addition to the Gregorian systems, the original 430-MHz ''Carriage House'' line feed has been retained. This feed (19 K/Jy) is used both for passive radio astronomy and as the feed for a 430-MHz pulsed radar system (150 kW average power). This radar is the prime instrument for ionospheric incoherent scatter experiments, but can also be used for planetary radar observations. The prime instrument for planetary radar observations is the S-band (2380 MHz) radar installed on the Gregorian. This radar is a CW (non-pulsed) system with 1 MW transmitted power and a phase-coding capability for delay-Doppler observations. A third (47 MHz) radar system is also available on the Carriage House. A 430-MHz transmitting capability was recently installed on the Gregorian and is now available for use in dual-beam ionospheric radar observations. More details and updates on system specifications and availability can be accessed on the observatory Web site (www.naic.edu).

Telescope pointing and realtime data acquisition are controlled using a network of VMEbus single-board computers running the VxWorks realtime system. The observatory supports remote observing for some types of projects under control of a graphical user interface (AOCONTROL). Available data acquisition devices (''backends'') include (1) a general-purpose A/D system capable of sampling four analog channels at up to 10-MHz rates with resolutions of 1 to 12 bits per sample per channel, (2) a 16384-channel Spectral Line Correlator with four RF sub-bands independently bandwidth-adjustable from 195-kHz to 50-MHz, (3) a 50-MHz Radar Decoder, (4) a 100-MHz Pulsar Processor with on-line pulse folding capability and (5) a 20-MHz 8-bit portable fast sampler with integrated high-speed data recorder. An S2 VLBI recorder and a Mark 4/VLBA system are also available.

Data may be recorded, depending on the application, on (1) 8mm tape using helical scan (Exabyte) drives, (2) 1/2-inch Digital Linear Tape, or (3) disk for access over the local area network.

The data reduction network consists of: over fifty CPUs, including SPARC-based workstations, Intel x86-based PCs, and servers; over 1 TBytes of disk; several 8mm and 4mm helical scan tape drives and DLT tape drives for data backup and archiving. A CD-R recording facility is also available. Data reduction software includes the commercial packages IDL from Research Systems and MATLAB from The Math Works, as well as public-domain packages like ANALYZ, AIPS, IRAF, CLASS and AIPS++. The Observatory is connected to the Internet via a dedicated 1.544 Mbps T1 link.

3. OBSERVING PROPOSALS

The Arecibo Observatory welcomes and encourages research projects by qualified scientists from other institutions. Proposals are evaluated on a trimester basis, with submission deadlines of February 1, June 1, and October 1 of any given

year. The normal scheduling window for a proposal begins four months after the corresponding deadline. All proposals are evaluated by anonymous referees outside of NAIC. A complete explanation of proposal submission and evaluation procedures can be found on the observatory Web site (www.naic.edu). Electronic proposal submission is preferred. The body of the proposal (a narrative giving the scientific and technical justification) should be e-mailed as a Postscript file to proposal@naic.edu. The proposer must also submit a separate cover sheet, preferably using our Web-based form. Those proposers who cannot submit electronically, or who cannot provide a Postscript version of the body, may send their proposals to: Director, Arecibo Observatory, HC3 Box 53995, Arecibo, PR 00612.

Those wishing to include Arecibo in their VLBI observations should submit proposals directly to the VLBA, EVN, or Global networks as usual, rather than to Arecibo.

4. STAFF

The NAIC scientific staff is located in both Arecibo, Puerto Rico and on the Cornell campus in Ithaca, New York. Dr. Paul F. Goldsmith, Director of NAIC, is based in Ithaca.

The observatory's Director of Operations, Dr. Daniel R. Altschuler, is based in Arecibo. NAIC-affiliated scientists and their areas of specialization are listed below.

4.1 Arecibo Staff

D. R. Altschuler - *Active Radio Sources*
R. Bhat - *Pulsars, Interstellar Medium*
P. Freire - *Pulsars*
J. Friedman - *Optical Observations of Ionosphere*
T. Ghosh - *Low Frequency Variability, Active Galactic Nuclei, Interstellar Scintillation, VLBI*
S. A. Gonzalez - *Ionospheric Observations*
Y. Gupta - *Pulsars*
J. K. Harmon - *Planetary Radar, Solar Wind*
E. Howell - *Asteroid and Comet Studies*
D. Janches - *Ionospheric Radar, Meteor Studies*
B. M. Lewis - *Normal Galaxies, Interstellar Medium, OH/IR Stars, Circumstellar Shells*
M. C. Nolan - *Planetary Radar, Asteroid Science*
K. L. O'Neil - *Extragalactic Astronomy*
S. Raizada - *Atmospheric Sciences, Lidar Studies*
C. J. Salter - *Galactic Continuum, AGN's, HI Absorption in Pulsars*
V. Slysh - *Extragalactic Astronomy, VLBI*
S. Stanimirovic - *Spectral Line, Pulsars*
M. P. Sulzer - *Atmospheric Physics, Ionospheric Modification*
C. A. Tepley - *Airglow, Ionospheric Radar, Lidar Studies*
Q. Zhou - *Ionospheric Observations*
P. Hofner - *Molecular Lines (Visiting Res. Assoc.)*
C. Pantoja - *Extragalactic Astronomy (Visiting Res. Assoc.*

4.2 Cornell Staff

D. B. Campbell - *Planetary Radar*
J. M. Cordes - *Pulsars, Interstellar Medium*
D. T. Farley - *Ionospheric Studies*
R. Giovanelli - *Extragalactic and Galactic Lines*
P. F. Goldsmith - *Molecular Clouds and Star Formation*
M. P. Haynes - *Extragalactic and Galactic Lines, Galaxies and Clusters*
Y. Terzian - *Planetary Nebulae, Interstellar Medium*
L. Baker - *Res. Support Spec. (Technical)*
G. Cortes - *Sr. Res. Assoc. (Technical)*

4.3 Summer Student Program

The Observatory conducts a Summer Student Program in astronomy and atmospheric sciences. For this program a small number of undergraduate and graduate students are chosen to spend the summer at Arecibo engaged in research programs under the supervision of staff scientists. Applications for the Summer Student Program should be submitted to NAIC by early February.

The NAIC summer students for the summer of 2001 were:

I. Cabrera, *UPR-Mayaguez*
H. Cersosimo, *UPR-Humacao*
S. Chung, *Wesleyan*
D. Daugherty, *U. Alabama*
L. DeRemer, *Wellesley*
M. Eydenberg, *U. New Mexico*
N. Figueroa, *UPR-Mayaguez*
M. Krko, *Colgate*
M. Nicolls, *Cornell*
V. Phillips, *U. Colorado*
K. Sandstrom, *Harvard*
E. Santos, *UPR-Mayaguez*

5. COMMITTEES

5.1 AU&SAC Committee

The Arecibo Users and Scientific Advisory Committee (AUSAC) meets annually in Puerto Rico to advise the NAIC on the future needs for instrumentation and facilities. The current committee members are:

G. D. Bothun, *U. Oregon*
P. R. Jewell, *NRAO*
V. M. Kaspi, *MIT*
S. E. Thorsett, *Princeton*
T. H. Troland, *U. Kentucky*
S. C. Unwin, *JPL*
R. Waltersheid, *Aerospace Corp.*

5.2 NAIC-VC Committee

The National Astronomy and Ionosphere Center Visiting Committee (NAIC-VC), appointed by Cornell to review the management and research programs of the Observatory, normally meets once a year. The current members are:

M. F. A'Hearn, *U. Maryland*
S. K. Avery, *U. Colorado*
D. C. Backer, *UC-Berkeley*
E. B. Churchwell, *U. Wisconsin*
E. Kudecki, *U. Illinois*
M. J. Reid, *Harvard-Smithsonian CfA*

6. PROGRAM HIGHLIGHTS

In this section we summarize some of the highlights of the science done in the past year by visiting scientists and observatory staff as part of formal, refereed observing proposals to NAIC. Here, as in previous years, we do not cover atmospheric science programs, which are outside the purview of this report.

