SPITZER 2007 CONFERENCE ABSTRACTS

Abramson, Anne
Yale University
Spitzer Observations of ISM Stripping in NGC 4330
We present Spitzer IRAC and MIPS observations of the Virgo cluster spiral galaxy NGC 4330, which is currently undergoing ICM-ISM stripping. This galaxy was observed as part of the Virgo Spitzer Survey. HI and optical observations of this galaxy have provided ample evidence that the ISM is actively being pushed out of the stellar disk. Nearly 50% of its HI emission is extraplanar to one side of the major axis, with 10% of the total emission coming from a tail which extends well outside of the edge of the stellar disk. H-alpha observations reveal that star formation is confined to the inner regions of the stellar disk where enough gas remains to fuel it. Spitzer IRAC and MIPS data provide a detailed picture of the effects of ram pressure stripping on the galaxy's ISM. No IR emission at any wavelength is detected in the HI tail, indicating that there is not sufficient star formation or stellar continuum heating to excite dust grains in the stripped gas. 8 micron data show that PAH emission is confined to the inner parts of the galactic disk, indicating that the stripped gas has a very low ratio of FIR to HI emission. A comparison between 24 micron and H-alpha, both of which trace star formation, shows that H-alpha emission is comparatively strong only at the edges of the star-forming disk, where the dust that normally obscures H-alpha emission has been stripped away. These observations have greatly enhanced our understanding of the stripping process and fate of the stripped gas in this galaxy.

Alexov, Anastasia
Caltech - IPAC/IRSA
Spitzer Data Access through the NASA/IPAC Infrared Science Archive (IRSA)
In August 2007, in collaboration with the Spitzer Science Center, IRSA released an interface to the Spitzer Space Telescope post-BCD products. The interface is accessible at http://irsa.ipac.caltech.edu/applications/Spitzer/Spitzer/ and offers coverage maps for all three instruments and their modes. The interface supports queries by position/target, by instrument and/or by program parameters. It returns spatial coverage and footprint maps, previews of data and metadata, and single file or bulk data download options.

IRSA has also curated and served Spitzer Legacy Enhanced Products and Ancillary data since 2003. Currently, it serves data from eight Legacy projects, and will serve data sets from all the Legacy teams (currently numbering 26).

Allamandola, Louis J
NASA Ames Research Center
The NASA Ames PAH IR Spectroscopic Database
Authors: C. Bauschlicher, Jr.1, J. Cami2,4, D.M. Hudgins3, A.L. Mattioda1, E. Peeters2,4, A. Ricca1,4, and L. J. Allamandola1

The unprecedented sensitivity and mid-IR spectroscopic capabilities of the Spitzer Space Telescope show that the mid-IR emission features, formerly known as the unidentified infrared bands, are unique and powerful diagnostics of physical and chemical conditions throughout the Universe.

These features are now generally attributed to the vibrational emission from Polycyclic Aromatic Hydrocarbons (PAHs), the molecular component of the interstellar carbon-rich dust population. This major breakthrough in understanding was made possible by combining observations with extensive theoretical and experimental studies which showed PAH spectra can reproduce the observed pattern of band positions, relative intensities, and variations. The Ames PAH IR spectral database created over the last 15 years represents an important part of the foundation for our understanding of this abundant and widespread material. This paper presents an overview of the database and some applications.

THE EXPERIMENTAL PAH SPECTRAL DATABASE- Driven by the astrophysical problem the IR spectroscopic properties of over 200 charged and neutral, cold, individual aromatic compounds have been measured.

THE COMPUTATIONAL PAH SPECTRAL DATABASE- It is not possible to obtain samples of all possible PAHs of interest for experimental study. This includes molecules for which the ion is a stable closed shell species while the neutral is a reactive open-shell radical. Such species could be formed easily in the ISM and be quite common, yet they are very difficult to form in the lab. Even for the neutrals, not all large PAHs of potential interest have been synthesized, nor is it straightforward to measure the complete mid-IR spectrum of ionized PAHs. Modern electronic structure theory offers a way to obtain accurate spectra of astrophysically important species that could not be obtained in any other way. There are about 600 spectra in the theoretical PAH spectral database. This includes the spectra of very large PAHs (C40 to C132), comparable to the size of the PAHs thought to dominate the interstellar emission spectrum, and many PAH variants.

Together, these data show that PAH spectra can reproduce the pattern of band positions, intensities, and variations of the observed interstellar IR emission in detail. While a number of these spectra have been published, and the spectra of 21 small neutral PAHs and 16 PAH cations are listed on the Ames database website (http://www.astrochem.org), the vast majority of the spectra in the database are not readily accessible to the public. It is our intention to make these data publicly available in a unified format over the next year.

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3- NASA Headquarters
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Andersen, Morten
Spitzer Science Center, Caltech
PAH Features in Supernova Remnants

Shocks from supernova are responsible for destruction of interstellar dust and possibly for the creation of poly aromatic hydrocarbons (PAHs, Jones et al 1996) However, the rate and effectiveness of the creation of PAHs in supernova shocks are largely unknown quantities.
Only with the sensitivity and spatial resolution with SPITZER has it been possible to obtain high quality spectra of Galactic supernova remnants to examine if PAHs are indeed created in the shock.
We have undertaken a spectroscopic survey of the known supernovae in the Galaxy that were detected in the GLIMPSE survey.
We present here new results on the presence of PAH in a subset of the supernovae, including RCW103 and G311.5-0.3, based on low resolution SPITZER IRS spectroscopy.
The ratio of the ratio of the 11.3 micron feature (due to C-H bending) to the 15-20 micron PAH plateau (due to C-C-C bending) is investigated.
We discuss the evolution of the PAH features across the supernova shell and use our spectra of a control field to disentangle the Galactic PAH features with those intrinsic to the supernova remnants.
We further combine the IRS spectra with MIPS spectral observations to constrain the relative abundance of large and Small grains to the amount of PAH detected.

Andersson, B-G
FUSE/JHU, SOFIA/USRA
Observational Evidence for Radiative Grain Alignment in the ISM
We have used multi-band optical polarimetry towards six nearby interstellar clouds, supported by NIR and FIR photometry, to show that the wavelength of maximum polarization shows a universal, linear dependence on the visual extinction, indicating a radiatively driven grain alignment mechanism. We show that the observed polarization is also sensitive to environmental factors, such as hot stars nearby

to the dust and, the characteristics of the embedded star formation in the clouds. These dependencies are consistent with, and might have been expected from, radiative grain alignment. We recover the dependence on the total-to-selective extinction seen in earlier studies, but only in the form or a zero level offset varying from cloud to cloud. Having established the first order dependence of the polarization curve on extinction will allow more detailed work to be pursued on the second order alignment and disalignment mechanisms.

