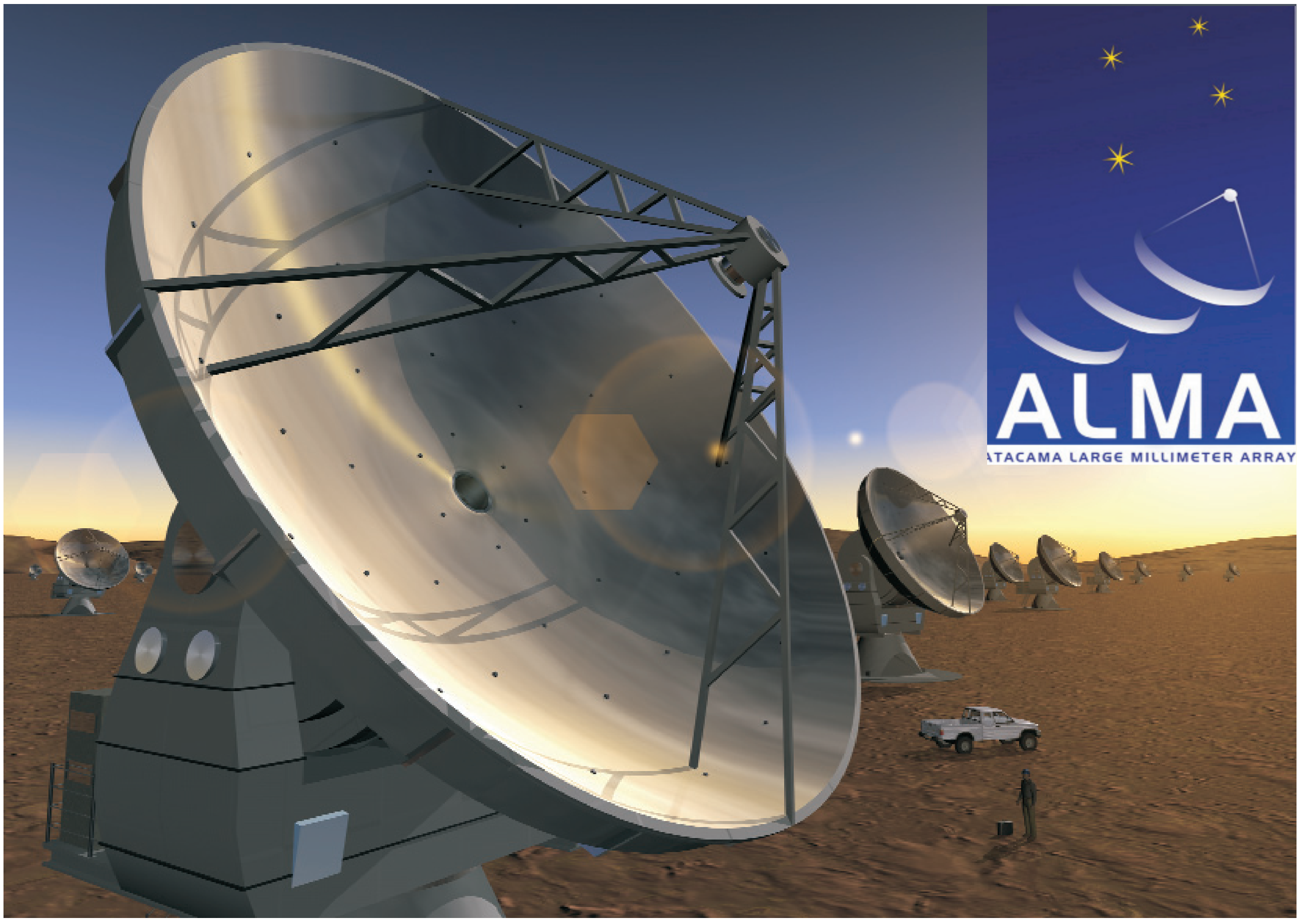


ALMA Science Workshop Abstract Book

Sponsored by NRAO and the University of Maryland

14 -15 May 2004

Composition: Al Wootten

The Atacama Large Millimeter Array (ALMA) is an international astronomy facility. ALMA is an equal partnership between Europe and North America, in cooperation with the Republic of Chile, and is funded in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC), and in Europe by the European Southern Observatory (ESO) and Spain. ALMA construction and operations are led on behalf of North America by the National Radio Astronomy Observatory (NRAO), which is managed by Associated Universities, Inc. (AUI), and on behalf of Europe by ESO.

ANASAC Membership

Andrew Blain	Caltech
Chris Carilli	NRAO
Dick Crutcher	U. Illinois
David Hollenbach	NASA-Ames
Jason Glenn	U. Colorado
Dan Jaffe	U. Texas
Luis Rodriguez	UNAM Morelia
Dave Sanders	U. Hawaii
Xiaohui Fan	U. Arizona
Christine Wilson	McMaster University
Lee Mundy	U. Maryland
Jean Turner	U. C. Los Angeles
Min Yun	U. Massachusetts
Phil Myers	Center for Astrophysics
Doug Johnstone	Herzberg Institute
Mark Gurwell	Center for Astrophysics
Joan Najita	NOAO

ASAC Members (red) are drawn from this group, which reports to the NRAO Director. The ANASAC provides a conduit between the NRAO and the NA scientific community for dissemination of information pertaining to the status and progress of the ALMA construction project and operations.

Advise the Director of the NRAO on issues relating to scientific use of ALMA, including requirements for ALMA user support, preparatory programs with existing facilities and/or providing access to new facilities in Chile, science with ALMA during the construction and commissioning stage, definition of and preparation for the N. A. ALMA Science Center that will be located in Charlottesville, and on science and priorities for ALMA Chilean operations and continual ALMA upgrades.

Contents

National Radio Astronomy Observatory

Wednesday, May 5, 2004

NRAO Home > ALMA Workshop > Agenda

Friday, May 14, 2004 Poster Book is available

8:00 Welcome: Fred K. Y. Lo (Director, NRAO)
The State of ALMA Construction: Massimo Tarenghi (Director, ALMA Project)

8:30 Session 1: Introduction to ALMA and The Design Reference Science Plan *M. S. Yun (U. Mass.), Chair*

- Introduction to ALMA: A. Wootten (NRAO; 30 minutes)
- ALMA Science Themes
  - Galaxies and Cosmology: A. Blain (Caltech; 40 minutes)
  - Star and Planet Formation: N. J. Evans (U. Tx.; 40 minutes)

10:30 Coffee Break

10:45 Session 2: ALMA Science Themes Continued and The ALMA Design Reference Science Plan *C. Wilson (McMaster U.), Chair*

- ALMA Science Themes (cont.)
  - Stars and Their Evolution: M. Meixner (STScI; 20 minutes)
  - Solar Systems Near and Far: M. Gurwell (CfA; 20 minutes)
- The ALMA Design Reference Science Plan
- Discussion

12:30 Lunch *(provided at the conference site and included in registration fee)*

1:30 Session 3: Working Groups -- Discussion of Scientific Goals *Breakout Sessions*

- Galaxies and Cosmology - Main Room *(Facilitators: Carilli, Wilson)*
- Star and Planet Formation - Breakout Room No. 1 *(Facilitators: Johnstone, Shepherd)*
- Stars and Their Evolution - Breakout Room No. 2 *(Facilitator: Osten)*
- Solar Systems Near and Far - Breakout Room No. 3 *(Facilitator: Butler)*

4:00 Tea Break

4:30 Session 4: Contemporary mm/FIR Instruments and ALMA (30 mins each topic; *C. Carilli, Chair*)

- Millimeter Interferometers: EVLA (Butler), SMA (Moran), CARMA (Vogel)
- Millimeter Antennas: LMT (Narayanan); GBT(Mason); ARO (Folkers)
- Submillimeter Antennas: JCMT/SCUBA II (Johnstone); CSO & HIFI (Lis)

6:30 Poster Session and Banquet

- Talk: P. vanden Bout (NRAO) "The Long Random Walk to ALMA"
- After-dinner discussion: Building the mm/FIR community: Funding, faculty, facilities

Saturday, May 15, 2004

8:30 Session 5: Group Summaries (Plenary Session)*Y. Shirley (NRAO), Chair*

- Poster Summaries and Discussion
- Galaxies and Cosmology
- Star and Planet Formation
- Stars and Their Evolution
- Solar Systems Near and Far

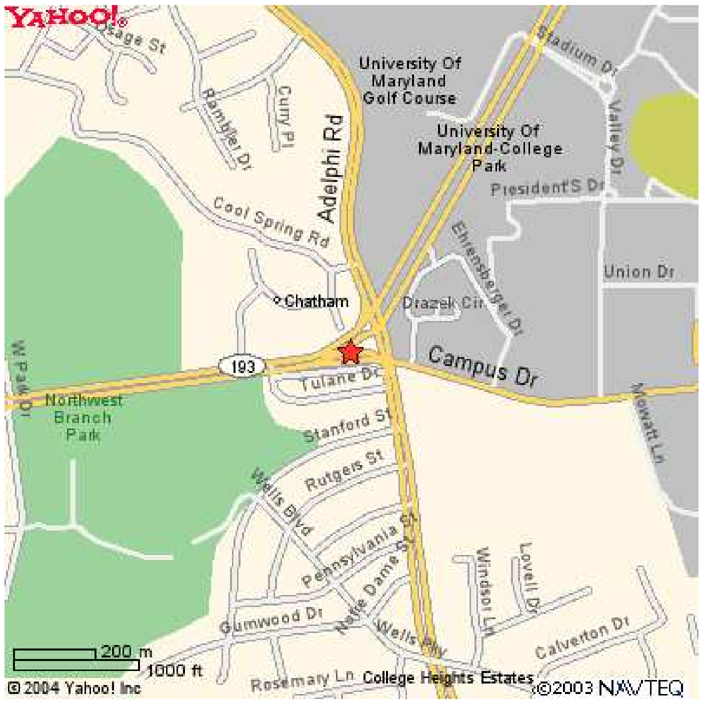
10:00 Coffee Break

10:30 Session 6: ALMA Science and The Needs of the Scientific User *K. Marvel (AAS), Chair*

- The North American ALMA Science Center
- Discussion

12:30 Lunch *(provided at the conference site and included in registration fee)*

Modified on Monday, 01-Mar-2004 09:20:51 MST



Map of meeting area at U. Md.