6.1 Spectral Line Radio Astronomy

Stanimirovic (NAIC), Dickey (U. Minnesota), Brooks (Macalister Coll.), Hedden, and Kirchner (Carleton Coll.) mapped two regions at the tip of the Magellanic Stream (MS), a huge tail of neutral hydrogen (HI) trailing behind the Magellanic Clouds and stretching across almost 100 deg on the sky. It is generally believed that the MS is the result of the wild interactive past of the Magellanic Clouds with our Galaxy, but consensus still has not been reached on the exact form of these interactions. The present project has two main scientific objectives: (1) to investigate how much the Galactic Halo influences the properties of the gas in the MS, and (2) to probe the structure of an almost primordial environment in which no stars have yet been found.

O'Neil (NAIC) and Bothun (U. Oregon) used the Arecibo Gregorian system to look for low surface brightness (LSB) galaxies whose morphologies indicate that they should have a reasonably high gas content, yet whose redshifts are unknown and which had not been found in previous HI searches with Arecibo or other telescopes. This project is being undertaken now to take advantage of the higher sensitivity and redshift range of the Arecibo telescope and L-narrow receiver. So far, HI has been detected in 27 of the 50 galaxies searched. The majority of the ''discovered'' galaxies lie between 13,000–20,000 km/s, making many of these systems considerably more massive than previously believed. This survey has more than doubled the number of known Malin-1 type galaxies, indicating that LSB galaxies may contribute considerably to the baryonic mass of the $z<0.1$ universe. Perhaps the most impressive find with this survey is UGC 4288. Previously this galaxy was believed to be a nearby dwarf galaxy with HI mass less than 10^7 solar masses. However, O'Neil and Bothun have found it to lie at a distance of 30,220 km/s, with an HI velocity width of 570 km/s and a HI mass of 5.2×10^{10} solar masses.

Schombert (U. Oregon), O'Neil, and Eder (NAIC) used the Digital Palomar Sky Survey (DPOSS), combined with the 2-Micron All Sky Survey (2MASS) to identify massive LSB galaxies which were not previously identified in other sky surveys and whose morphologies are suggestive of Malin 1-class objects. Preliminary results from this survey have found more than 15 of these objects, dramatically increasing the number of massive, LSB galaxies known.

Kanekar (NCRA), Ghosh (NAIC), and Chengalur (NCRA) have made high resolution Arecibo HI observations of the damped Lyman-α absorber (DLA) towards the quasar OI363. The Arecibo spectrum yields a spin temperature $T_s=890\pm160$ K, consistent with earlier lower sensitivity observations of the system. This value of T_s is far higher than spin temperatures measured for the Milky Way and local spirals, but is similar to those obtained in the majority of damped absorbers. For a multi-phase medium, the measured spin temperature is the column density-weighted harmonic mean of the temperatures of individual phases. Hence, Kanekar and Chengalur had conjectured earlier that the high T_s of the $z=0.221$ absorber and the majority of other DLAs could be explained if they were systems like dwarfs or LSB galaxies which contain larger fractions of the warm phase of HI than is the case for local spirals.

Hofner, Araya (UPR), Churchwell (U. Wisconsin), and Kurtz (UNAM) used the Arecibo C-band system to observe simultaneously the ground state transition of H_2CO and the hydrogen recombination line H110α at rest frequencies of 4829 and 4878 MHz, respectively, toward a sample of 21 ultracompact HII regions. Both H_2CO absorption and H110α emission lines were easily detected towards 20 of the 21 sources observed. These data will allow derivation of improved distance estimates toward this sample of ultracompact HII regions. Another goal of this project is the comparison of the extended ionized gas, which is sampled here in continuum and recombination line with a beam of about 1 arcmin, with the properties of the ultracompact HII regions.

Darling and Giovanelli (Cornell) conducted an OH megamaser (OHM) survey. Their detection of more than 50 new OHMs has doubled the sample of known OH megamasers and increased the sample for $z=0.1$–0.3 sevenfold. They have also detected a few OH ''gigamasers,'' one of which is the most luminous OHM ever detected. The Arecibo OHM survey selects IRAS galaxies with $z>0.1$ and detects OH masing from roughly 1 in 5.5 of these luminous IR galaxies. The survey provides new insight into the hosts and environments of OHMs, and is the first step towards using OHMs as luminous tracers of the merger history of galaxies, the dust obscured star-formation history of galaxies, and the merging rate of supermassive black holes. This team has constructed an OH luminosity function from their flux-limited survey and find a power-law falloff with increasing OH line luminosity which is consistent with the far-IR luminosity function of luminous infrared galaxies. This OH luminosity function will form the foundation for subsequent deep OHM surveys at higher redshifts. The survey has also made the first detections of variability in OHMs, the most likely source of which is Galactic interstellar scintillation.

Darling and Giovanelli (Cornell) attempted to detect OHMs in nearby active galactic nuclei (AGN) which are undetected by IRAS. These measurements revealed no OH lines associated with AGN in quiescent (non-interacting) systems. The observations place stringent limits on the influence of AGN in forming OHMs in non-interacting galaxies and give some confidence in the technique of using OHMs as tracers of merging systems.

Magnani (U. Georgia), LaRosa (Kennesaw St.), and Shore (U. Indiana) searched for HI evidence of neutral atomic flows in the environs of the high-latitude molecular cloud MBM16. Without the complication of galactic rotation or long sight lines through the disk, the HI velocity field in the vicinity of the target cloud is simpler to analyze than that of HI disk clouds. These observers will compare their HI data with CO data for this same cloud to see if there is a relation-

ship between the atomic and molecular gas at differing velocities. The Arecibo telescope is the only instrument in the world that has sufficient resolution of extended gas to allow the detailed HI-CO comparison that is needed in order to establish the presence of high-speed atomic flows.