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Appleton, Philip
NHSC-Caltech
IRS Spectroscopy and Imaging of Collisional Ring Galaxies
We present spectroscopy of a sample of collisional ring galaxies observed with the IRS, IRAC and MIPS. The IRS observations, taken with both the low and hi-res are aimed at investigating the physical conditions in the nuclei and rings in these near head-on collisional systems. The observations will be used, in conjunction with other optical and near-IR imaging and spectroscopy to investigate these generally low-metallicity systems.

Armus, Lee
Spitzer Science Center
Mapping the Wind from M82 with the IRS
As one of the nearest starburst galaxies, M82 is often used as a prototype when studying distant, star-forming galaxies. Besides hosting a burst of star formation, M82 is also driving an outflowing (super) wind along its minor axis. Superwinds have been identified in many other starburst galaxies over a large range in luminosities, but the wind in M82 is the closest, brightest example of this phenomenon. Here we present results from the first large-scale, mid-infrared spectral maps of the M82 wind taken with the IRS on Spitzer. We will use these maps to compare the properties of the dust, ionized gas, and warm molecular gas in the halo of M82, and compare these to observations at other wavelengths, and to models of the outflowing wind.

Bagetakos, Ioannis
University of Hertfordshire
An Inventory of Supershells in nearby Galaxies
The HI Nearby Galaxy Survey (THINGS), is a 21-cm HI line survey of a sample of 34 nearby (3-10 Mpc) galaxies. The observations were carried out with the VLA and have a velocity resolution of less than 5 km s-1 and an angular resolution of 6" which at this distance range corresponds to a linear resolution of 100-300pc. One of the primary goals of THINGS is to look at the fine-scale structure of the Interstellar Medium (ISM) and examine how it varies as a function of Hubble type, star formation rate, galaxy mass, metallicity, etc. Previous studies have shown that the morphology of the neutral ISM is greatly affected by massive stars through the combined effects of stellar winds and supernova explosions. Because massive stars tend to form in associations they will end their lives within the same, relatively short time span and within a small volume which leads to the formation of expanding bubbles of coronal gas in the ISM. These structures compress the neutral gas and can trigger secondary or induced star formation on their rims where presumably molecular clouds are formed. We present an inventory of more than 1000 holes and shells in 20 nearby galaxies, and some first results from a comparison between these galaxies as far as the properties of their HI holes are concerned. These properties include the size of the holes, their expansion velocities, energy requirements and kinematical ages.

Barmby, Pauline
University of Western Ontario
Initial Views of M31's Mysterious PAHs
The Andromeda galaxy, M31, seems to be a normal, if quiescent, star-forming galaxy. As the nearest large spiral, it's where the highest spatial resolution is available for studies of extra-galactic star formation. ISOCAM spectro-imaging showed that M31 has some very odd PAH spectra, with strong 11 and 12 micron features but almost completely lacking the normally dominant 6-8 micron features. In Spitzer Cycle 4 we have mapped a number of regions with the IRS short-low module, to see how the PAH ratios vary with metallicity, dust temperature and UV intensity. Here we present a first look at the results.

Beirao, Pedro
Leiden University
Spatially Resolved Spitzer-IRS Spectroscopy of the Central Region of M82
We present spatially resolved (~35 parsec) 5-38 um spectra of the central region of M82, taken with the Spitzer Infrared Spectrograph. The continuous spatial and spectral coverage allow us to study the physical conditions and their spatial variations within the nucleus of a starburst galaxy in unsurpassed detail. The spectra clearly show the typical starburst signatures, but with significant variations depending on the position within M82. Spectral maps of the forbidden emission lines [NeII] and [NeIII] show strong emission from young massive clusters. We find a relatively low ratio of [NeIII]/[NeII] ~ 0.13 - 0.21, being lowest at the center, and increasing outside the galactic plane along the large-scale outflows. Modelling [NeIII] and [NeII] emissions by MAPPINGSIII helps us to constrain the ages of the clusters at 2.5 - 5 Myr, for a typical ionization parameter. We show that it is possible the existence of ongoing star formation, but clusters of age ~ 1 Myr are less that 5 % the total number of clusters. Extinction, as measured by the optical depth at 9.8 um ($ au_{9.8}$), varies in the range 0 - 2.52. The regions with the highest $ au_{9.8}$ coincide with the CO 1-0 emission peaks. The PAH emission, which originates predominantly from the central clusters, shows spatial variations in the 6.2/11.3 um line ratio which can be attributed largely to the influence of the 10 um silicate absorption on the 11.3 um PAH feature. The silicate absorption feature is also likely resposible for the dispersion of 11.3/7.7 um PAH ratio, which is a diagnostic for PAH ionization. We derive temperatures between 380-700 K for the warm H$_2$ gas, using H$_2$ rotational lines. In the central region the H$_2$ S(1) equivalent width (EW) map correlates with the 11.3 um PAH EW map, indicating that H$_2$ is excited mainly by UV radiation from the young clusters. Our results demonstrate the importance of spatially resolved spectroscopy in starburst studies.

Benjamin, Robert
University of Wisconsin
Spitzer Views of Physical Processes in the Interstellar Medium
The sensitivity and angular resolution of the Spitzer Space Telescope has allowed for a nearly extintction-free view of both the stellar

and interstellar components of the Milky Way Galaxy. I will review the progress and puzzles that have come out of investigations with the Spitzer Space Telescope, including the global distribution of stars and star formation in the inner Galaxy and associated large-scale Galactic flows, the infrared emission from HII regions, wind blown bubbles, stellar bowshocks, planetary nebulae, and supernova remnants, and extinction studies of infrared dark clouds and the diffuse interstellar medium.

Bernard, Jean-Philippe
CESR/CNRS
ISM in the LMC, from the SAGE data
I will describe the latest findings regarding the diffuse IR emission in the LMC, using the SAGE Spitzer data from 3 to 160 microns. Correlation of this data with the HI and CO emission allows for the first time to study the distribution of the radiation field intensity, abundance of the various dust components, from large molecules (PAHs), very small grains and big grains. I will show that a significant emission excess is evidenced in the MIR which can be attributed to a flatter size distribution of the very small grains and probably reflects an important step in the dust life cycle in low metallicity systems. I'll also discuss the implication of the SAGE data analysis regarding the existence of an additional ubiquitous ISM phase of the LMC, which is only detected through dust emission so far and could be composed of pure H2 or cold HI.