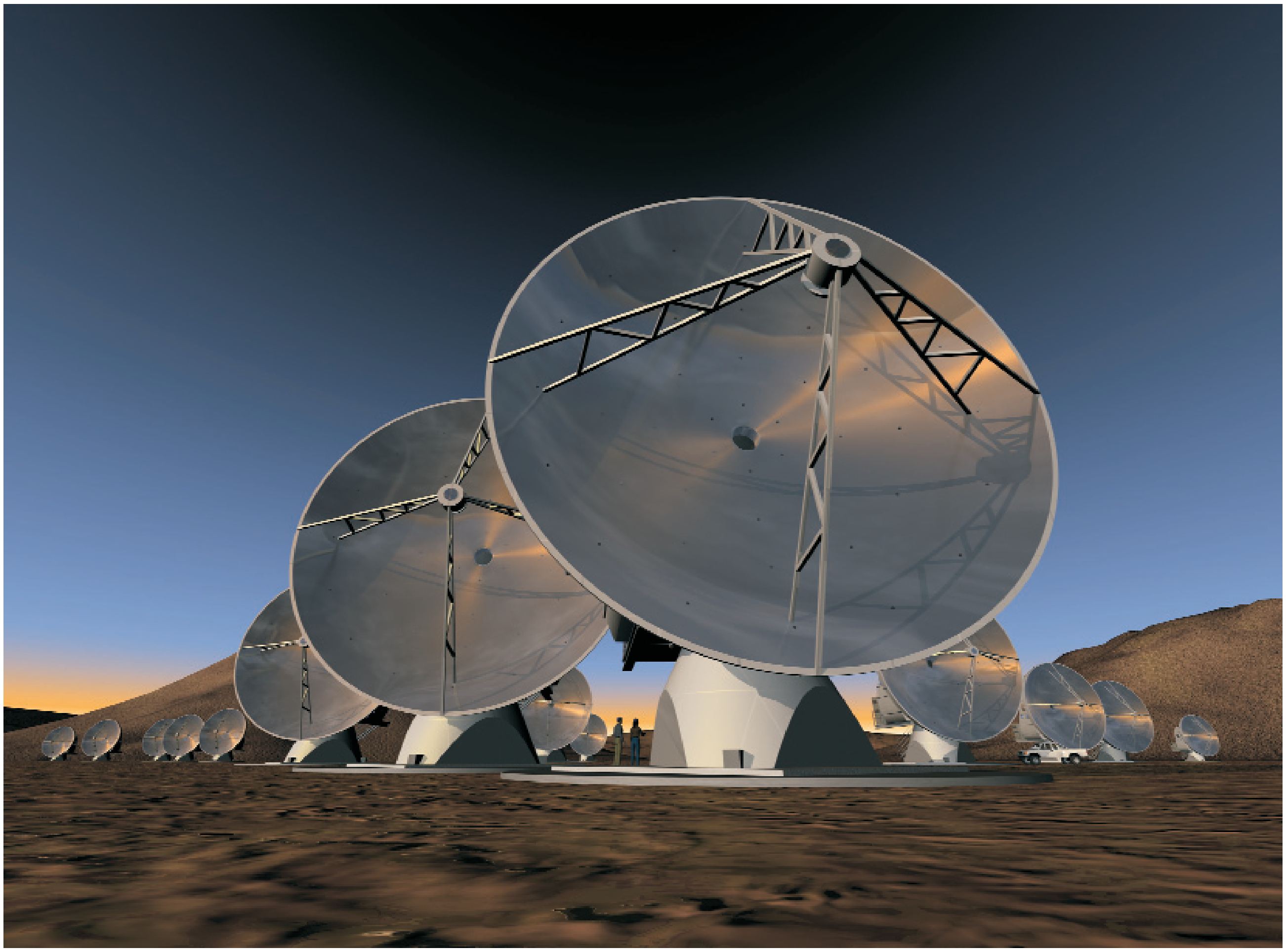
Chapter 2

Scientific Organizing Committee

- Chris Carilli (NRAO)
- Doug Johnstone (Herzberg Institute of Astrophysics)
- Lee Mundy (University of Maryland)
- Yancy Shirley (NRAO)
- Christine Wilson (McMaster University)
- Al Wootten (NRAO; Chair)
- Min S. Yun (University of Massachusetts)

2.1 Local Organizing Committee

- Al Wootten (NRAO; Chair)
- Lee Mundy (University of Maryland)
- Kevin Marvel (American Astronomical Society)
- John Trasco (University of Maryland)



Abstracts Submitted

Atmospheric Phase Correction Using Total Power Radiometry at the Submillimeter Array

James Battat, Raymond Blundell, James M. Moran, Scott Paine (CfA; jbattat@cfa.harvard.edu)

Phase noise caused by an inhomogeneous water vapor distribution in the atmosphere reduces the angular resolution, visibility amplitude and coherence time of millimeter and submillimeter wavelength interferometers. We present early results from our total power radiometry phase correction experiment carried out with the Submillimeter Array on Mauna Kea. From accurate measurements of the atmospheric emission along the lines of sight of two elements of the array, we estimated the differential atmospheric electrical path between them. In one test, presented here, the phase correction technique reduced the rms phase noise at 230 GHz from 72^o to 27^o over a 20 minute period with a 2.5 second integration time. This corresponds to a residual differential electrical path of 98 μm, or 15 μm of precipitable water vapor, and raises the coherence in the 20 minute period from 0.45 to 0.9.

Water Vapor Radiometry Assessment Using the Owens Valley Millimeter Array

A.J. Beasley (OVRO; tbeasley@ovro.caltech.edu), R.C. Bolton (OVRO), J.M. Carpenter (OVRO) & D.P. Woody (OVRO)

We report results from astronomical test observations involving bright calibrator sources taken simultaneously with antenna-based 22 GHz water vapor radiometer measurements. Comparison of the WVR brightness fluctuations with astronomical phase variations allows estimation of a brightness-phase scale factor, which can then be applied to weaker target sources. In this paper we will describe the technique under evaluation for the OVMA, some recent results and areas for further investigation. In the long run it is hoped that WVR measurements will provide extended coherent integration times and enable high-resolution observations during non-optimal observing conditions.

Invited Talk: Galaxies and Cosmology

Andrew W. Blain (CIT; awb@astro.caltech.edu)

In the last decade the millimeter, submillimeter and far-infrared wavebands have been opened up for detailed cosmological studies. Features in the cosmic microwave background have been used to constrain tightly several of the fundamental cosmological parameters. A new population of optically-faint but very luminous 'submillimeter' galaxies have been discovered at high redshifts, and are now known to contribute a significant fraction of all the energy radiated during the evolution of galaxies. In light of the launch of Spitzer Space Telescope and the development of the ALMA Design Reference Science Plan, I will review the exciting prospects for ALMA studies of high redshift galaxies, especially ultradeep fields and spatially resolved high-resolution spectroscopy.

W51B/W51C: Shock Triggered Star Formation?

C. L. Brogan (IfA; cbrogan@ifa.hawaii.edu), and C. J. Chandler (NRAO)

I will present recent JCMT observations of CO(3-2) emission toward the western boundary of W51B and W51C interface. W51C is a supernova remnant (SNR) that appears to be colliding with the backside of the W51B high mass star forming complex of HII regions. One signpost of SNR/molecular cloud interactions has already been observed at this boundary: OH (1720 MHz) masers. The goals of the current CO(3-2) observations are to determine the physical conditions in the shocked molecular gas containing the masers, and whether this gas is physically linked to the near by W51B HII region $G49.2-0.3$. Such an association could provide direct evidence for shock triggered star formation.

Design and Results of Water Vapour Radiometry Tests at the VLA

C. J. Chandler (NRAO; cchandle@nrao.edu), W. F. Brisken (NRAO), B. J. Butler (NRAO), R. H. Hayward (NRAO), and B. E. Willoughby (NRAO)

For the past year we have been testing a three-channel water vapour radiometer (WVR) on two VLA antennas. The output from one of the circularly-polarized feeds of a standard VLA 22-GHz receiver is split on exiting the dewar; one signal path leads to a temperature-stabilized plate on which the WVR detection system is mounted, the other leads to the normal astronomical system electronics. We measure the correlation between astronomical phase (assumed to be dominated by the troposphere), ϕ, and the WVR difference output from the two antennas, on various timescales. We find that in all cases applying a correction derived from the WVR improves the rms phase, for observing frequencies ranging from 8 GHz to 43 GHz. The improvement is most dramatic when the sky is clear and the tropospheric phase fluctuations are large. When there are clouds present the WVR output is contaminated by the fluctuations in system temperature caused by liquid water, and the correlation between ϕ and the WVR output is not as good. However, even in this case the rms phase is still improved by applying a correction derived from the correlation. Plans for a five-channel system based on MMIC technology, to be implemented on the EVLA, are also presented.

Relative Stellar Disk and Halo Masses in the Centers of Barred Spiral Galaxies

M.Das (U. Md.;mousumi@astro.umd.edu, G.Petitpas (U. Md.), P.J. Teuben (U. Md.), and S.N. Vogel (U. Md.)