Lewis (NAIC) continued his work on the ''births'' and ''deaths'' of OH/IR stars based on observations of their brief 1612-MHz emission phase. He now has detected three births and three deaths. The death of an OH/IR star (loss of all masers) is the easiest phase to reliably document. Moreover, these cases derive from the reobservation of just 250 stars over 15 years. IRAS 18455+0448, which previously had an exponentially decaying maser, is no longer detectable. U Equ (alias IRAS 20547+0247), the second instance, has faded from 0.5 Jy to <1 mJy. Finally, IRAS 15060+0947, which was first detected in May, 1985 with 143- and 370-mJy peaks, had a peak intensity of only 15 mJy in October, 2000. The birth of an OH/IR star is more difficult to document, as a prior non-detection may have been caused by interference or by encountering the star during a low intensity phase of its cycle. Nevertheless, the number of births presently matches the number of deaths, as expected for a steady state population. So, in addition to the new maser emission he detected earlier in V1511 Cyg, Lewis has recently observed 1612-MHz masers from IRAS 18432+1343 (250 mJy) and from IRAS 18280+0521 (100 mJy). These masers are both strong enough that, even if they had been a factor of three weaker when first surveyed, they should have been detected during previous Arecibo searches in May, 1987 and May, 1988, respectively.

Heiles (Berkeley) and Troland (U. Kentucky) used Arecibo to study the physical properties of the cold neutral medium (CNM) and the warm neutral medium (WNM) of the Galaxy, making use of the classic technique of on- and off-source observations of HI toward extragalactic continuum sources. This study yields several types of information. Spin temperatures can be derived for CNM components seen in absorption against the continuum sources. Also, upper limits to the temperatures of WNM components can be inferred from the widths of these components. Initial results from the data indicate that a significant fraction of the WNM lies in the range 500–5000 K, temperatures that are thermally unstable in equilibrium models of the interstellar medium. Also, the range of CNM temperatures (typically 25–75 K) is narrower than found in previous studies, with some temperatures less than 20 K. Measurement of magnetic fields in the CNM is a principal goal of the project, Stokes-V profiles revealing the line-of-sight field strengths via the Zeeman effect. Results so far suggest that field strengths in the CNM are typically of order 5 μG, comparable to the average field strength in the galactic disk. This result suggests that in the density range of 0.5 to 100 cm^{-3}, the interstellar magnetic field has little connection with the gas density. Either high-density gas forms from lower density gas via motions along the field lines or else ambipolar diffusion processes in the diffuse interstellar medium are much faster than previously estimated.

Swaters (DTM, Carnegie Inst.), Lane (NRL), and Briggs (Groningen) observed M61 to look for HI associated with the blue-shifted MgII doublet detected by Hubble Space Telescope. In the disk of M61 there is evidence for high-velocity gas, but they do not see any HI in emission between M61 and NGC 4301, except at the position of the HI cloud already detected in VLA observations.

Li and Goldsmith (Cornell) conducted an HI/OH survey of optically selected dark clouds. They observed 36 sources covering all starless cores in the Arecibo sky with $0<RA<6$ and angular sizes >2 arcmin. HI and OH (1665 and 1667 MHz) were observed simultaneously. Out of 36 sources observed, 29 have narrow absorption features with corresponding OH emission lines in velocity space. Four of the remaining seven have the OH lines on the slope of the 21-cm emission, and the effect of absorption is visible but not clear. Overall inspection attests to the prevalence of HI self-absorption associated with dark clouds. This suggests a more comprehensive view of the atomic interstellar medium, with temperature fluctuations both associated with, and independent of, molecular cooling.

O'Neil (NAIC), Gallagher (U. Wisconsin), and Conselice (STScI) began an Arecibo program to look for HI gas in dwarf elliptical galaxies in the Virgo cluster. Virgo dwarf ellipticals are the most common galaxy type in the nearby universe and could be important objects for understanding the evolution and formation of all galaxies. Their origin is also important for understanding and comparing various cosmological theories of structure formation (e.g., Cold Dark Matter) which predict that low-mass galaxies were among the first galaxies formed in the universe. The basic question this team are addressing is whether dwarf ellipticals in the Virgo cluster are an old cluster population or formed later, after the giant cluster ellipticals were in place. Previously this team has shown that the dwarf ellipticals have kinematic signatures of infall. They started the Arecibo program to determine if the gas content of these galaxies is consistent with this interpretation. If dwarf ellipticals are a purely old population, they will likely have no HI due to continuous gas stripping. On the other hand, if these galaxies originate from spirals or irregulars, the more recently transformed objects might retain some of their gas. Searches for HI in Virgo dwarf ellipticals have been made before, but these observers are performing a more extensive and higher sensitivity search using the upgraded Arecibo telescope. They examined 22 galaxies during the first part of the survey, finding two clear detections.

6.2 Continuum Radio Astronomy

Kaplan (Caltech), Cordes (Cornell), Condon (NRAO), Salter, and Davis (NAIC) used the Arecibo telescope to measure the continuum spectra and variability of sources from a complete sample of compact radio sources with extremely steep spectra. This sample is interesting because of its statistical properties and the steepness of the spectra. The sources push the 10^{12} K limit and require accurate measurements of the spectral indices and the locations of the flux-density maxima. Also, these sources could be variable on month-year time scales, which obviously affects the completeness. The team observed the sources with all of the Arecibo Gregorian receivers from 430 MHz to 5 GHz, using several

bands in the wide receivers (e.g. L-wide and C-Band). The degree of automation achieved allowed very smooth observations, with 40 sources being observed over two days. The observations were then repeated two months later to examine variability. While the data are not yet completely analyzed, initial results are promising. Continuum fluxes have been measured down to a few mJy at 5 GHz, and the recently improved 610-MHz focus was immediately noticeable. These observations will hopefully pave the way for Arecibo to regularly make rapid, multi-frequency continuum measurements.

6.3 Pulsar Radio Astronomy

Weisberg (Carleton Coll.), Stanimirovic (NAIC), Anderson, Jenet (Caltech), Johnston (U. Sydney), and Xilouris (U. Virginia) conducted multi-epoch HI absorption observations towards six bright pulsars. The main aim of this project is to probe structure in the interstellar medium (ISM) at smaller scales and with higher velocity resolution than has been achieved by previous studies. As pulsars move quickly through the ISM, our line of sight at different epochs samples different intervening clouds. Comparison of spectra taken at different epochs gives information about the size, density, and pressure of intervening clouds.

Stairs (NRAO), Camilo (Columbia), and other members of the Parkes multibeam survey collaboration made regular Arecibo observations of the 71-ms binary pulsar J1904 +0412. The orbital parameters of this 14.9-day binary system imply that the mass of the companion star is at least 0.2 solar masses. The pulsar is a member of the growing number of intermediate mass binary pulsar (IMBP) systems, where the companion star is thought to be a CO white dwarf. IMBPs differ from the classical millisecond pulsar low mass white dwarf systems in that the radio pulsars in IMBPs have longer spin periods and higher inferred surface magnetic field strengths, as well as significantly larger (but still essentially circular) orbital eccentricities. Despite the necessarily poor statistics at this stage, there are also suggestions that the scale height of IMBPs above and below the Galactic plane is a factor of 2–4 times smaller than for the millisecond pulsars. This points to a different origin for the IMBPs, distinct from either the low- or high-mass X-ray binary systems which are thought to produce millisecond pulsars and double neutron star binary systems, respectively.

