APRIL 29, WEDNESDAY

New tales of molecular gas in galaxies: (not so) near, and far

- *Jeff Wagg (NRAO - Socorro)*

Thanks to an increasing number of sensitive new instruments operating at submm-through-cm wavelengths, major advances in our understanding of galaxy formation and evolution have been made in recent years. Observations of redshifted CO line emission have allowed us to study the molecular gas in extreme quasar host galaxies around the time of reionization, and even more "normal" galaxies at redshifts, z$\sim$1.5. I will summarize our ongoing interferometric survey of molecular CO line emission in z$\sim$0.3 ULIRG to QSO transition objects where we have discovered evidence for "wet-dry" mergers. I will also present our latest observations of molecular gas in galaxies at z>6.5, including the first observations of CO line emission in Lyman Alpha emitters.

Water in the distant Universe

- *Violetta Impellizzeri (NRAO - Charlottesville)*

Astrophysical water masers are found in clouds of dense gas that surround the super-massive black hole at the center of most galaxies. Being within a few parsecs of the central engine, water masers can give valuable information about the mass of the black hole and jet-outflows, and can even be used to determine a very accurate distance to the AGN host galaxy. However, water masers are quite rare locally (z<0.06), and searches to higher redshifts are difficult due to the limited sensitivity of current radio telescopes. I will present the results of a survey for powerful water masers from 6 gravitationally lensed quasars with the Effelesberg radio telescope and the EVLA. Using the magnification provided by the foreground gravitational lens, water emission has been found in one quasar at redshift 2.64, a time when the Universe was only 1/5 the age it is today. The quasar, MG 0414+0534, is by far the most distant object water has been found in and the detection implies that water masers may be much more abundant in the past than first thought. Furthermore, our detection demonstrates the detectability of distant (unlensed) water masers with the next generation of radio arrays.

The deep Swire VLA field: faint radio populations

- *Veronica Strazzullo (NRAO - Socorro)*

The deep VLA field in the SWIRE Lockman Hole is a very deep 20cm continuum survey (rms at image center $\sim$2.7μJy) in a field which has been imaged at basically all wavelengths (X-rays, UV, optical, NIR, IR, as well as other radio frequencies). I will present a study based on NUV, optical, NIR and mid-IR photometry in 11 passbands from 2300$\mathring{A}$ to 4.5μm, which allows us to sample, up to redshift $z \geq 1$, a significant portion of the galaxies spectral energy distribution (SED) relevant to the study of the host stellar populations. We used the observed SEDs of the identified counterparts to investigate properties of a 90% complete sample of faint radio sources ($F_{1.4GHz} > 16\mu$Jy) in the redshift range $0.3 < z < 1.3$, deriving accurate photometric redshifts and classifing the host stellar populations, in order to constrain the nature of the radio emission in these galaxies.

The environment of MAMBO galaxies in the COSMOS field
- *Manuel Aravena (NRAO - Charlottesville)*

Submillimeter galaxies (SMG) represent a dust-obscured high-redshift population with undergoing massive star formation activity. Their properties and space densities have suggested that they may evolve into spheroidal galaxies in clusters. In this talk, I discuss the environment of the SMGs detected with the Max-Planck Bolometer camera (MAMBO) in the COSMOS field. Projected density maps of high-redshift BzK galaxies show that three MAMBO galaxies are located in statistically significant overdensities, being very unlikely that these associations are produced by chance. Photometric redshifts of the galaxies in these overdensities support these results. This provides evidence supporting that SMGs form in galaxy density peaks at high redshift being likely progenitors of massive local spheroidals.

Star formation and dust obscuration at z∼2: galaxies at the dawn of downsizing
- *Maurilio Pannella (NRAO - Socorro)*