We use observations of the gas kinematics to determine the relative masses of the stellar disk and the dark matter halo in barred galaxies. The gas flow in bars depends on the non-axisymmetry in the stellar mass distribution; so a comparison of the simulated and observed velocity field in a bar can be used to determine the contribution of the stellar mass to the total dynamical mass. This reveals to what extent the "Maximum Disk" is achieved in barred spiral galaxies. We have applied this technique to a sample of nearby barred galaxies. The observed velocity fields were derived from CO observations based in part on the BIMA SONG sample. The stellar potential was derived from the K band images and the halo potential was determined from the large scale HI distribution. Hydrodynamical simulations of gas flow in the potentials were used to generate velocity fields that were compared with observed CO gas kinematics in the bar. These simulations enable us to derive the relative stellar and dark matter masses in these galaxies. We present preliminary results of our investigation for two galaxies, NGC 3627 and NGC 5457, and also discuss the techniques used in our study. This research was supported by the NSF grant AST-0228974 to the University of Maryland.

Imaging the Black Hole in the Center of the Galaxy: ALMA and submm-VLBI

Sheperd Doeleman, (MIT Haystack Observatory; sdoeleman@haystack.mit.edu)

There is now abundant evidence that the compact radio source SgrA* marks the position of a massive black hole at the center of the Galaxy. Measured stellar orbits, proper motion studies, detection of polarized emission, identification of IR and X-ray flares, and sizes derived from Very Long Baseline Interferometry (VLBI) effectively rule out all but the most exotic and improbable black hole alternatives. What remains missing is the detection of an unambiguous 'event-horizon' signature and, once found, the means to study strong GR and accretion/outflow effects in the *immediate* environment of a massive black hole.

With its combination of large collecting area, mm/submm frequency range and location in the Southern Hemisphere, ALMA will be the essential element of a high frequency VLBI array capable of making detailed images of SgrA*. Use of new VLBI recording systems with bandwidths of 4 Giga-bits/second and higher will further boost the sensitivity of this VLBI array. Initial VLBI observations at 230 GHz with resolutions of 35 micro arc seconds (5 Schwarzschild radii for SgrA*) could be carried out using only a small number of ALMA dishes phased together. A fully phased ALMA array with all dishes will enable even higher frequency VLBI observations with resolutions at the 3 Schwarzschild radii level. Strong GR effects, including the 'shadow' expected to be observed as a result of light bending near the event horizon, will be targets of this VLBI array.

Building VLBI requirements into ALMA design, including the ability to phase and sum signals over the entire ALMA array, can make this Galactic Center project a unique early science result for ALMA. We discuss the scientific objectives, technical requirements, and capabilities of a submm VLBI array anchored by ALMA.

Invited Talk: Star and Planet Formation

Neal J. Evans II (U. Texas; nje@astro.as.utexas.edu)

After a general overview of the issues involved in the formation of stars and planets, I will report on recent work that helps to set the stage for ALMA. The discussion will include the issues involved in understanding massive, clustered star formation, and its connection to starburst galaxies. Then I will discuss the outstanding questions about the formation of relatively isolated, low-mass stars. The latter provide good laboratories for studying the formation of planetary systems. Finally, ALMA will be placed in the context of other missions that will precede it or run concurrently.

SCUBA2: A Submillimeter Bolometer Array Camera for the JCMT

Michel Fich (U. Waterloo), Pierre Bastien (U. de Montréal), Mark Halpern UBC), George Mitchell (St. Mary's University), David Naylor (U. of Lethbridge), and Wayne Holland (ATC, ROE)

SCUBA-2 will be a submillimeter wavelength bolometer array camera installed on the James Clerk Maxwell Telescope. A consortium of institutions in the UK, Canada, and the US are currently making this second-generation camera and it is expected that first science operations will begin in May 2006. SCUBA-2 will have a mapping speed a factor of one thousand times greater than SCUBA, the current JCMT camera. It will operate simultaneously at both 450 and 850 microns and will have two ancillary instruments: a polarimeter and a Fourier Transform Spectrometer. In this poster we will describe the current status of the instrument and plans for a number of large scale surveys that are expected to make up the bulk of the observing time with SCUBA-2.

New Scientific and Technical Developments at the Arizona Radio Observatory

L.M. Ziurys, A.J. Apponi, H.A. Fagg, T.W. Folkers, D.C. Forbes, W.A. Peters, B. Vila-Vilaro, P.A. Strittmater, C.S. Savage, D.T. Helfer, S. Milam, S.S. Doeleman and T. Krichbaum (Arizona Radio Observatory; tfolkers@hamms.as.arizona.edu)

We present a summary of the technical upgrades and developments that have taken place on both Arizona Radio Observatory telescopes, the 10m HHSMT and the KP 12m. Some of the scientific highlights that have occurred since those upgrades are also shown, including trasatlantic 2mm and 1.3mm VLBI observations, detections of several new molecular species in the ISM, etc.

Chemistry of Extrasolar Cometary Systems: What Can ALMA Do?

K. E. Saavik Ford (DTM)

The detection of water vapor (Melnick et al. 2001) and OH (Ford et al. 2003) around the carbon-rich AGB star, IRC+10216, has been interpreted as evidence for the existence of an extrasolar cometary system orbiting IRC+10216. This interpretation is based on the expectation that no oxygen-bearing molecules other than CO, and small amounts of SiO and HCO+, would be found in such a carbon-rich environment. The cometary system in IRC+10216, analogous to the Solar System's Kuiper Belt, should be the source of all oxygen-bearing molecules other than CO, SiO or HCO+ detected around the star. We discuss the recent detection of formaldehyde (H2CO) in the circumstellar envelope of IRC+10216, based on observations with the IRAM 30-m telescope. We will also discuss how ALMA could improve upon these observations in IRC+10216, and how ALMA could contribute to our understanding of the chemical composition and spatial distribution of other extrasolar cometary systems.

Disks and outflows towards high-mass protostars

Andy Gibb (U. Md.; agg@astro.umd.edu), Lee Mundy (U. Md.), Friedrich Wyrowski (MPIfR) and Melvin Hoare (U. of Leeds)

We present high-resolution BIMA observations of a number of regions of massive star formation at 2.7 and 1.4 mm. These studies are aimed at probing the detailed structure of the gas and dust on scales of 500 to 10 000 AU around young massive stars, in particular the disk-outflow geometry.

Observations of a sample of massive young stellar objects show that on scales of less than 1000 AU, the ionized wind contributes a significant proportion of the flux density at 2.7 mm, limiting our sensitivity to the dust emission. However, in the case of GL 490, which has a relatively weak wind, we clearly resolve the continuum emission into an elongated structure approximately 700 AU in diameter, orientated perpendicular to the CO outflow and near-infrared reflection nebula. Spectral line observations reveal a velocity gradient along the major axis of the dust emission, although it does not appear to show Keplerian rotation. It seems likely that this structure represents a circumstellar disk.

In a companion project, observations of a sample of hot cores shows that they are compact massive dust cores, which also appear to be rotating, and confirms the presence of outflows from embedded massive sources. The outflows are clearly bipolar, and appear to be collimated albeit relatively poorly given our resolution. These observations also highlight some of the likely future challenges involved for CARMA and ALMA studies of hot cores, with the high density of lines ($\sim$40 in a 1.8-GHz bandwidth) making it difficult to isolate the underlying continuum, but with the potential reward of a large number of images in many lines. The forecast for highly-detailed studies, therefore, looks excellent.

Invited Talk: Solar System Science with ALMA

Mark Gurwell (CfA; mgurwell@cfa.harvard.edu)

Big or small, near or far, all the denizens of our solar system will be 'reachable' with ALMA. ALMA will provide incomparable opportunities for studies of gas giant atmospheres, terrestrial planet surfaces, atmospheric circulation, and chemistry, the nuclei and 'atmospheres' of comets, and the solid surfaces of moons, asteroids, and KBOs. Come hear why planets aren't just flux calibrators anymore!

Finding Fast Switching Calibrators for ALMA

M.A.Holdaway (NRAO/Tucson), C.Carilli (NRAO/Socorro) and R.Laing (ESO/Garching)

In order to perform fast switching phase calibration effectively, we need to have a database of bright point-like sources at millimeter wavelengths. Optimally, this would include flux measurements at 86 GHz and spectral information at higher frequencies.

We present a sample of 31100 compact flat spectrum radio sources with $-40 < \delta < +60$, presumed extragalactic, which will be likely candidates for calibrator sources. We estimate that source variability at 4.85 GHz will deliver another 2800 sources which will be likely to be bright at 86 GHz, and may pick up a few more sources from other means, so we expect our sample will stand at approximately 35000 sources.

The Prototype Interferometer (PI) at the ALMA Test Facility (ATF) may be available to verify if these sources are indeed bright at 86 GHz, thereby making an early start to a programm which will form a major part of ALMA commissioning. The sensitivity of the prototype receivers should permit a noise level of about 3.5 mJy at 86 GHz and about 10 mJy at 250 GHz. We expect about a third of the sources will be brighter than 20 mJy at 86 GHz, and these detections will be reobserved at 86, 106, 215, and 263 GHz to determine the spectrum at higher frequencies and to have some data on variability. These observations should take about 80-90 days of time on the Prototype Interferometer, and it is suggested that these observations could be done at night in the spring and fall of 2005, subject to availability of equipment and manpower.

Atomic and Molecular Gas in Early Stage Interacting Systems

Daisuke Iono (U. Mass., CfA), Min S. Yun (U. Mass.) and Paul T. P. Ho (CfA)

We present HI and CO (1–0) observations of 10 equal-mass interacting systems obtained using the Very Large Array (VLA) and the Owens Valley Radio Observatory (OVRO). These sources are selected from previously published optical and CO (1–0) interacting galaxy surveys based on their size ($M_B \leq -19$), projected nuclear separation and the single dish CO (1–0) content ($S_{CO} \geq 20$ Jy Km/s), and the sample primarily consists of systems that have recently undergone the initial pericentric passage (i.e. early stage interacting systems). These results are analyzed in conjunction with a control sample of 20 nearby isolated systems in the BIMA SONG sample. It is found that the molecular gas in interacting systems is much more extended than in isolated systems, and that the fraction of molecular gas (M_{H_2}/M_{gas}) is higher in the perturbed disks. From these results and an analysis of a simulated disk-disk collision, it is inferred that the gas dissipation in the models occurs too quickly, and the validity of the assumptions and approximations made in the simulations are reviewed. A new merger sequence is proposed using 5 independent observational parameters, and this is found to be independent of the projected nuclear separation of the disks. Finally, discussion of the scientific goals achievable at ALMA is given in a context of observing gas and dust of nearby and high-z interacting systems.