Lorimer (NAIC), Camilo (Columbia), and Xilouris (U. Virginia) obtained phase-coherent timing solutions for all 17 of the ''unsolved'' pulsars discovered in the Hulse-Taylor Arecibo 430-MHz survey of 1973–74. The 40 pulsars discovered by that survey included the classic double neutron star binary system B1913+16. The survey still ranks as one of the most sensitive large-scale pulsar searches ever undertaken at 430 MHz. Since many of the pulsars discovered in the Hulse-Taylor survey are weak, it is perhaps not surprising that they have remained unsolved for so long. In order to fully exploit the Hulse-Taylor discoveries, accurate spin parameters are required to estimate the ages and magnetic field strengths of the sample of neutron stars detected. In addition, accurate position determinations are also useful for other followup studies of these pulsars (e.g., their polarization properties).

Wolszczan, Bogdanov (Penn St.), and Konacki (Caltech) continued regular timing of the planet pulsar PSR B1257 +12. Recent analysis of the entire set of pulse arrival times measured since 1990 has led to confirmation of the long suspected fourth periodicity in the timing residuals for this object. PSR B1257+12 already had three known inner planets, two of which have been confirmed by a detection of the effect of mutual gravitational perturbations. As the observed residuals reveal a shape that is characteristic of a highly eccentric orbit, it appears most natural to postulate that this is caused by the presence of a fourth, low-mass companion around the pulsar. Tentative modeling of the orbit of a possible fourth planet gives an object with a minimum mass twice that of Pluto in a 3.5-yr orbit with a semi-major axis of 2.6 AU and an eccentricity >0.5. This new detection gives a fascinating picture for the PSR B1257+12 planetary system of three terrestrial-mass bodies in almost circular orbits within 0.5 AU of the pulsar, and an outer Pluto-mass object in a highly eccentric orbit about five times farther away. It is tempting to speculate that this appearance for the pulsar system is the result of both orbital evolution (circularization of the inner orbits) and the initial conditions at the pulsar's birth in an asymmetric supernova explosion. A more precise characterization of the orbit of the fourth companion should become possible within another year of continued timing observations.

Lommen, Backer (Berkeley), Nice, Splaver (Princeton), and Stairs (NRAO) began a program to detect long wavelength (nanohertz) gravitational waves from their perturbation effect on pulsar signal propagation. The monitoring program was recently approved for monthly observing over the next four years. The coalescence of massive black holes may produce a stochastic gravitational wave background at a level that can be detected in pulsar timing. This measurement will place important constraints on the origin and evolution of massive black holes.

Stinebring (Oberlin) and collaborators continued to investigate the ''parabolic arcs'' that they have been seeing in pulsar secondary spectra (power spectra of the dynamic spectra of pulsar scintillations). These arcs are the transform-domain equivalent of the criss-cross patterns that have often been noted in pulsar dynamic spectra since the early 1970s. In addition to biweekly observations that the group makes to monitor time variability of the phenomenon toward a half dozen strong, nearby pulsars, they are continuing to explore the effect in archival data, much of it taken at Arecibo by Cordes (Cornell) during the 1980s. The most remarkable result to come out of the analysis of these earlier data is how little the arc pattern changes for a particular pulsar over more than twenty years. The basic curvature of the arc, which they believe is fixed by the location of a dominant scattering screen along the line of sight, as well as the tilt (with respect to the pulsar velocity vector) of filamentary structure in the plane of the screen, stays roughly constant over two decades. Work continues on making this statement quantitative, and on inferring an axial ratio for the secondary image that they believe is responsible for the parabolic arc when it interferes

with direct rays from the main (compact) pulsar image.

Stairs (NRAO), Thorsett (UCSC), Taylor (Princeton), and Wolszczan (Penn. St.) observed the double neutron star binary PSR B1534+12. This pulsar, like PSR B1913+16, is an excellent laboratory for testing the predictions of general relativity. The observations include biweekly monitoring to capture long-term timing trends and dispersion measure variations, and annual two-week campaigns with good orbital coverage to refine the relativistic timing parameters. With the post-upgrade Arecibo observations included in the timing solution, the orbital period derivative due to gravitational radiation is measured with a precision three times better than that quoted in the group's earlier publications. Another general relativistic effect seen in this pulsar is geodetic precession, in which the spin axis precesses around the total angular momentum vector. This causes a change in the line-of-sight cut across the pulsar's emission region, giving a profile that evolves secularly. Small profile shape changes were first noted by Arzoumanian in 1994; the recent observations confirm the evolution, provide more detail, and show that changes are occurring at both 430 and 1400 MHz.

Bhat (NAIC), Camilo (Columbia), Cordes (Cornell), Lorimer (Jodrell Bank), and Nice (Princeton) undertook a study of those Parkes multibeam survey pulsars visible from Arecibo. In the first phase of this project, Arecibo observations were made of some 35 Parkes pulsars (plus 45 others) at 0.4, 1.2, 1.5, and 2.4 GHz. The main objectives are: (1) to measure pulse broadening times, quantifying the lengthening of the pulse profile due to scattering between the pulsar and Earth, providing important input towards revising the best present model of the distribution of free electrons in the Galaxy; (2) to determine rotation measures and thereby map the Galactic magnetic field in a narrow but deep region of the first Galactic quadrant; (3) to estimate spectral indices for modeling the pulsar population and helping to optimize the directions of future pulsar searches.

6.4 Radar Astronomy

Margot, Nolan (NAIC), Ostro, Benner (JPL), and collaborators obtained Arecibo radar images of three near-Earth asteroids, 2000 DP107, 2000 UG11, and 1999 K4, showing each to be a binary system. These discoveries, which also included Goldstone radar observations, were the first definitive identifications of binary near-Earth asteroids. DP107 comprises 800-m and 300-m objects orbiting each other with a period of 1.7 days and a separation of 2.7 km. There was no indication from the initial optical observations that any of these three objects were binary, which underscores the importance of observing as many near-Earth asteroids as possible. The very existence of binary asteroids is something of a puzzle, and has obvious implications for asteroid collisional processes. The radar data on binaries can also be used to estimate their masses and densities.

Nolan, Margot, Howell (NAIC), Ostro, Benner (JPL), Campbell (Cornell), and collaborators conducted a vigorous program to observe other near-Earth asteroids. These included: 2000 DO8, 2000 CE59, 2000 UK11, 2000 WL107, 2000 XK47, 2001 BF10, 2000 YF29, 2000 EE104, 2001 CP36, 2001 GQ2, and 2001 EC16. The last of these was the first near-Earth asteroid observed bistatically with the Green Bank Telescope as the receiving station. Many of these asteroids were observed within days of their discovery. The observations are being used to estimate size, shape, roughness, and rotation, as well as constrain surface density/composition and refine orbits.

Black (NRAO), Campbell (Cornell), and Ostro (JPL) continued their program of radar observations of Titan that began in 1999. The major objective of the observations is to measure Titan's radar scattering as a function of longitude. Although the 2000 observations confirmed the average Titan scattering properties measured in 1999, some longitude coverage was lost to transmitter problems. On two days there were suggestions of a quasispecular component to the echo, but confirmation of this, and completion of the longitude coverage, will have to await new observations in the fall of 2001.