Bernard-Salas, Jeronimo
Cornell University
Abundances and Dust in the Magellanic Clouds
We present a mid-infrared spectroscopic study of a sample of Planetary Nebulae (PNe) in the Magellanic Clouds and on the giant HII region 30 Doradus. The data were taken using the Infrared Spectrograph on board the Spitzer Space Telescope. We discuss the implications from our study for the chemical evolution of Neon and Sulfur, and compare these with similarly obtained abundances of Galactic PNe and H\,II regions. Most of the Magellanic Cloud PNe show Polycyclic Aromatic Hydrocarbon (PAHs) features which are usually seen in carbon-rich spectra. Out of 25 objects, only 2 show oxygen-rich dust (amorphous silicates). Almost all of the carbon-rich PNe in the LMC show a strong silicon carbide (SiC) feature around 10um, but this feature is not common in the spectra of carbon-rich Galactic PNe. Magnesium sulfide (MgS) is also present in several PNe. One object, SMPLMC11, shows spectacular absorption bands due to molecules which are the precursors from which more complex hydrocarbons are formed.

The IRS mapping of the extended HII region 30 Doradus reveals a rich spectroscopic zoo which which ranges from spectra with strong emission lines and no dust, to dust dominated spectra including PAHs, and silicates in absorption or in emission. The Spitzer spectra has enabled us to characterize the spatial variations of these features; specifically the relation between the distance to the main ionising cluster with the charge of the PAHs, the distribution of the very small grains and of the photo-dissociation regions.

Berné, Olivier
CESR-LATT (CNRS and Univ. Toulouse)
The evolution of carbonaceous nanoparticles in the interstellar dust cycle: When signal processing meets Spitzer-IRS data
The smallest dust particles that carry the mid-IR aromatic bands and underlying continuum are a key component in the physical and chemical processes of the interstellar medium (ISM). They are likely made of polycyclic aromatic hydrocarbons (PAHs) but their nature and properties are not well known. The IRS-spectrograph onboard the Spitzer Space Telescope provides a unique opportunity to study the emission spectrum of theses particles in a wide variety of environments. We conducted a detailed analysis on the IRS spectra of planetary nebulae, reflection nebulae and protoplanetary disks, using adapted signal processing techniques. The results of this analysis show that it is possible to decompose the mid-IR spectrum of dust, at several levels in the cycle of intestellar matter, as the sum of a few simple spectra.
Each one of these spectra is linked to the physical/chemical nature of the emitting particles, and is closely related to physical conditions such as electron density or hardness of the UV field. Thus, not only this analysis enables to learn on the nature of dust, but it also provides a new tool for tracing physical conditions (e.g. in external galaxies) based on observed mid-IR spectra.

Bigiel, Frank
MPI for Astronomy
The Star Formation Law on sub-kpc Resolution in THINGS
I will present results from THINGS ("The HI Nearby Galaxy Survey"). The survey was carried out at the VLA and provides the currently best sensitivity and highest resolution HI survey data available. It covers 34 nearby galaxies and spans a wide range in galaxy parameter space, e.g. in HI mass, metallicity and star formation activity. I will present a detailed pixel-by-pixel study of the star formation law on 500 pc resolution for 19 THINGS galaxies, spirals and dwarfs, using ancillary CO, Spitzer 24 micron and GALEX UV data. I will show that a Schmidt law with power law index N = 1.0 +/- 0.2 relates star formation surface density and molecular gas surface density and that the ratio of HI to H2 is a strong function of radius and thus environment in a galaxy. I will also present results regarding testing different star formation recipes in THINGS.

Blagrave, Kevin
CITA, University of Toronto
The dust-gas correlation of Intermediate Velocity Clouds at the North Ecliptic Pole
Surveys of H I emission revealed the presence of high Galactic latitude H I gas (of then-unknown origin) at velocities inconsistent with Galactic rotation: intermediate-velocity clouds (IVCs) and high-velocity clouds. To constrain the connection of the IVCs to the local gas, we have been involved in an on-going project to correlate H I and infrared emission.

The ecliptic poles are unique among high Galactic latitude fields as they are covered relatively deeply by Earth-orbiting space observatories. Here, we focus specifically on the North Ecliptic Pole (NEP) and IRAS observations. In order to extract the full potential from the satellite coverage, we have collected deep 21-cm observations of the NEP region using the Green Bank Telescope (9' beam). We exploit the strong dust-gas correlation to determine the infrared dust emissivities of both the local and IVC components. The dust properties inferred from these emissivities suggest two different populations of grains, one local and one in the IVC -- consistent with findings in other high Galactic latitude IVC regions. In addition to supplying evidence for these two grain populations, I will discuss what these observations might imply with regards to the evolution and processing of the dust at the NEP.

Bolatto, Alberto
Department of Astronomy, University of Maryland
The Spitzer surveys of the SMC
I will present an overview of the recent results from the Spitzer Survey of the Small Magellanic Cloud (S^{3}MC) and its spectroscopic follow up (S^{4}MC). S^{3}MC imaged the main star forming body of the SMC and obtained photometric data in all Spitzer wavebands, from 3.6 to 160 μm. S^{4}MC obtained large ($8\arcmin\times8\arcmin$ in most cases) low resolution spectral maps of several regions of interest selected using
the imaging data. I will discuss our results on the nature and
distribution of the stellar populations detected by Spitzer, including Young Stellar Objects throughout the SMC and in particular in the giant HII region NGC~346. I will also present our results on a newly discovered population of early-B stars that have 24 μm excess with little or none optical extinction and/or NIR excess, suggestive of debris disks. I will discuss the observed variations in dust composition and PAH abundance, and their link to the local conditions. In particular I will discuss the distribution and amount of cold molecular gas, obtained from modeling the FIR emission, in relation to the star formation activity. I will also present the team results on the FIR-radio continuum relation within the SMC, and some of our early results from the spectacular S^{4}MC spectral maps produced by Spitzer.