Propagating Star Formation Around Single O Star HII Regions

Lewis B.G. Knee (HIA), Charles R. Kerton (Iowa State U.) and Christopher M. Brunt (FCRAO, U. Mass.)

The nearby quiescent clouds which only form low mass stars are not the main sites of star formation in the Galaxy. The vast majority of stars of all masses form in regions in which rare but prominent high mass O stars are born. It is thus important to understand the processes and modes of star formation on small scales in the harsh environment of HII regions/PDRs around O stars. Studying such phenomena is difficult in the HII regions of O star groups or clusters because their large physical size and complexity makes difficult isolation of the effects of individual O stars from the collective effects of the cluster. The large physical size (many parsecs) of typical evolved HII regions also makes the complete study of nearby HII regions, like Orion, problematic. In contrast, small HII regions associated with more distant isolated O stars are ideal targets for the study of star formation in such non-quiescent environments. Their small size permits easier acquisition of the multiwavelength data needed to trace all of the relevant physical components (HII, HI, H_2, stars) and the confusion caused by the effects of multiple O stars is avoided. We are involved in a multiwavelength program of observations of a set of isolated single O star HII regions selected from the Canadian Galactic Plane Survey. Here, we present our science program and preliminary results from our ongoing SCUBA JCMT dust continuum and SEQUOIA FCRAO spectral line observations.

Invited Talk: Stars and their Evolution

M. Meixner (STScI; meixner@stsci.edu)

Millimeter and submillimeter interferometry has revealed the nature of stars from their photospheres to their ejected circumstellar envelopes that enrich the interstellar medium. Their relative simplicity makes them excellent targets for basic studies of astrophysical processes such as dust formation. I will review our current state of knowledge of stars and their evolution as viewed at submillimeter and millimeter wavelengths, ending with some open issues in the field. Potential ALMA work on this topic, e.g. the DSRP, will be outlined at the end and its synergy with current and future missions will be highlighted.

Detecting Missing Galaxies at High Redshift with ALMA

Kentaro Nagamine (CfA; knagamin@cfa.harvard.edu, Renyue Cen (Princeton U. Obsy.), Lars Hernquist (IoA, U. of Cambridge), Jeremiah P. Ostriker (IoA, U. of Cambridge), & Volker Springel (MPIfA)

We study the evolution of the global stellar mass density in a ΛCDM universe using two different types of hydrodynamical simulations (Eulerian TVD and SPH) and the analytical model of Hernquist & Springel (2003). We find that the theoretical calculations all predict both a higher stellar mass density at $z \sim 3$ than indicated by current observations, and that the peak of the cosmic star formation rate history should lie at $z > 5$. Such a star formation history implies that as much as (70%, 30%) of the total stellar mass density today must already have formed by $z = (1, 3)$. Our results suggest that current observations at $z \sim 3$ are missing as much as 50% of the total stellar mass density in the Universe, perhaps owing to an inadequate allowance for dust obscuration in star-forming galaxies, limited sample sizes, or cosmic variance. If dust extinction is the major cause for this 'missing stellar mass', then observations in the submm and millimeter wavelengths using ALMA may enable us to detect galaxies unaccounted for at high redshift. According to the theoretical models, ALMA could identify an amount of stellar mass equal to or larger than that residing in the galaxies detected so far in optical and near-IR wavelengths. We also compare our results with some of the updated semi-analytic models of galaxy formation.

cf. astro-ph/0311294

Current performance and measurements of the SMA antennas

Nimesh Patel (CfA; npatel@cfa.harvard.edu), T. K. Sridharan (CfA), Todd Hunter (CfA), James Bataat (CfA)

All eight antennas of the Submillimeter Array are now deployed and equipped with receivers operating in the 230 and 345 GHz bands. Six of the antennas also have the 690 GHz receivers. Initial science observations have been ongoing for the past several months (see accompanying poster by Zhang et al.). The specifications for SMA, driven by science goals pose a series of significant technical challenges. The lessons learned while commissioning the SMA will be useful for the construction and testing of the ALMA antennas.

Here we present the current status of the antenna measurements, with emphasis on pointing and holography. The mount errors in the pointing model are characterized using optical guidescopes on each antenna. Radio pointing offsets are measured primarily at 230 GHz from continuum scans across planets (using synchronous detection with the chopping secondary). Feed-offset terms for the other bands are determined for each of the receivers with respect to the 230 GHz feed using planet scans.

The antenna surface is set by adjusting panels following holographic measurements carried out at 232.4 GHz, using a terrestrial beacon in the near-field. We have achieved the goal of 12 μm rms surface accuracy on one antenna. The rest are at 13—25 μm and are being improved.

In this poster we also present some details of the implementation of the automatic tuning of receivers, and atmospheric phase correction using total power radiometry.

VLA Searches for Glycine and Other Molecular Explorations

Jeffrey A. Pedelty, NASA

Amino acids are basic constituents of life, and recent laboratory experiments demonstrate they can be synthesized in the gaseous nebulae that are the birthplaces of stars. Amino acids and other complex organic molecules are formed in the laboratory when ice mixtures representative of interstellar grain mantles are subject to UV radiation similar to that produced by young stars. We describe sensitive searches with the VLA that did not detect the lowest energy form of glycine (conformer I) in the Orion Molecular Cloud (OMC-1) and Sagittarius B2(N-LMH). If glycine exists in these regions, it is weaker than our detection limit, is distributed across a wider spatial region than other large molecules, or is primarily in its high-energy form (conformer II).

We also present VLA observations of the organic molecules formic acid and methyl formate in OMC-1 and ethyl cyanide in Sagittarius B2(N-LMH) that indicate the molecules are in compact sources. The ethyl cyanide data reveal a rotating edge-on gaseous disk 0.1 pc in diameter and containing 2600 solar masses of gas or other material.

This poster summarizes results that were published last year in two papers in the Astrophysical Journal:

A Sensitive Very Large Array (VLA) Search For Small-Scale Glycine Emission Toward OMC-1, J. M. Hollis, J. A. Pedelty, L. E. Snyder, P. R. Jewell, F. J. Lovas, P. Palmer, and S.-Y. Liu. 2003, Astrophysical Journal, 588, 353. Kinematics of the Sagittarius B2 (N-LMH) Molecular Core, J. M. Hollis, J. A. Pedelty, L. E. Snyder, D. A. Boboltz, S.-Y. Liu, L. E. Snyder, P. Palmer, F. J. Lovas, and P. R. Jewell. 2003, Astrophysical Journal (Letters), 596, L235.

Dense Molecular Gas in the Tidal Tail of Stephan's Quintet

Glen Petitpas (U. Md.; petitpas@astro.umd.edu) and Chris Taylor (CSU Sacramento; ctaylor@csus.edu)

We present high resolution ^{12}CO J=1-0 observations of the candidate tidal dwarf galaxy in the eastern tail of Stephan's Quintet (HCG92). Within the 100$''$ field of view we detect three clumps of emission that may be partially resolved at our resolution of 6$''$. Two of the clumps lie in the tidal tail, while the third lies to the southeast and is coincident with a large HI feature, but does not correspond to any features at optical wavelengths. Dynamical analysis indicates that these candidate tidal dwarfs are gravitationally bound, and will survive to join the dwarf galaxy population of this system. We compare these results taken with BIMA to the advances in this field that will be provided by the ALMA array.

Construction of the third generation IRMA 20μm water vapour monitor for astronomical phase correction.

Robin R. Phillips (U. of Lethbridge; robin.phillips@uleth.ca), David A. Naylor (U. of Lethbridge) & James Di Francesco (HIA)

The Infrared Radiometer for Millimetre wavelength Astronomy (IRMA) is a compact, light weight, low cost, low maintainance water vapour monitor, with an accuracy that enables it to be used to correct the phase distortions caused by atmospheric water vapour in millimetre wavelength interferometers. The IRMA III prototype is a major improvement on earlier versions of IRMA, with an emphasis on simplicity and reliability. We present details of its modified design and construction in preparation for tests to be conducted on the Smithsonian SubMillimeter Array (SMA) telescope on Mauna Kea in May/June 2004. The test campaign involves using three IRMA III devices with the SMA to provide phase correction information for improving the quality of the astronomical interferometric data.

Conditions for observing with the ALMA at Chajnantor

Simon Radford, (NRAO)

The international Atacama Large Millimeter Array will be constructed on the high (5050 m) plateau southwest of Cerro Chajnantor, Chile, about 40 km east of the village of San Pedro de Atacama. Starting in 1995 April, the ALMA project has deployed an extensive suite of instruments to characterize atmospheric conditions at These instruments include a 225 GHz tipping radiometer to measures atmospheric transparency and temporal emission fluctuations, two 11 GHz interferometers to measure atmospheric phase fluctuations, two 183 GHz line radiometers to measure the water vapor content and test techniques to compensate for phase fluctutations, a submillimeter tipping photometer to measure the atmospheric transparency at 350 μm wavelength, radiosonde launches, a precision hygrometer, and other meteorolgical instruments. Submillimeter Fourier transform spectrometers have also been operated at Chajnantor.

These measurements since have demonstrated Chajnantor is a premier site for observations at millimeter and submillimeter wavelengths, with exceptional atmospheric conditions. In comparison to other observatory locations, the atmospheric transparency and phase stability at Chajnantor are better more often than at Mauna Kea and the transparency is competitive with the South Pole. At Chajnantor, the best conditions occur early in the morning during the winter. There are significant correlations between several of the meteorological parameters, in particular the transparency and the phase stability.