I present first results of a study aimed to constrain the star formation rate and dust content of galaxies at z∼2. I use a sample of BzK-selected star-forming galaxies, drawn from the COSMOS survey, to perform a stacking analysis of their 1.4 GHz radio continuum as a function of different stellar population properties, after removing AGN contaminants from the sample. Dust unbiased star formation rates are derived from radio fluxes assuming the local radio-IR correlation. The main results of this work are: i) specific star formation rates are constant over about 1 dex in stellar mass and up to the highest stellar mass probed; ii) the dust attenuation is a strong function of galaxy stellar mass with more massive galaxies being more obscured than lower mass objects; iii) a single value of the UV extinction applied to all galaxies would lead to grossly underestimate the SFR in massive galaxies; iv) correcting the observed UV luminosities for dust attenuation based on the Calzetti recipe provide results in very good agreement with the radio derived ones; v) the mean specific star formation rate of our sample steadily decreases by a factor of ~ 4 with decreasing redshift from $z = 2.3$ to 1.4 and a factor of ~ 40 down the local Universe. These empirical SFRs would cause galaxies to dramatically overgrow in mass if maintained all the way to low redshifts, I suggest that this does not happen because star formation is progressively quenched, likely starting from the most massive galaxies.

Do the fundamental constants change with time ?
- *Nissim Kanekar (NRAO - Socorro)*

Astrophysical studies of redshifted spectral lines provide a powerful probe of putative changes in low-energy fundamental constants across a large lookback time. After reviewing the current state of the field, I will summarize our recent results from radio studies of fundamental constant evolution, based on three techniques: (1) "conjugate" satellite OH 18cm lines, (2) redshift comparisons between NH_3 inversion and CS rotational lines, and (3) redshift comparisons between HI 21cm hyperfine and CI resonance lines. Finally, I will discuss the improvements that are likely to be possible in such studies with the advent of new telescopes such as the EVLA and ALMA over the next decade.

The proper motion and parallax of a black hole X-ray binary
- *James Miller-Jones (NRAO - Charlottesville)*

Black hole X-ray binary systems spend most of their time in a low-luminosity ($L_{\rm X} < 10^{33.5}$ erg s^{-1}) quiescent state. While there is circumstantial evidence for jets in this state, such jets are weak, implying that quiescent black hole X-ray binaries are persistent, core-dominated, radio-emitting systems, and are therefore good candidates for high-precision astrometric observations to measure their parallaxes and proper motions. I present preliminary results from a program to measure a parallactic distance to the black hole X-ray binary V404 Cyg, which yield the first accurate geometric distance to a stellar-mass black hole. Taken together with the known position and radial velocity of the source and the fitted proper motion, this can be used to infer its full three-dimensional space velocity and hence its peculiar velocity with respect to its local standard of rest, allowing us to probe the formation mechanism of the black hole in this system.

VLBI Observations of HI in Compact Symmetric Objects: the case of B2352+495
- *Esteban Araya (NRAO & University of New Mexico)*

B2352+495 is a prototypical example of a Compact Symmetric Object (CSO). It has a double radio lobe symmetrically located with respect to a flat-spectrum radio core (the location of the AGN) and has a physical extension of less than 200 pc. We report VLBA observations of H I absorption toward B2352+495 to investigate the properties of this remarkable radio source, in particular, to explore whether the radio emission can be contained by circumnuclear material (frustration scenario) or whether the source is likely to be young. We confirmed the two H I absorption features previously detected toward B2352+495 − a broad line almost centered at the systemic velocity of the galaxy and a narrow redshifted component. We find evidence for a velocity gradient in the broad component consistent with rotation around the supermassive black hole. Our results support the youth interpretation and suggest the use of VLBI H I observations as an independent tool to study the $M_{BH} - \sigma_*$ relation. A review of all CSOs observed at high angular resolution in the H I line is also presented.

A Non-radial Oscillation Model for Radio Pulsars

- *Rachel Rosen (NRAO - Green Bank)*

We present a non-radial oscillation model that can successfully reproduce many properties of drifting subpulses in pulsars. By demonstrating the presence of oscillation modes in pulsars, we hope to pave the way for asteroseismology of neutron stars. This model is an alternative to the drifting spark model of Ruderman and Sutherland (1975). This behavior includes the time-averaged pulse properties, the individual pulse properties, and the subpulse phase jumps and orthogonal polarization modes. We show that our model can be successfully fit to the data by conducting a quantitative analysis of PSR 0943+10.