Boogert, Adwin
Caltech
The c2d Spitzer Spectroscopic Survey of Ices Around Low-Mass Young Stellar Objects

Interstellar ices are the main reservoir of volatile molecules
in dense molecular clouds and circumstellar environments.
The ice absorption features in ground-based and Spitzer/IRS
3-30 um spectra of a large (~50) sample of low mass young stellar
objects are analyzed. The origin of the bands between 5-8 um
is discussed. We claim that at least 8 different carriers
are responsible for these bands. Simple neutral species
(H2O, HCOOH, H2CO, NH3, CH3OH) are present, and likely
also ions (NH4+, HCOO-). The latter could form a more refractory
salt as the ices are heated. Evidence for ice heating
is strong in our sample. Evidence is also found for the presence of heavily processed material (e.g. organic residue).
The composition of the ices thus evolves as a result
of energy absorbed by nearby YSOs, although the extent and nature
of the energetic processing is still unclear. These results are of great interest to the chemical evolution of planet-forming
disks.

Bot, Caroline
Caltech
diagnostic value of mid-infrared fine structure lines in galaxies
Several fine-structure lines from ions are observed in the mid-
infrared Spitzer Spectrograph IRS wavelength range. These lines are excited primarily by collisions and their intensity depends mostly on the electron density and on the abundances of the ions. In the litterature, large use of these lines, together with ionized hydrogen emission, has been made to probe abundances and abundance patterns in galaxies. However, this empirical method relies on the assumption that ionized hydrogen and the different ionized species are cospatial. I will present an analysis of the fine-structure lines of Ne, Ar and S observed in two samples: the center of nearby galaxies from the Spitzer Infrared Nearby Galaxies (SINGS) with IRS and compact HII regions in the Milky Way with SWS (ISO). This study aims at testing the spatial
distribution of these different ionized elements. We compared the
product of the filling factor (f) and of the emission measure (EM), deduced from a combination of the mid-IR lines between different elements. This comparison displays systematic offsets between each elements, which are correlated with the first ionization potential of the different species. This shows that the regions where hydrogen, argon, neon and sulfur are ionized, are different. I will discuss the origin of these offsets and their impact on abundance studies.

Brunner, Gregory
Rice University
Mapping the Spatial Distribution of Warm H2 in Nearby Galaxies with the Spitzer IRS
In order to understand the connection between the warm (T = 100 – 1000 K) molecular gas traced by the pure rotational mid-infrared H2 lines and the cold (T < 100 K) molecular gas traced by CO, we have undertaken a program to map the spatial distribution of pure rotational mid-infrared H2 line emission in nearby galaxies with the Spitzer Infrared Spectrograph (IRS). Using our own Spitzer IRS spectral mapping mode observations of M51 and archival Spitzer IRS spectral mapping observations M74, M101, IC342, and NGC2403, we have mapped the spatial distribution of warm molecular gas traced by the H2 S(0) – H2 S(3) pure rotational mid-infrared lines in these 5 galaxies. We present maps of the H2 S(0) – H2 S(3) line emission and maps of the warm H2 surface density distributions created from the emission maps for each galaxy. We also compare the H2 emission distributions to the cold molecular gas distributions traced by CO emission observed as part of the Berkeley-Illinois-Maryland Array Survey of Nearby Galaxies (BIMA SONG) and show that the H2 emission distributions are generally spatially coincident with the CO emission.

This work is based on observations and archival data obtained with the Spitzer Space Telescope, which is operated by the Jet Propulsion Laboratory, California Institute of Technology under a contract with NASA. Support for this work was provided by an award issued by JPL/Caltech.

Burgdorf, Martin
liverpool JMU
Search for Extraplanar Dust in NGC 891 and NGC 5907 with the IRS PUI

In this contribution I report on the detection of mid-infrared radiation extending to 5 kpc from the midplane of the nearby, edge-on galaxy NGC 891. The observations cover the range from 2 to 20 kpc above the galaxy midplane on both sides of the disk. The detection is made with the peakup imaging modes of the Infrared Spectrograph aboard Spitzer. The measured surface brightness profiles at 16 and 22 microns are the same, within the uncertainties of about 30%. The surface brightness at 22 microns decreases exponentially with distance from the galaxy with a scale height of 1.3 kpc. Most of the observed mid-infrared radiation is emitted by interstellar dust. These results are compared with data from NGC 5907, where the presence of extraplanar emission in the peak-up imaging is less clear.

Cami, Jan
University of Western Ontario / SETI Institute
Modeling the PAH bands

The space-borne infrared telescopes ISO and Spitzer have shown that the interstellar infrared emission spectrum with strong bands near 3.3, 6.2, 7.7, and 11.2 micron is common throughout the Universe. These bands -- often called the Unidentified InfraRed (UIR) bands or Aromatic InfraRed Bands (AIB) -- dominate the mid-IR spectra of most galactic objects and they have been detected in a large number of extragalactic objects. Not only are these features observed in many different objects, there is also significant variability in the spectroscopic details from one object to another and from one region to another within extended sources. Clearly, these spectra contain a wealth of information which reflects the physical conditions in the emission zones and composition of the emitting materials. Many studies have therefore attempted to use these easily observed features as diagnostic tools for various purposes. However, a full exploitation of these astronomical spectra has been held back by lack of fundamental data on suitable emitting materials of sufficient breadth and depth to probe the astrophysical environments in which they are observed.

It is now widely accepted that this spectrum is produced by fluorescent emission from highly vibrationally excited polycyclic aromatic hydrocarbon molecules (PAHs) and closely related species and the features are now often referred to as the PAH emission bands.

In this presentation, we use the NASA Ames database of theoretically calculated frequencies and intensities for a large number of Polycyclic Aromatic Hydrocarbon (PAH) molecules and closely related species and present a detailed comparison with observations of the so-called Unidentified InfraRed (UIR) bands representing the different

characteristic classes of UIR spectra. We find that we can closely reproduce the observed UIR spectra for all classes in the ranges 6--9 micron and 10--14 micron, offering credibility for the hypothesis that the UIR bands are indeed due to the various vibrational modes of PAHs and related species. We will also show how the spectral variations of the PAH bands in different environments can be explained by differences in the size distribution, the charge state and the precise chemical composition of the contributing molecules.

Carey, Sean
Spitzer Science Center
Infrared Extinction Profiles of Dense Molecular Cores
We present spatial extinction maps of five well-characterized infrared dark clouds (IRDCs) at 8, 24 and 70 microns using data from the "MIPSGAL" and Galactic Legacy Infrared Mid-Plane Survey Extraordinaire (GLIMPSE) surveys. The extinction curves agree well with theoretical extinction models for the dense interstellar medium (ISM). We investigate the spatial structure of the extinction and compare the estimated dust column densities to those derived from submillimeter continuum emission and to the gas column density as traced by optically thin millimeter spectral lines. The extinction profiles drop off sharply at the periphery of the IRDCs suggesting that the density profiles are also sharply truncated. Density profiles are constructed accounting for excitation of very small dust grains in the limbs of the IRDCs.