The NRAO is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.

Probing the Mysterious Onset of Bipolarity in Dying Stars

Raghvendra Sahai, (JPL; raghvendra.sahai@jpl.nasa.gov)

Observationally, it is well established that planetary nebulae (PNe) show a dazzling variety of elliptical and bipolar morphologies (e.g. Sahai & Trauger 1998), whereas AGB stars are surrounded by roughly spherical gas-dust envelopes resulting from dense, slow ($\sim$5-15 km s^{-1}) stellar winds ejected with rates up to 10^{-4} M$\odot$yr^{-1} (e.g., Neri et al. 1998). In the very short (10^3 yr) transition period between the AGB and planetary nebula (PN) phases, some physical process (or processes) becomes operational which accelerates, and imposes bipolarity upon, most circumstellar outflows (proposed theories usually require binary systems, rotation, and/or strong magnetic fields). Pre-Planetary nebulae (PPNe) - objects in transition between the AGB and PN evolutionary phases - hold the key to some of the most vexing problems in our understanding of these very late stages of evolution for low and intermediate mass stars. Although at present there is no consensus for what causes the change from a spherical wind to bipolar mass-loss in these stars, fast collimated outflows or jets, which become operational during the PPN and/or very late AGB phase, have been hypothesized as the primary mechanism (Sahai & Trauger 1998).

Millimeter-wave interferometric observations offer one of the best probes of the dynamics and energetics of the shock acceleration process, which transfers a substantial amount of directed momentum to large parts of the dense AGB wind. The simultaneous availability of high spatial and spectral resolution makes mm-wave interferometry a uniquely valuable probe of the complex processes which result in the shaping of the circumstellar environment. In this paper, we describe how a combination of HST imaging and ground-based interferometric observations of molecular-line (and continuum) emission is providing new insights into the mass-loss history of dying stars. We draw upon both published results as well as those from our current, ongoing surveys with OVRO and HST. As already demonstrated by our HST results, the substantial increase in sensitivity and angular resolution which will be enabled by ALMA over current mm-wave observations, is likely to produce new challenges to existing paradigms for, and new breakthroughs in our understanding of, the dramatic transformation of round AGB mass-loss envelopes into bipolar/multipolar PNe.

Spiral Arm Streaming in M51

Rahul Shetty (U. Md.; shetty@astro.umd.edu), Stuart Vogel (U. Md.), Peter Teuben (U. Md.), and Eve Ostriker (U. Md.)

We describe and evaluate methods for estimating streaming velocities as a function of arm distance in a spiral galaxy, and apply these to BIMA CO 1-0 and Fabry-Perot Hα observations of the grand design spiral M51. Both CO and Hα give generally consistent streaming profiles, but the profiles vary significantly with location within the galaxy. We apply mass and angular momentum conservation relations to obtain estimates of the spiral pattern speed and of variations in CO emissivity. Using the streaming velocity profiles, we compare tidal and quasi-stationary density wave models for the origin of the spiral arms.

Integrating Single Dish and Interferometric Dust Continuum Observations of Low-mass Protostars: An Example for ALMA

Yancy L. Shirley (NRAO), Lee G. Mundy (U. Md.) and Neal J. Evans II (U. Tx. at Austin)

Current theoretical models of low-mass (M $<$ few M_{sun}) star formation predict the evolution of the density, temperature, and velocity structure within the envelope of the core. In particular, the density profile as a function of radius is a strong discriminator between theoretical models. Submillimeter and millimeter dust continuum is a powerful probe of the physical conditions in the envelopes of star-forming cores since the optically thin emission is sensitive to the density, temperature, and opacity structure along the line-of-sight. Recent surveys with the single-dish bolometer camera, SCUBA, have imaged the continuum emission on large scales (10^3 to 10^4 AU) towards more than 50 Pre-protostellar cores, Class 0, and Class I cores. State-of-the-art radiative transfer models account for heating from the interstellar radiation field and/or an internal source, beam convolution, and chopping. By simultaneously matching the observed continuum intensity profiles (at multiple wavelengths) and the observed spectral energy distribution, the models constrain the physical structure of the core. However, the models are unable to place strong constraints on the conditions within the central beam, typically on scales $\leq 10^3$ AU. Interferometric continuum imaging is vital for probing the inner envelope structure and constraining the emission properties of a disk.

Integrated radiative transfer models of SCUBA 850 and 450 μm observations and BIMA 2.7 mm observations of the Class 0 core, L1527 are presented. We discuss the early-science capabilities of ALMA to do the same experiment with higher sensitivity and at the same wavelength as the single-dish observations.

Resolving the Host Galaxy of the Nearby QSO I Zw 1 with Sub-Arcsecond Multi-Transition Molecular Line Observations

J.G. Staguhn (GSFC, U. Md., SSAI; staguhn@stars.gsfc.nasa.gov), E. Schinnerer (NRAO), A. Eckart (U. Koln) and J. Scharwächter (U. Koln)

We present the first sub-kpc ($\sim 0.7'' \approx 850$ pc) resolution ^{12}CO(1-0) molecular line observations of the ISM in the host galaxy of the QSO I Zw 1. The observations were obtained with the BIMA mm-interferometer in its compact A configuration. The BIMA data are complemented by new observations of the ^{12}CO(2-1) and ^{13}CO(1-0) line with IRAM Plateau de Bure mm-interferometer (PdBI) at $0.9''$ and $1.9''$ resolution, respectively. These measurements, which are part of a multi-wavelength study of the host galaxy of I Zw 1, are aimed at comparing the ISM properties of a QSO host with those of nearby galaxies as well as to obtain constraints on galaxy formation/evolution models. Our images of the ^{12}CO(1-0) line emission show a ring-like structure in the circumnuclear molecular gas distribution with an inner radius of about 1.2 kpc. The presence of such a molecular gas ring was predicted from earlier lower angular resolution PdBI ^{12}CO(1-0) observations. A comparison of the BIMA data with IRAM PdBI ^{12}CO(2-1) observations shows variations in the excitation conditions of the molecular gas in the innermost $1.5''$ comprising the nuclear region of I Zw 1. The observed properties of the molecular cloud complexes in the disk of the host galaxy suggest that they can be the sites of massive circumnuclear star formation, and show no indications of excitation by the nuclear AGN. This all indicates that the molecular gas in a QSO host galaxy has similar properties to the gas observed in nearby low luminosity AGNs.

See http://arxiv.org/abs/astro-ph/0403538

Simulations of Velocity Fields of Disk Galaxies

Peter Teuben (U. Md.;teuben@astro.umd.edu) and Rob Swaters (U. Md.)

Extracting velocity fields from data cubes, and the subsequent analysis of velocity fields to derive rotation curves and mass models for disk galaxies is subject to many observational and computational biases. The recently completed BIMA CO(1-0) Survey of Nearby Galaxies (SONG) prompted us to revisit some of the issues in this area. We simulate interferometric array observations of model rotating disk galaxies, and investigate methods for optimum extraction of dynamical parameters.

Predictions on the observability of molecular lines at high redshifts: LMT and ALMA

O. Vega (INAOE), M. Chavez (INAOE; mchavez@inaoep.mx), A. Bressan (INAF, SISSA), G. L. Granato (INAF, SISSA), L. Carrasco (INAF, SISSA) and D. Mayya (INAF, SISSA)

We study the molecular clouds environment in local Luminous Infrared Galaxies, aimed at understanding and modelling its evolution in the more extreme conditions that characterize high redshift star forming galaxies. To this purpose, we present a new method that rests on a consistent comparison of the results of the global (from UV to radio) continuum SED fitting, with the analysis of molecular line emission. The SED fitting, performed with GRASIL a population synthesis code that accounts for star-light reprocessing by dust in molecular clouds and cirrus component, provides us with the mass of molecular gas, and the optical depth of the molecular clouds. These quantities are used to constrain the analysis of the observed molecular line emission, made by assuming the Large Velocity Gradients Approximation. Preliminary results highlight the role of the denser regions that enshroud the young stellar clusters. They dominate the optical depth of molecular clouds and are responsible of the HCN emission, and a large fraction of CO(3-2), CO(2-1) and even CO(1-0) emission. This new model allow us to explore and compare the capabilities of ALMA and LMT in detecting CO in high z galaxies, with different level of star formation activity.

Spectral Line On-The-Fly Mapping at ARO (Arizona Radio Observatory)

B. Vila-Vilaro (ARO),J. Bieging (SO), J. Bally (CASA), P. Maloney (CASA), T. Folkers (ARO), W. Peters (ARO), and D. Forbes (ARO)

Spectral On-The-Fly mapping is a very powerful tool for observations of bright extended regions on the sky. With the upgrade to a new faster control system on the HHSMT (ARO) sub-mm telescope it is now possible to carry out this observing mode at both ARO telescopes (i.e., HHSMT and KP 12m), using all the backends simultaneously, with time resolutions of 100ms. We present preliminary results using this technique on both to map several well-known galactic molecular regions.

Zeroing In on Dense Cores: Early Results from the BIMA Survey of Cores in the Perseus Cloud

N. H. Volgenau (U. Md.; volgenau@astro.umd.edu), L. G. Mundy (U. Md.) and L. W. Looney (U. Ill.)

Standard star formation theory begins with isolated dense cores that evolve quasi-statically, but observations show that cores create stars in environments that are turbulent and interactive. This discrepancy has led to the recent swell of theoretical work and numerical simulations that shows how star formation might occur under turbulent conditions. The key discriminators between the two scenarios are the detailed kinematics (velocity fields) and the physical conditions (*e.g.* shape, density, temperature distribution) of cores as they approach and cross the star formation threshold. We examine the role of turbulence in core evolution by mapping dense cores in the Perseus Cloud. Our sample is drawn from the survey of Perseus cores observed with the Berkeley-Illinois-Maryland Association (BIMA) interferometer in the 2.7 mm continuum and the $C^{18}O$ $J = 1 \rightarrow 0$ line. We use the optically thin $C^{18}O$ line emission to trace the core kinematics. The high resolution maps indicate that the velocity fields are complex down to scales of 100s of AU; in general, the velocity fields are not dominated by systematic gradients indicative of simple rotation or related to the degree of multiplicity. Furthermore, the observed emission line widths do not decrease systematically at higher resolutions. The dispersion in measured line widths increases on small scales, similar to the behavior seen in models of turbulent clouds. The minimum line widths are generally consistent with sonic turbulence (the H_2 sound speed) rather than thermal broadening of the emitting molecule.