Nicholson, Campbell (Cornell), French (Wellesley), and Black (NRAO) continued their program of yearly radar observations of Saturn's rings. The goals include studying azimuthal asymmetries in ring scattering (thought to reflect subtle dynamical effects related to particle clumping) and following changes in scattering with changing ring inclination over several years. Delay-Doppler images of the rings were obtained with a range resolution of 10,000 km, which is good enough to separate the echoes from the A and B rings.

Campbell, Carter (Cornell), Margot (NAIC), and Campbell (Smithsonian) conducted a program of S-band radar observations of Venus. Monostatic (Arecibo-only) observations were made to map the echo's Stokes polarization parameters over much of the visible hemisphere of the planet. In addition, bistatic observations were made with the Green Bank Telescope to obtain interferometric altimetry over Maxwell Montes, the highest mountain range on Venus. The Stokes measurements have revealed a number of areas with significant linear polarization, indicating penetration of the radar wave into a surficial layer and reflection from either embedded rocks or a denser underlying surface. These polarization signatures are associated with some impact craters, fields of small volcanic domes, and areas showing wind streaks.

Simons, Pritchard (Caltech), Slade, and Jurgens (JPL) also made bistatic radar observations of Venus, in this case using Goldstone antennas in interferometer mode to receive the Arecibo transmissions. The goal was to make digital elevation models of selected areas on the planet.

Harmon (NAIC), Slade (JPL), and Campbell (Cornell) conducted a program of S-band radar observations of Mercury. These were delay-Doppler measurements designed to obtain full-disk images over both the Mariner-imaged and unimaged hemispheres. The long-code technique was used to avoid echo overspreading effects. The Arecibo upgrade and use of shorter pulses has yielded images with much higher quality and resolution than was achieved pre-upgrade.

Hapke, Zebker, and Tyler (Stanford) made delay-Doppler radar observations of the Galilean satellites Europa, Ganymede, and Callisto. These were long-code observations designed to obtain radar reflectivity maps free of echo overspreading (albeit, with the usual N/S ambiguity). Only Callisto showed discernable surface features, which is consistent

with the radar blandness inferred for these objects from earlier Doppler-only measurements.

Campbell (Smithsonian), Campbell (Cornell), and Thompson (JPL) made 430-MHz radar observations of the Moon. These were delay-Doppler observations to make reflectivity maps with 500-m resolution. The purpose was to study the depth and rock population of the mare regolith, constrain the composition of the mare basalt flows, discern structure in impact crater floors, and determine properties of low-return areas such as the regional pyroclastic deposits.

6.5 VLBI

Arecibo took part in seven experiments in support of the Japanese VSOP Space-VLBI mission (H. Hirabayashi, PI). One of these was an OH-line observation in collaboration with the Bear Lake and Robledo telescopes and the HALCA orbiting antenna.

As this report was being written, Arecibo's new VLBA4 terminal had successfully completed commissioning tests. This new capability makes Arecibo available for VLBI observations with the VLBA, EVN, and Global networks. The initial Arecibo observations as a network participant using the new VLBA4 system are scheduled for November, 2001.

7. OBSERVING PROGRAMS

The following list gives the numbers, titles, and coauthors of all observing proposals scheduled on the Arecibo telescope during the period from July, 2000 through June, 2001.

7.1 Spectral Line Radio Astronomy

A1167 - *Evolutionary Tracks of Active Spiral Galaxies* - Hunt, L. (CAISMI-CNR), Eder, J., Ghosh, T. (NAIC), Malkan, M. (UCLA).

A1256 - *Extragalactic Radio Recombination Lines - A Pilot Project* - Hofner, P. (UPR), Terzian, Y. (Cornell), Kurtz, S. (UNAM), Kubik, D. (NAIC).

A1306 - *Statistically Sampling HI and OH Zeeman Splitting with Absorption Lines* - Heiles, C. (UC-Berkeley), Troland, T. (U. Kentucky).

A1312 - *Light Travel Time Dimensions for* $|b|>10°$ *OH/IR Stars* - Lewis, B. (NAIC).

A1340 - *HI in Local Group dSph Galaxies and HVCs* - Blitz, L., Simon, J. (UC-Berkeley), Robishaw, T. (U. Maryland).

A1341 - *A Search for OH Megamasers in the PSCz Catalog at* $0.1<z<0.45$ - Darling, J., Giovanelli, R. (Cornell).

A1342 - *Are OH Megamasers Produced Exclusively in Mergers?* - Darling, J., Giovanelli, R. (Cornell).

A1354 - *HI Emission from a Damped Lyman Alpha Absorber* - Kanekar, N., Chengalur, J. (NCRA/TIFR), Ghosh, T. (NAIC).

A1366 - *21-cm Observations of Nearby Low Surface Brightness Galaxies: Investigating the LSB Tully-Fisher Relation* - O'Neil, K. (NAIC), Bothun, G., Schombert, J. (U. Oregon).

A1369 - *Gas Mass Fractions and the Evolution of LSB Dwarf Galaxies* - Schombert, J. (U. Oregon), Eder, J. (NAIC).

A1374 - *The Convergence Depth of the Universe* - Giovanelli, R., Haynes, M., Catinella, B. (Cornell).

A1387 - *Variability in OH Megamasers* - Darling, J., Giovanelli, R., Cordes, J. (Cornell).

A1388 - *The Kinematics of Dwarf Irregular Galaxies* - Eder, J., Arecibo Summer Students (NAIC).

A1392 - *A Satellite of the High Velocity Cloud W491* - Hoffman, G., Pocceschi, M. (Lafayette), Salpeter, E. (Cornell).

A1393 - *The Outer Edge of W486* - Hoffman, G., Pocceschi, M. (Lafayette), Salpeter, E. (Cornell).

A1397 - *Dynamical Study of HI in Two High-Latitude Clouds* - Magnani, L. (U. Georgia), La Rosa, T. (Kennesaw St.), Shore, S. (U. Indiana).

A1399 - *HI Envelopes and the Impact Parameters of Low Surface Brighness Galaxies* - O'Neil, K. (NAIC).

A1400 - *Determining the* $z<0.1$ *Baryon Budget* - O'Neil, K. (NAIC), Bothun, G. (U. Oregon).

A1408 - *The Magellanic Stream* - Stanimirovic, S. (NAIC), Dickey, J. (U. Minnesota), Hedden, A., Kirchner, A. (Carleton).

A1439 - *HI Observations of Low Surface Brightness 2-MASS Galaxies* - Monnier-Ragaigne, D., van Driel, W. (Paris), Schneider, S. (U. Mass.), Jarrett, T. (IPAC).

A1440 - *Extreme Deviations from the Tully-Fisher Relation* - O'Neil, K. (NAIC).

A1441 - *Search for AGN Malin Galaxies* - Schombert, J. (U. Oregon), O'Neil, K., Eder, J. (NAIC).

A1444 - *V1511 Cyg: The Prototype for Newly Born OH/IR Stars* - Lewis, B. (NAIC).

A1445 - *A Search for Newly Born OH/IR Stars* - Lewis, B. (NAIC).

A1446 - *21-cm Survey of Low Surface Brightness Galaxies Found in the KISS Fields* - Kearns, K. (U. Wisconsin), O'Neil, K. (NAIC).