Chakrabarti, Sukanya
Harvard University
"Observing" Galaxy Simulations with RADISH: Understanding the Star Formation Histories of Galaxies
Hydrodynamical simulations have opened up a new way of visualizing the time evolution of galaxies. However, to investigate the connection between simulations and observations of galaxies, it is necessary to develop an interface between these two media. Chakrabarti & Whitney (2007) have developed a three-dimensional, self-consistent Monte Carlo code called RADISH, which interfaces with the time outputs of galaxy simulations to calculate the emergent SED (from optical to millimeter wavelengths) and images. It has been used to produce simulated Spitzer color-color plots, and specifically to explain trends in observed color-color plots, as well as to explain the cold-warm far-IR classification of ULIRGs (Chakrabarti et al. 2007a, 2007b).

I will review some of these recent results and present new results that show how one can discriminate between different star formation prescriptions in galaxy simulations. Star formation prescriptions in galaxy simulations are all designed to reproduce globally averaged relations like the Kennicutt-Schmidt (K-S) law. While they all satisfy globally averaged relations like K-S, different star formation prescriptions do have different star formation histories. I will demonstrate how to discriminate between different star formation prescriptions by performing radiative transfer calculations through galaxy simulation outputs.

Chapin, Edward
University of British Columbia
First Results from a New 250, 350 and 500um Imaging Survey in Vulpecula with the Balloon-borne Large-Aperture Submillimeter Telescope (BLAST)
We present the first results from a new 250, 350 and 500 micron Galactic plane survey taken with the Balloon-borne Large-Aperture Submillimeter Telescope (BLAST) in 2005. This survey's primary goal is to identify and characterize high-mass proto-stellar objects. The region studied here covers 4 deg^2 near the open cluster NGC 6823 in the constellation Vulpecula (lon=59 deg). We find 60 compact sources (<60" diameter) detected simultaneously in all three bands. Their spectral energy distributions (SEDs) are constrained through BLAST, IRAS, Spitzer MIPS and MSX photometry, with inferred dust temperatures spanning ~12--40K assuming a dust emissivity index \beta=1.5. The luminosity-to-mass ratio, a distance-independent quantity, spans ~0.2--130 L_sun/M_sun. Distances are estimated from coincident 13CO1-->0 velocities combined with a variety of other velocity and morphological data in the literature. In total, 49 sources are associated with a molecular cloud complex encompassing NGC 6823 (~2.3 kpc), 10 objects with the Perseus Arm

(~8.5 kpc) and one object is probably in the outer Galaxy (~14 kpc). Near NGC 6823, the inferred luminosities and masses of BLAST sources span ~40--10000 L_sun, and ~15--700 M_sun respectively. The mass spectrum is compatible with molecular gas masses in other high-mass star forming regions. Several luminous sources appear to be Ultra Compact HII regions powered by early B stars. However, many of the objects are cool, massive gravitationally-bound clumps with no obvious internal radiation from a protostar.

Chiar, Jean
SETI Institute/NASA Ames
The Relationship between the Optical Depth of the 9.7 micron Silicate Absorption Feature and Infrared Differential Extinction in Dense Clouds
We have examined the relationship between the optical depth of the 9.7 micron silicate absorption feature (tau(9.7)) and the near-infrared color excess, E(J-Ks), in the Serpens, Taurus, IC 5146, Chameleon I, Barnard 59, and Barnard 68 dense clouds/cores. Our data set, based largely on Spitzer IRS spectra, spans E(J-Ks)=0.3-10 mag (corresponding to visual extinction between about 2 and 60 mag). All lines of sight show the 9.7 micron silicate feature. Unlike in the diffuse ISM where a tight linear correlation between the 9.7 micron silicate feature optical depth and the extinction (Av) is observed, we find that the silicate feature in dense clouds does not show a monotonic increase with extinction. Thus, in dense clouds, tau(9.7) is not a good measure of total dust column density. With few exceptions, the measured tau(9.7) values fall well below the diffuse ISM correlation line for E(J-Ks)>2 mag (Av>12 mag). Grain growth via coagulation is a likely cause of this effect. (Published in Chiar et al. ApJ, 2007, 666, L73)

Chiar, Jean
SETI Institute/NASA Ames
Ices in the Quiescent IC 5146 Dark Cloud
IC 5146 is a nearby (200pc) dark cloud complex in Cygnus. The lack of star formation activity makes it an excellent laboratory for the study of the chemical complexity in the earliest stages of dense molecular cloud evolution. We have used the Spitzer Infrared Spectrometer (IRS) to probe dust and ice along 10 sight-lines toward K-Giant background stars, sampling a range of visual extinction from 2-20 mag. The highest Av sightlines show clear detections of ices at 6.0 micron(water-ice mixture), 6.85 micron (processed ice) and 15.2 micron (CO2). For several of these sources, we have used SpeX on NASA's IRTF to obtain 2.0 to 5.0 micron spectra in order to measure the 3.0 micron water-ice and 4.67 CO ice features. The "ice-threshold", the minimum Av at which the 3.0 micron water-ice feature is detected, is ~4 mag, similar to that deduced for the quiescent Taurus dark cloud.

Chu, You-Hua
University of Illinois
Formation and Feedback of Massive Stars in the LMC
Formation and Feedback of Massive Stars in the LMC
You-Hua Chu and Robert Gruendl (University of Illinois)

The Large and Small Magellanic Clouds (MCs; LMC & SMC) are the only galaxies where star formation can be studied both globally across the entire galaxy and locally at astrophysically interesting scales. Optical observations of massive stars and H-alpha observations of ionized gas reveal sites of star formation within the last 10 Myr. The energy feedback from these massive stars is manifested by the hot gas detected in X-rays and turbulent motions shown in high-dispersion H-alpha spectra. Recent Spitzer observations further allow us to identify and inventory massive young stellar objects (YSOs) from the on-going star formation. It is thus possible to use all available information to investigate the conditions for massive star formation and the relationship between the current star formation and the energy feedback from previously formed massive stars.

We have used the Spitzer survey of the LMC, aka SAGE, in conjunction with higher-resolution optical and near-IR images to identify and inventory massive (>10 Msun) YSOs in the LMC. We have further examined the interstellar environments of the massive YSOs to answer the following questions: (1) Under
what conditions are massive stars formed? (2) Are stellar masses correlated with the conditions of star formation? (3) Can massive stars form in isolation? (4) How prevalent is star formation triggered by energy feedback from previous star formation?