This research is supported by NSF grant AST-0028963.

What could the ALMA find in the galactic central regions?

Keiichi Wada, Kohji Tomisaka (NAOJ)

We have performed three-dimensional, non-LTE radiative transfer calculations for ^{12}CO and ^{13}CO lines, using our high-resolution, time-dependent hydrodynamical 3-D models of the 'torus' around supermassive black hole in the galactic center. The hydrodynamical simulations reveal inhomogeneous and turbulent gas structure and dynamics on a sub-pc scale in a circum nuclear starburst region. Thick disks interlaced with filaments, clumps and holes are naturally formed due to interplay among energy feedback from supernovae, self-gravity of the gas, galactic rotation, and radiative cooling. The intensity maps of the molecular lines for the circum nuclear disk show a clumpy structure that reflects the intrinsic inhomogeneous structure of the gas disk. The fine structure of the 'torus' could be resolved in the nearby active galaxies using the ALMA. We also found that the CO-to-H2 conversion factor is not uniformly distributed in the central 100 pc region. ^{12}CO (J=1-0) line intensity depends strongly on the intensity itself, whereas ^{12}CO (J=3-2) is nearly constant over two-orders of magnitude of the intensity. The X factor is also discussed.

Warm molecular gas in galaxy-galaxy merger NGC6090

Junzhi Wang (CfA, Peking U.;jwang@cfa.harvard.edu), Qizhou Zhang (CfA), Zhong Wang (CfA), Paul T. P. Ho (CfA), Giovanni G. Fazio (CfA), Yuefang Wu (Peking U.)

We present observations of the CO 2-1 and 3-2 transitions toward the merging galaxies of NGC6090 with the Submillimeter Array (SMA)[e]. The high resolution ($\sim 2''$) CO 2-1 data reveal three gas concentrations. The main component is peaking in the overlap region between the two galaxies, where the near-IR and radio continuum emission are weak. The CO 2-1 emission

from the face-on galaxy NGC6090E is somewhat stronger than that from the edge-on galaxy NGC6090W. The CO 3-2 emission peaks in the overlap region, similar to the CO 2-1 emission. More than 50% of the CO 3-2 emission arises from the $2''$ (1.2 kpc) area of the overlap region. There appears to be CO 3-2 emission toward the nuclear region and the north-west arm of NGC6090E, while no CO 3-2 emission is detected toward NGC6090W. Unlike the CO gas, most of the radio continuum emission comes from NGC6090E. The strong CO emission, together with the weak radio continuum emission, suggests that the star formation history in the overlap region has not proceeded long enough to produce significant numbers of supernovae which would be detectable with their strong radio continuum emission.

Submitted to ApJL

[e]The Submillimeter Array (SMA) is a joint project between the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics, and is funded by the Smithsonian Institution and the Academia Sinica.

BIMA Observations of the Solar Chromosphere

Stephen M. White (U. Md.), Maria Loukitcheva (St. Petersburg State U.) and Sami Solanki (MPIfAeronomy)

We have carried out BIMA observations of three distinct regions of the solar chromosphere in order to search for wave power predicted by simulations of convection to play a role in chromospheric heating. The millimeter images are compared with optical data to confirm the success of the observations. We have made movies of snapshot images using special maximum entropy deconvolution techniques developed for these data. We have spent some effort in testing these techniques, and show that they recover oscillating model test sources provided that they are located in regions where flux is present on average. We provide an explanation for the behaviour of the deconvolution process. Power is seen on timescales predicted to be present by the models, and analysis of the results is ongoing.

Probing molecular clouds in the LMC at high angular resolution

T. Wong (CSIRO ATNF, U. NSW), J. B. Whiteoak (CSIRO ATNF), M. Hunt (U. NSW), J. Ott (CSIRO ATNF) and Y.-N. Chin (Tamkang U.)

The Australia Telescope Compact Array (ATCA) is the first southern millimetre array, and thus an important forerunner to ALMA. A frequency-agile 5-element array is expected to be operational by 2004 June. In the past year, we have been using the prototype 3-element array to observe a dense molecular clump in the N113 region of the Large Magellanic Cloud. The results provide some insight into how the chemical abundances in the clump vary with size scale, but also underscore the importance of short baselines to fully recover flux from extended sources.

Hunting massive protostellar candidates for detailed ALMA followups

Friedrich Wyrowski (MPIfR; wyrowski@mpifr-bonn.mpg.de, Andy Gibb (U. Md.), Jennifer Hatchell (MPIfR), Thushara Pillai (MPIfR) and Mark Thompson (U. of Kent)

At the current stage of massive star formation (MSF) research it is crucial to find objects prior to the formation of hot cores and ultracompact HII (UCHII) regions. The evidence for so-called pre-proto-cluster cores – cold condensations on the verge of or already collapsing – is still missing. If such cores can be identified, analyzing their physical and chemical state will give us clues about the initial conditions and earliest phases of MSF. This led us to use the BIMA interferometer and the SCUBA array at the JCMT to search for secondary, cold condensations in the fields toward known UCHII regions, since many of them are located in clusters and at least in some cases one expects to find earlier phases of MSF and the raw material out of which massive stars form in the vicinity of UCHIIs. The results so far are very encouraging and provide us with a unique new sample of massive pre/protocluster candidates, currently followed up in various line tracers. Here we report on the current status of the project and put our results so far in perspective to the ALMA capabilities.

ALMA potential targets: High-z young/forming galaxies from Subaru wide-field deep surveys

Yamada, Toru (NAOJ; yamada@optik.mtk.nao.ac.jp)

We introduce the samples of high-redshift forming galaxies selected in Subaru deep and wide-field surveys which can be considered as excellent targets for ALMA observations. They are: (i) Lyα blobs (LABs) at $z < 3$. We have detected more than 30 LABs at z=3.1 in the proto large-scale structure in SSA22 field. They extend more than d $\sim 30kpc$ and provide candidates for forming massive galaxies. (ii) Luminous ($M_1 500 < -22$) and Large ($r_{hl} > 5kpc$) Lyman Break galaxies (LLLBGs) at $z \sim 4$ selected from Subaru/XMM-Deep Survey field (02h15m, -05d). SXDS is a wide-field (1.2 sq.deg) deep ($B < 27.5, V < 27, R < 27, i < 26.5, z < 25.5$) multicolor survey, which is coordinated with multi-wavelength observations with facilities such as XMM, GALEX, VLT, UKIRT (UKIDSS UDS), Spitzer(SWIRE), BLAST, JCMT SCUBA(SHADES), and VLA, etc. Besides LLLBGs, it may provide various excellent targets for ALMA. (iii) Lyα emission-line galaxies at $z = 4.9, 5.7, and 6.6$ in various fields. We discuss these objects as 'proto-typical' science targets of ALMA.

Dense Ionized Gas in Two Merging Nuclei of Arp 220

Min S. Yun (U. Mass.; myun@astro.umass.edu), N. Z. Scoville (CIT), and H. Shukla (Stanford Research Systems)

We have conducted H41α and 93 GHz continuum observations of the prototypical ULIRG Arp 220 using Owens Valley Millimeter Array in order to investigate the location and magnitude of the current massive star formation activity and the properties of the gas directly associated. Both the line and continuum emission are detected with a good S/N, and they are consistent with optically thin spontaneous emission near LTE condition. By analyzing together with the archival VLA H92α and multi-wavelength continuum observations, we found a substantial difference in the ongoing star formation activity between the two merging nuclei. The mean density of the ionized gas ($n_e = 10^{3-4}$ cm^{-3}) is lower than that of the molecular gas, and the total ionized gas mass ($M_{HII} = (1-3) \times 107 M_{\odot}$) is a few percent of the total molecular gas mass.

Early Science from the SMA

Qizhou Zhang (SAO, CfA; qzhang@cfa.harvard.edu) and the SMA Team (SAO, CfA and ASIAA)

The dedication of the Submillimeter Array in November 2003 marks the completion of the major construction of the project, and the beginning of routine astronomical observations. The Array consists of eight 6-meter antennas with 2 GHz IF bandwidth in each of two sidebands, currently operating in the 230, 345 and 690 GHz bands. In this poster, we will describe the scientific program undertaken in the past two years. We will present results obtained on solar system objects, young and evolved stars, the Galactic Center and nearby galaxies.

The SMA is a collaborative project of the Smithsonian Astrophysical Observatory (SAO) and the Academia Sinica Institute of Astronomy & Astrophysics of Taiwan (ASIAA).

Chapter 3

Information

3.1 Banquet

The banquet will be held at the University of Maryland Conference Center. It will be held on Friday, 14 May, 2004. Cocktails begin at 7 p.m. with a cash bar. Dinner will be served at 8 p.m.

3.2 Abstracts

Abstracts for posters will be available on-line and referenced at the ADS astronomy electronic literature service. LaTeX style forms are available at the WWW site; you are now holding the booklet of posters. This booklet has been made available to participants at the Conference and electronically on the Web site of the Conference about one week in advance. A copy of the Conference Abstracts will be provided to the Astrophysics Data System (ADS).