Precision Pulsar Timing and the Interstellar Medium

- *Paul Demorest (NRAO - Charlottesville)*

High-precision pulsar timing is a powerful experimental tool for tests of fundamental physics such as general relativity and the properties of matter at nuclear densities. By timing an array of milliseond pulsars it is possible to form a nHz-frequency gravitational wave detector, sensitive to supermassive black hole mergers throughout the universe. Current MSP timing observations such as those carried out by the NANOGrav group using Arecibo and the GBT achieve timing precisions on the order of 100 ns. The dominant astrophysical effect preventing higher-precision results is likely to be the influence of the ionized interstellar medium on the pulsed radio signal. Properly addressing this issue will soon become even more important if we are to utilize future large-area radio telescopes such as the SKA to their full potential for pulsar timing. In this talk I will present ongoing research aimed at finding new and improved ways to characterize and remove the effect of the ISM on the pulsar signal.

Gas Evolution of Galaxies and the Environmental Dependence of the HI Mass Function

- *Brian Kent (NRAO - Charlottesville)*

Large HI surveys are cataloging the neutral gas content of nearby galaxies In particular, the wide-field Arecibo Legacy Fast ALFA survey (ALFALFA; Giovanelli et al. 2007, Kent et al. 2008) is making use of the 21 cm line of neutral hydrogen to measure the properties of some 30,000 galaxies in the local Universe. The survey samples a variety of galaxy environments, including the nearby Virgo Cluster at 16.7 Mpc distant, and the anti-Virgo region in the opposite area of sky. Of particular interest is the study of the density of galaxies in a given mass range - a determination called the HI mass function (HIMF). The HIMF serves as a useful diagnostic tool when comparing neutral gas content to the already well determined optical luminosity functions that trace the stellar content. I will describe previous HIMFs and compare with the ALFALFA survey results, specifically Virgo and the possible cluster effects on the HIMF.

Molecular Gas Content of HI Monsters
- *Aeree Chung (NRAO - Socorro)*

One of the key physical constraints for star formation activity in a galaxy is its total cold gas content. The most luminous galaxies with the highest star formation rate in the Local Universe, so-called ultraluminous infrared galaxies (ULIRGs), require gas rich progenitors, and determining the frequency of gas rich normal galaxies can lead to an estimate of the duty cycle for the ULIRG phenomenon. Recently we have started probing molecular gas properties in the systems with $M_{\rm HI} \geq 10^{10}\ M_{\odot}$ in order to determine the total cold gas mass of gas rich galaxies as a function of redshift. In this talk, I will present the preliminary result from our medium resolution ($\sim$85 km s^{-1}) CO observations of $\sim$ 30 HI rich galaxies ($M_{\rm HI} \geq 10^{10}\ M_{\odot}$) at $z \approx 0.04 - 0.08$.

The Dynamic Radio Sky: Future Directions at cm/m-Wavelengths astronomy
- *Geoffrey Bower (UC Berkeley)*

The time domain of the radio wavelength sky has been only sparsely explored. Nevertheless, recent discoveries from limited surveys and serendipitous discoveries indicate that there is much to be found on timescales from nanoseconds to years and at wavelengths from meters to millimeters. These observations have revealed unexpected phenonmena such as rotating radio transients and coherent pulses from brown dwarfs. Additionally, archival studies have revealed an unknown class of radio transients without radio, optical, or high-energy hosts. The current generation of new meter- and centimeter-wave radio telescopes such as the MWA, LWA, PAPER, and ATA will exploit wide fields of view and flexible digital signal processing to systematically explore radio transient parameter space, as well as lay the scientific and technical foundation for the SKA. Known unknowns that will be the target of future transient surveys include orphan gamma-ray burst afterglows, radio supernovae, tidally-disrupted stars, flare stars, and magnetars.

Simulations and analysis for the Long Wavelength Array
- *Masaya Kuniyoshi (University of New Mexico)*

The LWA will be a tracking aperture synthesis radio telescope operating in the frequency range 20-80MHz with a high spatial resolution (arcsecond) and mJy sensitivity, where the detailed observation has never done before. The LWA will consist of about 50 stations spread over southwest of New Mexico. Each station is made up of about 256 dipoles spread in region of 100m diameter. The dipole configuration is determined such that the synthesized beam has minimal grating lobes. The celestial target area will be tracked by phasing these dipoles for the desired direction in the sky. Away from the local zenith, the shape of the station beam is determined by the projected shape of the distribution of the dipoles at each station. Consequently, as the stations track a fixed astronomical co-ordinate, the station beam shape changes continuously as a function of time. A time-variable beam-forming weighting scheme can be used to minimize the variations in the station beam at the cost of loss of sensitivity. I will describe the simulation results of the behavior of LWA station beam. I will also discuss the time-variable beam-forming weighting scheme to minimize the variation of the station beam.