Clayton, Geoffrey
Louisiana State University
Dust Formation in Type II Supernovae

Recent detection of large amounts of dust in high red-shift galaxies has led to an increased interest in the importance of Type II supernovae (SNe) as dust producers. The dust in high-z galaxies must come from young, massive stars so Type II SNe could be potential sources. We are observing SNe in nearby galaxies to study their dust formation. Three observational signatures of this dust formation have been observed, a decrease in the continuum brightness in the visible, a developing infrared excess, and asymmetric, blue-shifted emission-line profiles. These indicators usually appear around 300-600 days after the SN explosion, unfortunately when the brightness of the SN has diminished considerably. But using Spitzer, along with the use of other large sensitive land based telescopes, more late-time data have become available, and in the cases of SNe 1999em, 2003gd, and 2004et, there is evidence of dust forming in the ejecta. Others show possible indicators of dust formation, and with continuing observations we hope to find that this is a common, though difficult to detect, occurrence. We are using new Gemini, Spitzer, HST, and other data to investigate the amount and nature of dust produced in Type II SNe.

Compiegne, Mathieu
CITA
Aromatic emission bands from the HII region head the Horsehead nebula

Aromatic Infrared Bands (AIBs) have been detected in a wide range of interstellar conditions (e. g., Boulanger et al., 1998; Uchida et al., 2000). These bands have already been reported in spectra of HII regions but never with clear proof that their emitters are located within the ionised gas rather than in the associated photodissociation region (e. g., Peeters et al., 2002). Moreover, several studies report the destruction of PAHs in highly excited HII regions which is attributed to the strong radiation field (e. g., Kassis et al., 2006).
We present our Infrared Spectrograph (IRS) data of the Horsehead nebula (part of the “SPECPDR” program, Joblin et al, 2005). AIBs are clearly detected in the HII region ahead of the Horsehead nebula. We report the correlation of the ionised gas emission intensity with those of the 11.3 μm AIB which is a proof that AIBs emitters are located within the ionised gas. We show that the shape of the AIBs spectrum in this environment can be explained by the presence of neutral PAHs. We also discuss the survival of PAHs within the physical conditions of this HII region.
This result highlights the transition of PAH properties between neutral gas and highly excited HII regions in the ideal conditions of the Horsehead nebula and allow us to derive a physical scenario in order to interpret spectra of more intricated or extra-galactic sources.

Corbelli, Edvige
INAF-Osservatorio Astrofisico di Arcetri
The gas to star conversion in Local Group spirals

The Local Group spirals M31 and M33 are our closest disk galaxies and offer a unique opportunity to trace in detail the distribution of the baryonic and dark component and gain important information on the disk formation and evolution.
Starting from the most recent results on the atomic and molecular gas distribution in these two galaxies I will then add important information for M33 to trace the processes which regulate the star formation in this nearby blue, low luminosity galaxy.
The M33 disk is made up of four distinct zones: the central one where we have just found kinematic evidence for a weak bar, the second zone where spiral arms trigger the formation of giant molecular clouds and bright star forming sites, the third one where active star formation proceeds without large molecular complexes, and finally the outer disk which links the active star forming disk

to the environment. We complement data of previous surveys with Spitzer images and IR photometry of discrete SF sites in this galaxy. The sensitivity and resolution of Spitzer maps for this galaxy are so high as to unveil all necessary ingredients for understanding the gas to stars conversion process throughout the whole star forming disk. M33 becomes then an ideal prototype for future studies on blue galaxies, actively forming stars which host no large amount of molecules or dust.

Covey, Kevin
Harvard-Smithsonian Center for Astrophysics
The Luminosity and Mass Function of Low-Mass Stars in the Galactic Disk
We present an initial measurement of the luminosity and mass functions of low mass stars as constructed from a catalog of matched Sloan Digital Sky Survey (SDSS) and 2 Micron All Sky Survey (2MASS) point sources. We have assembled a photometric catalog of 25,000+ matched SDSS and 2MASS point sources over a 'Calibration Region' spanning 30 square degrees on the sky. We have obtained follow-up spectroscopy, complete to J=16, of 500+ low mass dwarf candidates within a 1 square degree sub-set of this footprint, and thousands of additional dwarf candidates in the remaining 29 square degrees. This spectroscopic sample verifies that less than 1% of the photometric catalog is affected by incompleteness, contamination, or bias. Using this sample, we have derived the luminosity and mass functions of low-mass stars in the Galactic disk over nearly a decade in mass (0.7 Msolar < M* < 0.1 Msolar), comparing our results to those from studies of young clusters and the local volume-complete sample. Having validated the accuracy and reliability of this method, we are now extending this technique to analyze millions of stars within the SDSS/2MASS overlap.

Danforth, Charles
Univ. Colorado
Imaging the IR Cirrus Toward PKS0405-12
The infrared cirrus is a network of diffuse interstellar clouds seen over 50% of the sky at high Galactic latitude. Our interest in the cirrus is two-fold. First, the cirrus appears to contain a substantial amount of molecular hydrogen (Gillmon & Shull 2006), with H2 fraction showing a correlation with both cirrus intensity and total hydrogen column density. Using cirrus flux as a proxy for N(H2) allows us to correct large-scale HI surveys for the "missing" molecular contribution and estimate the total (atomic + molecular) mass in this diffuse ISM phase. Second, the cirrus may delineate the disk-halo interface and be a site of enhanced cooling, through H2 rotational excititaion, and triggered star formation. Detailed studies of cirrus morphology at small scales (less than 1') can provide the physical structure of the cirrus: thickness, particle density, and cooling rates.

We present deep, high-latitude observations of the cirrus mission toward PKS0405-12, the first of six fields in an ongoing IR/far-UV/21cm observation program of H2, HI, and cirrus. Correlated, emission is clearly visible at 8, 70, and 160 microns with clear structure at scales below 1'. This represents a considerable improvement over the resolution of IRAS data (>5') and will help correct the scatter in the cirrus-N(H2) relationship. We further analyze the high resolution, narrow field of view Spitzer data in the context of the wide-field, low resolution IRAS data. We look for breaks in the power-spectrum slope indicative of the physical scale of the cirrus layer.