A1447 - *HI Self-Absorption Study of B5 and L1544* - Li, D., Goldsmith, P. (Cornell).

A1452 - *HI Observations of Low Redshift Galaxies that Hosted a Supernova* - Lewis, B. (NAIC), Terzian, Y. (Cornell).

A1455 - *First Measurements of the Zeeman Effect in CH* - Goodman, A. (Harvard), Heiles, C. (UC-Berkeley).

A1456 - *Studies of the Large-Scale Galactic Magnetic Field via the Zeeman Effect* - Troland, T. (U. Kentucky), Heiles, C. (UC-Berkeley).

A1457 - *A Crucial Test of the Role of Magnetic Fields in Star Formation* - Troland, T. (U. Kentucky), Crutcher, R. (U. Illinois).

A1465 - *C-band Spectral Line Test Observations* - Hofner, P. (UPR).

A1472 - *Investigating the Star Formation Histories of Low Luminosity Early-type Galaxies* - Concannon, K., Rose, J. (UNC), Caldwell, N. (Smithsonian), Gaba, A. (UNC).

A1475 - *KISS Dwarfs: The HI Properties of a Complete Sample of Active Star-forming Dwarf Galaxies* - Lee, J. (U. Arizona), Salzer, J. (Wesleyan), Impey, C. (U. Arizona).

A1489 - *Dwarf Ellipticals in Rich Clusters: The First Galaxies or Evolved Spirals?* - Conselice, C. (STScI),

O'Neil, K. (NAIC), Gallagher, J. (U. Wisconsin), Wyse, R. (Johns Hopkins).

A1494 - *OH Observations of Comet C/1999 T1 McNaught-Hartley* - Lovell, A. (Agnes Scott), Howell, E. (NAIC), Schloerb, P. (U. Mass.).

A1516 - *High Velocity Clouds W413 and W479* - Hoffman, G., Hirani, A. (Lafayette).

A1518 - *OH Masers for VLBI* - Slysh, V. (Astro. Space).

A1524 - *Followup on the Arecibo Set of OH/IR Stars* - Lewis, B. (NAIC).

7.2 Continuum Radio Astronomy

A1355 - *Quasi-Simultaneous Continuum Spectra of the Steepest Spectrum Compact Radio Sources* - Kaplan, D. (Caltech), Cordes, J. (Cornell), Condon, J. (NRAO), Salter, C. (NAIC).

7.3 Pulsar Radio Astronomy

P1001 - *Timing Observations of Three Recently Discovered Millisecond Pulsars* - Anderson, S. (Caltech), Foster, R. (NRL), Wolszczan, A. (Penn St.).

P1004 - *Timing Observations of Two Pulsars Associated with Supernova Remnants* - Anderson, S. (Caltech), Cadwell, B. (Penn. St.), Foster, R. (NRL), Jacoby, B., Wolszczan, A. (Penn. St.).

P1014 - *Confirmation of Intermediate Latitude Pulsar Survey Candidates* - Anderson, S., Kulkarni, S. (Caltech), Navarro, J. (Norway).

P1018 - *A High Time Resolution Study of Pulsar Emission* - Jenet, F., Anderson, S., Prince, T. (Caltech), Wolszczan, A. (Penn. St.).

P1019 - *Precision Pulsar Metrology* - Backer, D., Somer, A., (UC-Berkeley), Foster, R., Cadwell, B. (NRL), Wolszczan, A. (Penn St.).

P1028 - *Timing Observations of Pulsars in Globular Clusters* - Kulkarni, S., Anderson, S., Prince, T. (Caltech), Wolszczan, A. (Penn. St.).

P1037 - *Biweekly Timing Observations of Millisecond Pulsars* - Stairs, I., Nice, D., Taylor, J., Thorsett, S. (Princeton), Camilo, F. (U. Manchester).

P1050 - *High Precision Timing of Millisecond Pulsars* - Anderson, S., Jenet, F. (Caltech), Kaspi, V. (MIT), Kulkarni, S., Prince, T. (Caltech), Wolszczan, A. (Penn. St.)

P1095 - *Timing Observations of the Planet Pulsar PSR B1257+12* - Wolszczan, A. (Penn. St.).

P1096 - *Precision Timing of the Relativistic Binary Pulsar PSR B1534+12* - Wolszczan, A. (Penn. St.), Konacki, M. (U. Torun).

P1098 - *Timing Observations of Three Recently Discovered Millisecond Pulsars* - Anderson, S. (Caltech), Foster, R. (NRL), Wolszczan, A. (Penn. St.).

P1115 - *Timing Observations of Two Pulsars Associated with Supernova Remnants* - Anderson, S. (Caltech), Cadwell, B., Foster, R. (NRL), Jacoby, B., Wolszczan, A. (Penn. St.).

P1134 - *A Search for Giant Pulses from M33 and Nearby Globular Clusters* - McLaughlin, M. (Cornell), Arzoumanian, Z. (NASA), Cordes, J. (Cornell), Hankins, T. (NRAO).

P1228 - *Masses, Space Motions and Long-Term Timing of Two Intermediate Mass Binary Pulsar Systems* - Camilo, F., Stairs, I. (Jodrell Bank), Nice, D., Splaver, E., Taylor, J. (Princeton), Xilouris, K. (NAIC).

P1273 - *Follow-up Timing Observations of Newly Discovered Pulsars* - Fruchter, A. (STScI), Xilouris, K., Lorimer, D., Eder, J. (NAIC).

P1278 - *A Deep Search for Millisecond Pulsars* - McLaughlin, M., Arzoumanian, Z., Cordes, J. (Cornell), Lorimer, D. (NAIC).

P1281 - *Interstellar Scintillations: Probing Pulsars and the ISM* - Stinebring, D. (Oberlin), McLaughlin, M., Cordes, J. (Cornell).

P1303 - *Contrasting Core and Conal Dominated Single Pulses of Radio Pulsars* - Gill, J. (ACZG), Lorimer, D. (NAIC), Thorsett, S. (UCSC).

P1318 - *A Deep Search for High Velocity Pulsars* - McLaughlin, M., Cordes, J. (Cornell), Arzoumanian, Z. (NASA), Lorimer, D. (NAIC).

P1325 - *Timing of Pulsars Discovered in the Parkes Multibeam Survey* - Stairs, I., Camilo, F., Lyne, A., McKay, N.(U. Manchester).

P1345 - *Timing Measurements of 20 Recently Discovered Pulsars* - Feiler, G. (Torun), Kizilton, B., Wolszczan, A. (Penn St.).

P1360 - *A Dual Frequency Search for Massive Binary Pulsars* - Lorimer, D. (NAIC), Ramachandran, R., Tauris, T. (Amsterdam)

P1370 - *PSR B1534+12: Timing and Monitoring Geodetic Precession* - Stairs, I. (NRAO), Thorsett, S. (UCSC), Taylor, J. (Princeton).

P1376 - *Angular Broadening of Nearby Pulsars* - Gwinn, C., Hiranu, C. (UCSB), Deshpande, A. (Raman), Ramachandran, R. (Amsterdam).