The Role of Magnetic Fields in the Interstellar Medium of Irregular Galaxies
- *Amanda Kepley (University of Virginia & NRAO)*

Irregular galaxies are the present day analogs of the high redshift building blocks of galaxies like the Milky Way. The shallow potential wells of irregular galaxies makes their interstellar medium a chaotic system prone to disruption by star formation, interactions, and mergers. An important, but oft-overlooked component of the interstellar medium of irregulars is their magnetic field. Previous observations suggest that irregulars have a wide range magnetic field strengths and properties. To increase the number of irregulars with detailed observations of their magnetic fields, we present detailed observations of two irregular galaxies with the VLA and WSRT: NGC 4214 and NGC 1569.The magnetic field of NGC 1569 is shaped by the outflow of gas from this galaxy, but may play a significant role in channeling gas out of the central regions of the galaxy. The magnetic field of NGC 4214 is mostly random and is not a dominant source of pressure. We will place these fields into the context of the interstellar medium of these galaxies. Finally, we will draw conclusions on the role of magnetic fields in irregular galaxies in general.

COMMON (CO Multi-scale Mosaics of Nearby) Star Formation: Nearby Star-forming Regions at High Resolution
- *Stuartt Corder (NRAO/Joint ALMA Observatory)*

The last decade has seen an increase in the number single dish radio telescopes with focal plane arrays. This increase has resulted in deep imaging of nearby star forming regions in a variety of spectral lines. This in turn has allowed the study of the velocity structure of the clouds and a comparison to numerical models of turbulent star formation. However, these surveys do not have sufficient spatial resolution to map the interface between the star formation feedback mechanisms and the ambient cloud. Similarly, single dish bolometer arrays have mapped dust condensations in these regions as well. Again, the resolution is insufficient to resolve blended sources. In the last year, we have undertaken a program to begin mapping some of the nearest star forming regions with the Combined Array for Research in Millimeter Wave Astronomy (CARMA) in three CO transitions and continuum. Here, I report on the status of the program as well as the goals and future plans. This type of study will benefit greatly from the completion of the Atacama Large Millimeter Array (ALMA) and I discuss the current status and near future of ALMA.

Wide field, high sensitivity VLBI: surveying with mas resolution
- *Adam Deller (NRAO - Socorro)*

The coming decade will see the fruition of a trend towards deep, wide surveys at multiple wavelengths. This avalanche of data promises to revolutionise our understanding of star formation and galaxy evolution over a swathe of cosmological history. However, the instruments to be used (EVLA, Pan-STARRS, LSST etc) will not reach the resolutions attainable today with Very Long Baseline Interferometry (VLBI). High-resolution radio observations are a powerful discriminant between AGN and star formation, and so adding VLBI data to existing pan-chromatic surveys is one way to wring further insight from these wonderful datasets. VLBI observations, however, have traditionally been narrow-field, making surveying a hopelessly expensive proposition. In this talk I will describe how the imminent,

simultaneous availability of wider observing bandwidths (and hence sensitivity) and flexible new correlator architectures will allow VLBI resolution "surveys" in an efficient fashion. I will briefly describe some of the results of a very small pilot program and present some estimates for what will be possible with the upgraded Very Long Baseline Array over the next couple of years.

MAY 1, FRIDAY

EVLA, The Instrument
- *Michael Rupen (NRAO - Socorro)*

After more than 20 years, the Very Large Array (VLA) remains one of the premier radio telescopes in the world, offering a unique combination of flexibility and sensitivity. The Expanded VLA (EVLA) will provide order-of-magnitude gains in sensitivity and spectral capabilities, as well as continuous frequency coverage from 1 to 50 GHz. Here I review the EVLA's current status and future promise, emphasizing its unique new capabilities.

EVLA, The Early Science
- *Claire Chandler (NRAO - Socorro)*

I will describe the capabilities that will be offered for EVLA Early Science between now and the completion of the EVLA construction project. I will also describe programs by which general users and "resident" observers will have access to these capabilities.