Dobbs, Clare
University of Exeter
The formation of GMCs by agglomeration and self gravity in spiral galaxies
We show 3D MHD isothermal numerical simulations of GMC formation in spiral galaxies. Two scenarios for GMC formation are investigated, the agglomeration of gas and smaller clouds into GMCs by spiral shocks, and gravitational instabilities in the spiral arms. GMC formation by agglomeration occurs when there is a clumpy component of the ISM, i.e. cold HI or molecular gas. If only cold gas

is present, GMC formation can only occur by agglomeration, since the Jeans mass of the cold gas is less than that of a GMC. On the other hand, if there is only warm gas, GMCs can only form by gravitational instabilities. Generally, the ISM is presumed to contain both cold and warm components. Then both agglomeration and gravitational instabilities play a role. However, if the surface density is relatively low, the warm component will be stable to gravitational instabilities, and GMC formation occurs primarily by agglomeration. Properties of the GMCs, in particular their spacing along the spiral arm, then depend on the strength of the spiral shock. Nevertheless, self gravity increases the chances of clumps agglomerating, enhancing structure in the disk. At higher surface densities, self gravity dominates, determining the large scale structure of the disk and properties of GMCs.

Draine, Bruce
Princeton University
Dust Masses, PAH Fractions, and Starlight Intensities in the SINGS Galaxies
Dust models have been used to reproduce the infrared and submm emission
from the SINGS galaxies. It is found that the dust masses estimated from
these models -- based on only the observed IR and submm emission --
correlate very well with the gas mass and metallicity.
In most galaxies, the estimated dust mass
is consistent with a substantial
fraction of
interstellar C, Mg, Si, and Fe being locked up in
solid grains. The interstellar media in these galaxies
evidently maintain a large
fraction of their "refractory" elements in solid form.

The dust models also allow estimation of the PAH content of the galaxies.
The fraction of the interstellar dust mass that is contributed by
PAHs correlates with galaxy metallicity.

The dust modeling involves estimation of the distribution of starlight
intensities in the galaxies.
The dust-weighted starlight intensity <U> varies from
galaxy to galaxy, with a median <U>=2.4 (in units of the
starlight intensity in the local Milky Way). The dust models require that
a fraction of the dust heating take place in regions of high starlight
intensity, which are presumed to correlate with star-forming regions.

For nearby galaxies, the global modeling described above can be
repeated on the scale of the 160um psf, revealing variations in dust
surface density, PAH fraction, and starlight intensity properties
within galaxies.

Dudik, Rachel
George Mason University
Mid-Infrared Fine Structure Line Ratios in Active Galactic Nuclei Observed with Spitzer: Evidence for Extinction by the Torus?
The Case of the Low Line Ratios: Mid-infrared (mid-IR) emission-lines from highly ionized gas originating in the Narrow Line Region (NLR) of Active Galactic Nuclei (AGN) offer us the opportunity to examine the physical state of the gas within a few hundred parsecs from the central black hole. Indeed IR spectroscopic observations, especially in the era of the Infrared Space Observatory (ISO), have provided us with some of the most reliable tools for studying the NLRs of AGNs. However, while there are clear advantages

of mid-IR fine-structure diagnostics in studying the physical state of the ionized gas, very little work has been done to investigate their robustness in determining the gas densities of the NLRs in a large sample of local AGNs. Indeed it is quite possible that these line ratios are affected by aperture effects, extinction, and/or other physical processes not considered before. In this talk we present the first systematic investigation of the [NeV] (14um/24um) and SIII (18um/33um) infrared line flux ratios, used to probe density, in a sample of 41 local AGNs observed with the Infrared Spectrograph on board Spitzer. Surprisingly, our results indicate that these line ratios cannot be used to probe the density of the NLR and in fact are significantly affected by extinction, possibly by the torus.

Dwek, Eli
NASA Goddard Space Flight Center
Stellar Evolutionary Effects on the Abundances of PAH and SN-Condensed Dust in Galaxies
Spectral and photometric observations of nearby galaxies show a correlation between the strength of their mid-IR aromatic features, attributed to PAH molecules, and their metal abundance, leading to a deficiency of these features in low-metallicity galaxies. We suggest that the observed correlation represents a trend of PAH abundance with galactic age, reflecting the delayed injection of carbon dust into the ISM by AGB stars in the final post-AGB phase of their evolution. We also show that larger dust particles giving rise to the far-IR emission follow a distinct evolutionary trend closely related to the injection of dust by massive stars into the ISM.

Engelbracht, Charles
Steward Observatory
Metallicity Effects on Dust Properties in Starbursting Galaxies
We present infrared observations of 66 starburst galaxies over a wide range of metallicities, to measure how metallicity affects their dust properties. The data include imaging and spectroscopy from the Spitzer Space Telescope, supplemented by groundbased near-infrared imaging. We confirm a strong correlation of aromatic emission with metallicity, with a threshold at a metallicity (12+log[O/H]) ~8. The large scatter in both the metallicity and radiation hardness dependence of this behavior implies that it is not due to a single effect, but to some combination. We show that the far-infrared color temperature of the large dust grains increases towards lower metallicity, peaking at a metallicity of 8 before turning over. We compute dust masses and compare them to HI masses from the literature to derive the gas to dust ratio, which increases by nearly 3 orders of magnitude between solar metallicity and a metallicity of 8, below which it flattens out. The abrupt change in aromatic emission at mid-infrared wavelengths thus appears to be reflected in the far-infrared properties, indicating that metallicity changes affect the composition of the full range of dust grain sizes that dominate the infrared emission. In addition, we find that the ratio L(8um)/L(TIR), important for calibrating 24um measurements of high redshift galaxies, increases slightly as the metallicity decreases from ~solar to ~50% of solar, and then decreases by an order of magnitude with further decreases in metallicity. Although the great majority of galaxies show similar patterns of behavior as described above, there are three exceptions, SBS0335-052E, Haro11, and SHOC391. Their infrared SEDs are dominated energetically by the mid-IR near 24um rather than by the 60-200um region. In addition, they have very weak near infrared outputs and their SEDs are dominated by emission by dust at wavelengths as short as 1.8um. The latter behavior indicates that the dominant star forming episodes in them are extremely young. The component of the ISM responsible for the usual far infrared emission appears either to be missing, or inefficiently heated, in these three galaxies.

FLAGEY, Nicolas
Spitzer Science Center
An Explosive Discovery within the Eagle Nebula
We report the discovery of structured diffuse infrared emission in MIPSGAL 24 microns Spitzer images of the Eagle Nebula that fills the wind-blown cavity of this massive star forming region. We combine the Spitzer data with ISO and MSX observations to present a spectral energy distribution of this emission. The SED peaks at 24 microns and is fit by emission from silicates and/or graphite grains at ~90 K. We show that the emission cannot be powered by the NGC 6611 cluster radiation. The spatial extent, the dust temperature and the infrared brightness can all be accounted for by collisional heating of interstellar dust swept by a supernova explosion.