P1383 - *Pulsar Observations with AOFTM: Measuring Pulse Broadening* - Bhat, R. (NAIC), Cordes, J. (Cornell).

P1384 - *Interstellar Scintillation Studies: Probing Pulsars and the Interstellar Medium* - Bhat, R. (NAIC), Cordes, J., Chatterjee, S. (Cornell).

P1386 - *Pilot Polarization Observations Using the WAPP: Geodetic Precession of B1913+16* - Cordes, J., Wasserman, I. (Cornell), Bhat, R., Lorimer, D. (NAIC).

P1396 - *A Pilot Search for Young and Rapidly Rotating Pulsars in the Galactic Plane* - Lorimer, D. (NAIC), Cordes, J., McLaughlin, M. (Cornell), Arzoumanian, Z. (NASA).

P1404 - *High Frequency Exploration of PSR J1022+1001, J1713+0747, B1855+09 and B1937+21* - Lommen, A., Backer, D. (UC-Berkeley).

P1406 - *Probing the Eclipse Region in PSR B1957+20* - Splaver, E., Nice, D. (Princeton), Lorimer, D. (NAIC), Khechinashvili, D. (J. Kepler Astro. Ctr.).

P1409 - *A Pulsar Absorption Study of Very Small Scale Structure in Interstellar HI* - Weisberg, J. (Carleton), Stanimirovic, S. (NAIC), Anderson, S., Jenet, F. (Caltech).

P1423 - *Probing the Interstellar Electron Density with New Parkes Multibeam Survey Pulsars* - Bhat, R. (NAIC), Cordes, J., Chatterjee, S. (Cornell), Lazio, J. (NRL), Manchester, R. (CSIRO), Lyne, A. (Jodrell Bank).

P1424 - *Confirmation of Pulsar Candidates from the*

Princeton-Arecibo Upgrade Survey - Nice, D., Brisken, W. (Princeton), Camilo, F. (Columbia), Thorsett, S. (UCSC).

P1425 - *Timing of Three Recently Discovered Pulsars* - McLaughlin, M. (Cornell), Arzoumanian, Z. (NASA), Cordes, J. (Cornell), Lorimer, D. (NAIC), Chatterjee, S. (Cornell).

P1426 - *Pulsar Phase Resolved Spectra at High Frequencies: Investigation of the Radio Emission Mechanism* - Bhat, R. (NAIC), Backer, D., Lommen, A. (UC-Berkeley).

P1427 - *Measuring the Galactic Magnetic Field Using the Newly Discovered Pulsars (and Measuring their Spectral Indices, too)* - Nice, D. (Princeton), Camilo, F. (Columbia).

P1428 - *Parallax Measurements of PSR J0030+0451* - Lommen, A., Backer, D. (UC-Berkeley).

P1429 - *New Single-Pulse Observations of PSR 0611+22* - Nowakowski, L., Sotero, N. (UPR).

P1431 - *Tests of the Most Precise Pulsar Timing* - Splaver, E., Nice, D. (Princeton), Lommen, A., Backer, D. (UC-Berkeley).

P1435 - *Scintillation Study of Emission Regions of Pulsars* - Gwinn, C., Schwartz, C. (UCSB), Bhat, R. (NAIC), Jenet, F. (Caltech).

P1436 - *A 20-cm Search for Pulsars in Globular Clusters Using WAPP* - Kaspi, V. (MIT), Stairs, I. (NRAO), Lorimer, D. (NAIC).

P1437 - *A Quasi-Periodically Disappearing Pulsar* - Kramer, M., (Manchester), Stairs, I. (NRAO), Lyne, A. (Manchester), Lorimer, D. (NAIC).

P1468 - *A Young Pulsar in IC433: A Target of Opportunity Proposal* - Jacoby, B. (Caltech), Frail, D. (NRAO), Keohane, J., Williams, N., Clearfield, C. (U. No. Carolina).

P1477 - *Multifrequency Timing of PSR B1257+12 and PSR B1534+12* - Wolszczan, A., Bogdanov, S. (Penn. St.).

P1479 - *Long-Term Timing of PSR B1534+12* - Stairs, I. (NRAO), Thorsett, S. (UCSC), Taylor, J. (Princeton).

P1480 - *PSR B1534+12: Intensive Timing and Monitoring Geodetic Precession* - Stairs, I. (NRAO), Thorsett, S. (UCSC), Taylor, J. (Princeton).

P1481 - *Probing the Nano-Hertz Gravitational Wave Background with a Pulsar Timing Array* - Backer, D., Lommen, A. (UC-Berkeley), Nice, D., Splaver, E. (Princeton), Stairs, I. (NRAO).

7.4 Radar Astronomy

R1261 - *High Resolution UHF Search for Interstellar Radar Particle Sources* - Mathews, J., Janches, D. (Penn. St.), Meisel, D. (SUNY), Zhou, Q. (NAIC).

R1316 - *Radar Observations of Mainbelt Asteroids in October 1999 and January 2000* - Magri, C. (U. Maine), Nolan, M. (NAIC), Ostro, S., Giorgini, J. (JPL), Hudson, R. (Wash. St.), Yeomans, D. (JPL).

R1333 - *Radar Observations of the Galilean Satellites* - Harcke, L., Zebker, H., Tyler, G. (Stanford).

R1361 - *A Two-Year Radar Survey of Fifty Mainbelt Asteroids* - Magri, C. (U. Maine), Nolan, M. (NAIC), Ostro, S., Giorgini, J. (JPL).

R1391 - *Radar Observations of Mercury and Venus (Solar Wind) in 2000* - Harmon, J. (NAIC), Slade, M. (JPL), Coles, W. (UCSD).

R1398 - *Radar Observations of Four Mainbelt Asteroids in August and September 2000* - Nolan, M. (NAIC), Magri, C. (U. Maine), Howell, E., Margot, J.-L. (NAIC), Hudson, S. (Wash. St.).

R1401 - *Radar Imaging of Three Large Near-Earth Asteroids in July 2000* - Ostro, S., Benner, L., Giorgini, J. (JPL), Hudson, S., (Wash. St.).

R1403 - *Radar Observations of Asteroid 2100 Ra-Shalom* - Shepard, M. (Bloomsberg St.), Ostro, S., Benner, L. (JPL), Nolan, M. (NAIC).

R1414 - *Observations of Near-Earth Asteroid 2000 DO8* - Margot, J.-L., Nolan, M. (NAIC), Ostro, S., Benner, L. (JPL).

R1415 - *Radar Ranging of the Galilean Satellites in 2000* - Harmon, J. (NAIC), Ostro, S., Standish, E., Lieske, J. (JPL)

R1416 - *Digital Elevation Models of Selected Regions of Venus Derived Using Earth-Based Radar Interferometry* - Simon, M., Pritchard, M. (Caltech), Slade, M., Jurgens, R. (JPL).

R1417 - *Lunar Radar Mapping at 430 MHz* - Campbell, B. (Smithsonian), Campbell, D. (Cornell), Thompson, T. (JPL).

R1418 - *Radar Imaging of Asteroid 4183 CUNO* - Benner, L., Ostro, S. (JPL), Hudson, R. (Wash. St.), Nolan, M., Margot, J.-L. (NAIC), Giorgini, J., Yeomans, D. (JPL).