3.3 Communication

Telephone calls and faxes should be directed to the Business Office of the Inn and Conference Center at 301-985-7652; Fax No. 301-985-7850. Incoming calls and messages should state the intended recipient is attending the astrophysics conference. Messages will be posted on a Message Board near the meeting registration area. There are pay telephones available at several locations in the Center. There is no telephone available at the registration desk.

If you are staying at the Inn and Conference Center and have a laptop computer, all lodging rooms have internet connections. Check with the Business Office (located to the left of the conference registration desk) for information on the location of other internet connections in the building. If it is more convenient, you can use the computer facilities at the Department of Astronomy; a 15-20 minute walk from the conference site. Check with persons at the registration desk for details.

Callers and those sending faxes MUST identify the fact that the message is for someone attending the ALMA conference.

The telephone number is 301-985-7652
The fax is (301) 985-7445

3.4 Thanks

Thanks to Susan Lehr for running the conference machinery, to Marc Pound and Carolyn White for help with the web pages and to Pat Smiley for realization of the poster book.

Participant List

Beasley, Tony *email:* tbeasley@ovro.caltech.edu
Benford, Dominic *email:* dominic.benford@nasa.gov
Blain, Andrew *email:* awb@astro.caltech.edu
Boboltz, Dave *email:* dboboltz@usno.navy.mil
Brogan, Crystal *email:* cbrogan@ifa.hawaii.edu
Bronfman, Leonardo*email:* leo@das.uchile.cl
Butler, Bryan *email:* bbutler@nrao.edu
Carilli, Chris *email:* ccarilli@nrao.edu
Chandler, Claire *email:* cchandle@nrao.edu
Chavez, Miguel *email:* mchavez@inaoep.mx
Darling, Jeremy *email:* darling@ociw.edu
Das, Mousumi *email:* mousumi@astro.umd.edu
di Francesco, James*email:* james.difrancesco@nrc-cnrc.gc.ca
Doeleman, Shep *email:* dole@haystack.mit.edu
Emerson, Darrel *email:* demerson@nrao.edu
Evans, Neal *email:* nje@astro.as.utexas.edu
Fan, Xiaohui *email:* fan@as.arizona.edu
Fich, Mike *email:* fich@uwaterloo.ca
Folkers, Tom *email:* tfolkers@hamms.as.arizona.edu
Ford, K. E. Saavik*email:* saavik@dtm.ciw.edu
Gallimore, Jack F.*email:* jgallimo@bucknell.edu
Giacconi, Riccardo*email:* rgiaccon@aui.edu
Gibb, Andy *email:* agg@astro.umd.edu
Giovanelli, Riccardo *email:* riccardo@astro.cornell.edu
Guame, Ralph *email:* rgaume@usno.navy.mil
Gurwell, Mark A. *email:* mgurwell@cfa.harvard.edu
Gwon, Chul *email:* cgwon@astro.umd.edu
Hardy, Eduardo *email:* ehardy@nrao.edu
Harris, Andrew *email:* harris@astro.umd.edu
Haynes, Martha *email:* haynes@astro.cornell.edu
Hibbard, John *email:* jhibbard@nrao.edu
Holdaway, Mark *email:* mhodawa@nrao.edu
Infante, Leopoldo *email:* linfante@astro.puc.cl
Iono, Daisuke *email:* diono@cfa.harvard.edu
Johnstone, Doug *email:* doug.johnstone@nrc-cnrc.gc.ca
Joncas, Gilles *email:* joncas@phy.ulaval.ca
Kannappan, Sheila *email:* sheila@astro.as.utexas.edu
Kessler-Silacci, Jackie *email:* jes@astro.as.utexas.edu
Knee, Lewis B. G. *email:* lewis.knee@nrc-cnrc.gc.ca
Kundu, Mukul *email:* kundu@astro.umd.edu
Lai, Shih-Ping *email:* slai@astro.umd.edu
Langston, Glen *email:* glagnsto@nrao.edu
Lis, Darek *email:* dcl@submm.caltech.edu
Lloyd, James *email:* jpl@astro.caltech.edu
Lo, Fred *email:* flo@nrao.edu
Mardones, Diego *email:* mardones@das.uchile.cl

Marvel, Kevin B. *email:* marvel@aas.org
Matthews, Brenda *email:* brenda@astron.berkeley.edu
McMullin, Joseph *email:* jmcmullin@nrao.edu
Meixner, Margaret *email:* meixner@stsci.edu
Miller, Neal *email:* nmiller@h2.gsfc.nasa.gov
Moran, James *email:* moran@cfa.harvard.edu
Myers, Steven T. *email:* smyers@nrao.edu
Nagamine, Ken *email:* knagamin@cfa.harvard.edu
Narayanan, Gopal *email:* gopal@astro.umass.edu
Osten, Rachel *email:* rosten@nrao.edu
Patel, Nimesh A. *email:* npatel@cfa.harvard.edu
Pedelty, Jeff *email:* Jeff.Pedelty@nasa.gov
Petitpas, Glen *email:* petitpas@astro.umd.edu
Phillips, Robin *email:* robin.phillips@uleth.ca
Pound, Marc *email:* mpound@astro.umd.edu
Radford, Simon *email:* sradford@nrao.edu
Sahai, Raghvendra *email:* raghvendra.sahai@jpl.nasa.gov
Sanders, David B. *email:* sanders@ifa.hawaii.edu
Sarma, Anuj *email:* anuj.sarma@eku.edu
Seaquist, E. R. *email:* seaquist@astro.utoronto.ca
Shepherd, Debra *email:* dshepher@nrao.edu
Shetty, Rahul *email:* shetty@astro.umd.edu
Shirley, Yancy *email:* yshirley@aoc.nrao.edu
Silverberg, Robert*email:* Robert.Silverberg@nasa.gov
Sridharan, Tirvpat*email:* tksridha@cfa.harvard.edu
Staguhn, Johannes *email:* staguhn@stars.gsfc.nasa.gov
Tarenghi, Massimo *email:* mtarengh@eso.org
Taylor, Russ *email:* russ@ras.ucalgary.ca
Teuben, Peter *email:* teuben@astro.umd.edu
Thornley, Michele *email:* mthornle@bucknell.edu
Tilanus, Remo *email:* rpt@jach.hawaii.edu
Vanden Bout, Paul *email:* pvandenb@nrao.edu
Vila-Vilaro, Baltasar *email:*bvila@as.arizona.edu
Vogel, Stuart *email:* vogel@astro.umd.edu
Volgenau, Nikolaus*email:* volgenau@astro.umd.edu
Wada, Keiichi *email:* wada.keiichi@nao.ac.jp
Wang, Junzhi *email:* jwang@cfa.harvard.edu
Webb, Tracy *email:* webb@strw.leidenuniv.nl
White, Stephen *email:* white@astro.umd.edu
Wiklind, Tommy *email:* wiklind@stsci.edu

Overview of all DRSPs - with links to general list. Also accessible here.

	Title	Lead author	No. of hours	
Theme 1:	**Galaxies and Cosmology**			
1.1	*The high-redshift universe*			
1.1.1	Unbiased survey of submm galaxies: continuum survey at 1 mm	Guilloteau	80	DRSP
1.1.2	Unbiased survey of submm galaxies: combined line+cont at 3 mm	Guilloteau	256	DRSP
1.1.3	Unbiased survey of submm galaxies: pointed cont at 650 GHz	Guilloteau	300	DRSP
1.1.4	Unbiased survey of submm galaxies: line survey 210-275 GHz	Guilloteau	180	DRSP
1.1.5	Molecular line studies of submm galaxies	Carilli	170	DRSP
1.1.6	Ultradeep ALMA continuum survey	Blain	2130	DRSP
1.1.7	Deep search for line-emitting galaxies	Blain	150	DRSP
1.1.8	Follow-up of high-z submm galaxies	Blain	1500	DRSP
1.1.9	Dust in normal Lyman Break galaxies	Sawicki	80	DRSP
1.2	*Gravitational lenses*			
1.2.1	Weak lensing using ALMA	Blain	100	DRSP
1.2.2	Ultradeep galaxy survey through clusters	Blain	540	DRSP
1.2.3	PLANCK follow-up	Blain	500	DRSP
1.2.4	A submm study of strong gravitational lenses	Wiklind	230	DRSP
1.2.5	Dust in gravitationally lensed Lyman Break galaxies	Sawicki	94	DRSP
1.3	*Quasar absorption lines*			
1.3.1	Spectral line survey in high-z absorption systems	Wiklind	171	DRSP
1.3.2	Deep search for new molecular absorption line systems	Wiklind	125	DRSP
1.4	*SZ with ALMA*			
1.4.1	Sunyaev-Zel'dovich Effect of Proto-Clusters	Sugiyama	300	DRSP
1.4.2	Kinetic Sunyaev-Zel'dovich Effect of Galaxy Clusters	Yoshida	321	DRSP
1.5	*Gas in galactic nuclei*			
1.5.1	Imaging Molecular material in AGN vicinity	Schinnerer	64	DRSP
1.5.2	Circumnuclear Starburst Rings: From Gas to Stars	Schinnerer	80	DRSP
1.5.3	Nuclear dense gas in active galaxies	Schinnerer	96	DRSP