R1419 - *S-Band Radar Mapping of Saturn's Rings* - Nicholson, P., Campbell, D. (Cornell), French, R. (Wellesley), Black, G. (NRAO).

R1420 - *Bistatic Radar Observations of the Lunar South Pole* - Margot, J.-L. (NAIC), Campbell, D. (Cornell), Slade, M., Jurgens, R. (JPL).

R1422 - *S-Band Radar Observations of Titan and Iapetus in 2000* - Black, G. (NRAO), Campbell, D. (Cornell), Ostro, S. (JPL).

R1466 - *Radar Observations of Comet C/1999 S4 (LINEAR)* - Margot, J. (NAIC), Campbell, D. (Cornell), Harmon, J., Nolan, M. (NAIC).

R1467 - *Radar Imaging of Near-Earth Asteroid 2000 CE59* - Nolan, M., Margot, J.-L. (NAIC), Giorgini, J., Benner, L., Ostro, S. (JPL).

R1471 - *Radar Observations of Binary Asteroid 2000 DP107* - Margot, J.-L., Nolan, M. (NAIC), Ostro, S., Benner, L., Jurgens, R., Slade, M., Giorgini, J. (JPL), Campbell, D. (Cornell).

R1482 - *Radar Observations of Three Dynamically Distinctive Near-Earth Asteroids* - Ostro, S. (JPL), Hudson, S. (Wash. St.), Benner, L. (JPL), Nolan, M., Margot, J.-L. (NAIC).

R1483 - *Surface Properties of Venus from Radar Observations* - Campbell, D. (Cornell), Margot, J.-L. (NAIC), Carter, L. (Cornell), Campbell, B. (Smithsonian).

R1490 - *Interferometric Radar Observations of Near-Earth Asteroid 1999 KW4* - Margot, J.-L., Nolan, M. (NAIC).

R1491 - *Urgent Proposal to Observe Near-Earth Asteroid 2000 UK11* - Nolan, M., Howell, E., Margot, J.-L. (NAIC), Campbell, D. (Cornell).

R1493 - *Urgent Proposal for Radar Observations of Asteroids 2000 UG11 and 2000 UK11* - Ostro, S. (JPL).

R1495 - *Radar Observations of Near-Earth Asteroid 2000 WL107* - Nolan, M., Margot, J.-L., Howell, E. (NAIC), Ostro, S. (JPL).

R1496 - *Radar Observations of 2000 XK47* - Nolan, M. (NAIC), Ostro, S. (JPL), Margot, J.-L. (NAIC), Benner, L. (JPL).

R1497 - *Radar Observations of 2001 BF10* - Howell, E., Nolan, M., Margot, J.-L. (NAIC), Beattini, A. (IAS-CNR).

R1498 - *Radar Observations of 2000 YF29* - Nolan, M. (NAIC), Ostro, S. (JPL), Margot, J.-L. (NAIC), Benner, L. (JPL).

R1506 - *Radar Observations of Mercury in 2001* - Harmon, J. (NAIC), Slade, M. (JPL), Campbell, D. (Cornell).

R1527 - *Radar Observations of 2000 EE104 in April 2001* - Nolan, M., Howell, E. (NAIC).

R1528 - *Radar Observations of Asteroid 2001 CP36* - Nolan, M., Howell, E (NAIC), Ostro, S., Benner, L. (JPL).

R1533 - *Delay-Doppler Imaging of Asteroid 2001 GQ2* - Nolan, M. (NAIC), Margot, J.-L. (Caltech), Benner, L. (JPL), Campbell, D. (Cornell).

7.5 VLBI

V1190 - *Arecibo Support of the VSOP Space-VLBI Project* - Hirabayashi, H. (ISAS), Fomalont, E. (NRAO).

7.6 Special

S1145 - *Project Phoenix: SETI Targeted Search Observations* - Tarter, J. (SETI Inst.).

S1529 - *Observing Demonstration for Arecibo Summer School* - O'Neil, K. (NAIC).

PUBLICATIONS

The following is a list of publications from NAIC staff **(boldface)** *and visiting scientists. The list is not necessarily complete. These contributions appeared in the open literature or were in press during the period from July, 2000 through June, 2001.*

Benner, L.A.M., Ostro, S.J., Hudson, R.S., & Rosema, K.D., 2000, ''Radar Observations of Asteroid 3908 Nyx (1980 PA),'' BAAS, 32, 1001.

Black, G.J., **Campbell, D.B.**, & Ostro, S.J., 2001, ''Icy Galilean Satellites: 70 cm Radar Results from Arecibo,'' Icarus , 151, 160.

Burton, W.B., Braun, R., & Chengalur, J.N., 2001, ''Arecibo Imaging of Compact High Velocity Clouds,'' A&A, 369, 616.

Chetterjee, S., **Cordes, J.M.**, Lazio, T.J.W., Goss, W.M., Fomalont, E.B., & Benson, J.M., 2001, ''Parallax and Kinematics of PSR B0919+06 from VLBA Astrometry and Interstellar Scintillometry,'' 2001, ApJ, 550, 287.

Crutcher, R.M., & Troland, T.H., 2000, ''OH Zeeman Measurement of the Magnetic Field in the L1544 Core,'' ApJL, 537, L139.

Darling, J., & **Giovanelli, R.**, 2001, ''A Search for OH Megamasers at $Z>0.1$. II. Further Results,'' AJ, 121, 1278.

Deshpande, A.A., & Rankin, J.M., 2001, ''The Topology and Polarization of Sub-beams Associated with the Drifting Sup-pulse Emission of Pulsar B0943+10. I. Analysis if Arecibo 430- and 111-MHz Observations,'' MNRAS, 322, 438.

Dickey, J.M., Mebold, U., **Stanimirovic, S.**, & Stavely-Smith, L., 2000, ''Cold Atomic Gas in the Small Magellanic Cloud,'' ApJ, 536, 756.

Eder, J., & Schombert, J., 2000, ''Gas Rich Dwarfs from the PSS-II. III. HI Profiles and Dynamical Masers,'' ApJS, 131, 47.

Everett, J.E., & Weisberg, J.M., 2001, ''Emission Beam Geometry of Selected Pulsars Derived from Average Pulse Polarization Data,'' ApJ, 553, 341.

Franco, J., Kurtz, S., **Hofner, P.**, Testi, L., Garcia-Segura, G., & Martos, M., 2000, ''The Density Structure of Highly Compact HII Regions,'' ApJL, 542, L143.

Freire, P.C., Kramer, M., & Lyne, A.G., 2001, ''Determination of the Orbital Parameters of Binary Pulsars,'' MNRAS, 322, 885.

Frey, S., Gurvits, L., **Altschuler, D.R.**, **Davis, M.M.**, **Perillat, P.**, **Salter, C.**, Aller, H.D., Aller, M.F., & Hirabayashi, H., 2000, ''Dual Frequency VSOP Observations of AO 0235+164,'' PASJ, 52, 975.

Gil, J.A., & Sendyk, M., 2000, ''Spark Model for Pulsar Radiation Modulation Patterns,'' ApJ, 541, 351.

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