1.6	*The AGN engine*			
1.6.1	High resolution imaging of radio hot spots	Carilli	32	DRSP
1.6.2	High resolution imaging of X-ray hot spots in radio jets	Carilli	16	DRSP
1.6.3	The general relativistic shadow of Sgr A*	Carilli	16	DRSP
1.6.4	mm VLBI observations of core-jets	Carilli	50	DRSP
1.6.5	Imaging the molecular gas in high-z FIR-luminous QSOs	Carilli	120	DRSP
1.6.6	mm VLBI imaging of IDVs	Carilli	50	DRSP
1.6.7	Search for flat spectrum mm-loud AGN	Carilli	20	DRSP
1.7	*Galaxies in the local universe*			
1.7.1	The GMC Scale Chemical Anatomy of Nearby Galaxies	Meier/Turner	144	DRSP
1.7.2	The Molecular ISM in Low Surface Brightness Galaxies	Turner	96	DRSP
1.7.3	Calibrating the I_CO to N(H_2) Conversion Factor	Meier/Turner	140	DRSP
1.7.4	Structure of the ISM in irregular galaxies	Wilson	180	DRSP
1.7.5	Low Frequency Survey of Free-Free Emission in starbursts	Turner	43	DRSP
1.7.6	Study of Gas Masses and Star Formation Efficiencies	Turner	120	DRSP
1.7.7	Gas Content and Dynamics of Elliptical Galaxies	Wilson	56	DRSP
1.7.8	Gas densities and dynamics in central regions	Tatematsu	99	DRSP
1.7.9	CO(6-5) emission from a small sample of ULIRGs	Isaak	65	DRSP
1.7.10	Searching for Proto- Super Star Clusters in the Antennae	Wilson	20	DRSP
1.7.11	The CO-to-H2 conversion factor	Tatematsu	169	DRSP
1.8	*ALMA and the Magellanic Clouds*			
1.8.1	Structure and starformation of LMC/SMC molecular clouds	Aalto	170	DRSP
1.8.2	Evolved stars and mass loss in the Magellanic Clouds	Aalto	320	DRSP
1.8.3	Background quasars and the chemistry of the MC ISM	Black	360	DRSP
1.8.4	Low Frequency Continuum Survey of Free-Free Emission in the LMC	Turner	56	DRSP
1.8.5	Gas and Dust in 30 Doradus	Turner	80	DRSP
1.9	*Gamma ray bursts*			
1.9.1	GRB environment	Frail	300	DRSP
1.9.2	ToO Observing of GRB Afterglows	Van Dyk	10	DRSP
Theme 2:	**Star and planet formation**			
2.1	*Initial conditions of star formation*			
2.1.1	Small scale structure of molecular clouds	Pety	200	DRSP
2.1.2	Density and temperature profile in pre-stellar cores	Bacmann	125	DRSP
2.1.3	Kinetic Temperature Structure in Protostars and YSO	Mangum	15	DRSP

2.1.4	Density and temperature profile in high-mass cores	Bacmann	155	DRSP
2.1.5	Spatial Density Probe Comparison in Protostars and YSOs	Mangum	15	DRSP
2.1.6	The Connection Between Cloud Structure and the IMF	Chandler	400	DRSP
2.1.7	Physical Structure of Low-mass Star-Forming Cores	Shirley	120	DRSP
2.1.8	Infall velocity structure of starless cores	Myers	100	DRSP
2.1.9	Envelope Structure of Intermediate-Mass YSOs	di Francesco	192	DRSP
2.2	*Young stellar objects*			
2.2.1	Mapping the turbulence in a molecular cloud	Richer	121	DRSP
2.2.2	Magnetic field geometry in protostellar envelopes	Richer	200	DRSP
2.2.3	Structure and collapse of protostellar envelopes	Richer	240	DRSP
2.2.4	Infall toward protostars	Wootten	300	DRSP
2.2.5	Magnetic field in molecular outflows	Richer	168	DRSP
2.2.6	Energetics of the HH 80-81 outflow	Shepherd	90	DRSP
2.2.7	Survey of massive molecular outflows	Shepherd	0	DRSP
2.2.8	Survey of the central fields in massive molecular outflows	Shepherd	20	DRSP
2.2.9	Deep integration on the massive jet source HH80-81	Shepherd	182	DRSP
2.2.10	The intenal structure of the BHR71 outflow	Gueth	65	DRSP
2.3	*Chemistry of star-forming regions*			
2.3.1	Chemical survey of hot cores	van Dishoeck	585	DRSP
2.3.2	Depletion of molecules in low-mass cores	Tatematsu	216	DRSP
2.3.3	Chemical differentiation in sf-regions	Wright	134	DRSP
2.3.4	Unbiased line surveys of high mass star forming regions	Schilke	612	DRSP
2.3.5	Low freq. spectral survey aimed at complex organics	Turner	35	DRSP
2.3.6	Survey of HCO+ absorption in diffuse clouds	Lucas	80	DRSP
2.3.7	Absorption line survey	Lucas	57	DRSP
2.3.8	Chemical Enhancements in Outflows	Plume	16	DRSP
2.4	Protoplanetary disks			
2.4.1	CO surveys of disks around stars from 0.3 to 3 msun	Dutrey	2760	DRSP
2.4.2	Molecular surveys in 2-3 ``small'' samples from 0.5 to 3 msun	Dutrey	229	DRSP
2.4.3	Continuum survey from 80 to 900 GHz	Guilloteau	260	DRSP
2.4.4	Disks in the sub-stellar regime	Testi	175	DRSP
2.4.5	Gaps in nearby protoplanetary disks	Guilloteau	13	DRSP
2.4.6	Transitions disks around CTTs/WTTs & near ZAMS stars	Bacmann	88	DRSP
2.4.7	Structure of debris disks & Vega-type objects	Dutrey	690	DRSP
2.4.8	Structure and properties of disks around high-mass (proto-)stars	Testi	190	DRSP
2.4.9	Dust and Gas distribution in multiple-systems	Dutrey	120	DRSP

Theme 3:	**Stars and their evolution**			
3.1	*The Sun*			
3.1.1	Structure and Dynamics of the Chromosphere	Benz	10	DRSP
3.1.2	Solar Radio Recombination Lines	Benz	10	DRSP
3.2	*Mm continuum from stars*			
3.2.1	Evolution of magnetic activity in main-sequence stars	Guedel	30	DRSP
3.2.2	Magnetic energy release and High-En Part in Atmospheres	Guedel	14	DRSP
3.2.3	Thermal Emission from Red Giant and Supergiant Stars	Menten	100	DRSP
3.2.4	The photospheres and proper motions of normal stars	Black	100-200	DRSP
3.2.5	Millimeter observations of nonthermal emission from active stars	Osten	25	DRSP
3.2.6	Millimeter survey of stellar disk emission from late-type giants and supergiants	Osten	4	DRSP
3.2.7	Flares from Young Stellar Objects: what we learned from the 2003 January flare in GMR-A	Furuya	96	DRSP
3.3	*Circumstellar envelopes*			
3.3.1	Probing the Dust Formation Zone around Red Giant Stars	Menten	200	DRSP
3.3.2	Line surveys in evolved stars	Cox	680	DRSP
3.4	*Post-AGB sources*			
3.4.1	Post-AGB stars: PPN and PN	Cox	238	DRSP
3.4.2	Molecular and atomic gas in PN	Cox	73	DRSP
3.5	*Supernovae*			
3.5.1	Structure of the Molecular Gas shocked by SNR	Tatematsu	220	DRSP
3.5.2	SNR-cloud interaction in the LMC	Tatematsu	80	DRSP
3.5.3	TOO: new SN	Tatematsu	180	DRSP
3.5.4	The populations of relativistic particles and the magnetic field structure in the Crab Nebular and other pleions	Bandiera	229	DRSP
3.5.5	ToO Observing of Radio Supernovae	van Dyk	50	DRSP
3.5.6	Monitoring of Radio Supernovae	van Dyk	30	DRSP
Theme 4:	**Solar system**			
4.1	*Planetary atmospheres*			
4.1.1	The dynamics of Mars' and Venus' middle atmopheres	Lellouch	100	DRSP

4.1.2	Mars's three-dimensional water cycle	Lellouch	160	DRSP
4.1.3	Chemistry in Venus' and Mars' atmosphere	Lellouch	92	DRSP
4.1.4	Giant planets stratospheres: composition and dynamics	Lellouch	154	DRSP
4.1.5	Search for broad tropospheric lines in GP troposphere	Lellouch	12	DRSP
4.1.6	Chemical-dynamical couplings in Titan's atmosphere	Lellouch	160	DRSP
4.1.7	Io's volcanism	Lellouch	100	DRSP
4.1.8	The atmospheres of Triton, Pluto and other TNOs	Lellouch	288	DRSP
4.2	*Planetary surfaces and dynamics*			
4.2.1	Albedos, size and surface properties of TNOs	Lellouch	140	DRSP
4.2.2	Mapping the surfaces of the Moon, Mercury and Mars	Butler	66	DRSP
4.2.3	Mapping the surfaces of large icy bodies	Butler	104	DRSP
4.2.4	Structure and composition of Saturn's rings	Butler	48	DRSP
4.2.5	Mapping the surfaces of larger asteroids	Butler	105	DRSP
4.2.6	Sizes and albedos of NEAs	Butler	20	DRSP
4.2.7	Astrometry of NEAs and TNOs	Butler	30	DRSP
4.2.8	Radar observations of NEAs	Butler	0	DRSP
4.3	*Comets*			
4.3.1	A complete picture of Earth-grazing comet 103P/Hartley 2	Bockelee-Morvan	144	DRSP
4.3.2	ALMA-TOO observation of an Oort cloud comet	Bockelee-Morvan	216	DRSP
4.3.3	ALMA observes the great comet of the decade	Bockelee-Morvan	256	DRSP
4.3.4	Characterization of the Jupiter-family comet population	Bockelee-Morvan	308	DRSP
4.3.5	Is Hale-Bopp still alive ?	Bockelee-Morvan	100	DRSP
4.3.6	Chiron distant activity	Bockelee-Morvan	40	DRSP
4.3.7	CO nucleus outgassing of 29P/Schwassmann-Wachmann 1	Bockelee-Morvan	40	DRSP
4.3.8	Radar observations of comets	Butler	12	DRSP
4.4	*Extrasolar planets*			
4.4.1	Direct detection of Jupiters around nearby stars	Menten	500	DRSP
4.4.2	Dynamical parameters of planets by astrometry	Lestrade	100	DRSP
4.4.3	Search for extrasolar planets via astrometry of nearby stars	Butler	144	DRSP

Last update 06-12-03. Jes Jørgensen (joergensen@strw.leidenuniv.nl).