Flaherty, Kevin
Steward Observatory
Infrared Extinction Toward Nearby Star-Forming Regions
We present an independent estimate of the interstellar extinction law for the Spitzer IRAC bands as well as a first attempt at extending the law to the 24 micron MIPS band. The source data for these measurements are observations of five nearby star-forming regions: the Orion A cloud, NGC 2068/71, NGC 2024/23, Serpens and Ophiuchus. Color excess ratios E(H-Ks)/E(Ks-lam) were measured for stars without infrared excess dust emission from circumstellar disks/envelopes. For four of these five regions, the extinction laws are similar at all wavelengths and differ systematically from a previous determination of the extinction law, which was dominated by the diffuse ISM, derived for the IRAC bands. This difference could be due to the difference in the dust properties of the dense molecular clouds observed here and those of the diffuse ISM. In addition, we extended our extinction law determination to 24 microns for Serpens and NGC 2068/71 using Spitzer MIPS data. Our work confirms a relatively flatter extinction curve from 4 - 8 microns than the previously assumed standard, as noted by all of these recent studies. The extinction law at 24 microns is consistent with previous measurements and models, although there are relatively large uncertainties.

France, Kevin
CASA / Colorado
Cold Dust Emission and Extinction Correlations in BLAST Observations of IC 5146
We present new sub-mm observations of the northern
streamer region of IC 5146. These observations were carried out
during the 2005 flight of the Balloon-borne Large-Aperture
Sub-millimeter Telescope (BLAST). The data are broadband images
centered on 250, 350, and 500 microns. We combine the BLAST
images with archival IRAS and Spitzer-MIPS observations
to determine the spectral energy distributions (SEDs) of
several point-like and diffuse sources in IC 5146.
The SEDs reveal dust temperatures ranging from ~10 K
for diffuse structures to ~20 K for regions containing
IRAS point sources and/or known protostars.
We also present a preliminary analysis showing a correlation
between the coldest diffuse regions and the
extinction at optical and near/mid-IR wavelengths,
providing evidence that the
coldest regions in IC 5146 are infrared dark clouds.

Galliano, Frédéric
University of Maryland
The PAH and Dust Contents of an Evolutionary Sequence of Nearby Galaxies

A proper understanding of the processes controlling cosmic dust evolution requires observational constraints on the variation of galaxies' dust content with time. Nearby galaxies constitute useful systems to carry on such measurements, since they can be considered as snapshots of galaxy evolution at different epochs of their aging, due to the wide range of ISM metallicity they span. However, the complexity of galaxies considered as a whole makes an accurate estimate of the dust abundances very difficult. In particular, systematic variations from a galaxy to another (dust composition, age of the stellar populations, radiation conditions, contribution of HII regions, etc.) can bias the evolutionary trends derived from measured dust abundances.

I will present a SED modeling strategy aimed at solving these degeneracies. This empirical approach is fully constrained by the UV-to-radio continuum emission. It accounts for the contribution of HII regions to the total SED of a galaxy, where the PAHs do not likely survive. The PDR dust component is heated both by the escaping radiation from HII regions, and by a diffuse interstellar radiation field. The escaping stellar radiation is constrained by the UV-visible data, and consistent with the chemical evolution of the galaxy. In particular the detailed mid-IR spectrum is fitted to provide an accurate determination of the PAH abundance. This SED model has been successfully used to derive the PAH and dust distinct evolutionary trends, from 35 nearby galaxies (1/50<Z/Zsun<3) observed by Spitzer and ISO (astro-ph/0708.0790).

Galliano, Frédéric
University of Maryland
Variations of the Mid-IR Aromatic Features Inside and Among Galaxies
I will present the results of a systematic study of mid-IR spectra of Galactic regions, Magellanic HII regions, and galaxies of various types (dwarf, spiral, starburst), observed by the satellites ISO and Spitzer. We studied the relative variations of the 6.2, 7.7, 8.6 and 11.3 micron features inside spatially resolved objects (such as M 82, M 51, 30 Dor, M 17 and the Orion Bar), as well as among 90 integrated spectra of 50 objects. Our main results are that the 6.2, 7.7 and 8.6 micron bands are essentially tied together, while the ratios between these bands and the 11.3 micron band varies by one order of magnitude. This implies that the properties of the PAHs are remarkably universal throughout our sample, and that the relative variations of the band ratios are mainly controled by the fraction of ionized PAHs. In particular, we show that we can rule out the modification of the PAH size distribution as an explanation of these variations. Using a few well-studied Galactic regions (including the spectral image of the Orion Bar), we give an empirical relation between the I(6.2)/I(11.3) ratio and the ionization/recombination ratio G_0/n_e. Finally, I will discuss the physical interpretation of the I(6.2)/I(11.3) ratio, on galactic size scales.

Gogarten, Stephanie
University of Washington
Spatially Resolved Star Formation History of NGC 300
We present new Hubble Space Telescope (HST) observations of NGC 300
taken as part of the ACS Nearby Galaxy Survey Treasury (ANGST).
Individual stars are resolved in these images down to a magnitude of 27.5 in F814W. We compare our observed color-magnitude diagrams
(CMDs) with synthetic CMDs based on theoretical isochrones to
determine the star formation history of the galaxy in 25 bins along a radial strip. The areas which show recent star formation are coincident with the spiral arms, while the galactic center contains
predominantly older stars. Regions in between the spiral arms contain a large number of stars of intermediate age.

Goicoechea, Javier
LERMA-LRA (CNRS, Observatoire de Paris)
Detection of Class 0/I transition protostar near Ced~201 PDR
We present the detection and characterization of a low-mass protostar in the interesting but short-lived evolutionary stage between Class 0 and I sources. The protostar can be associated with IRAS 22129+7000, located at ~ 0.4 pc from Cederblad 201
photodissociation region (PDR). The cold circumstellar envelope surrounding the source has been resolved from its 1.2 mm dust

continuum emission with MAMBO IRAM-30m. The deeply embedded protostar is clearly detected in the IRAC (4.5, 5.6, and 8 um), IRS (20-35 um) and MIPS (70 um) emission
and also in the Ks band.
The presence of a well collimated molecular outflow
(mapped with the Caltech Submillimeter Observatory in the CO J=3-2 line) suggests that the protostar (+disk?) system is accreting material from the natal envelope. Indeed, optically thick line profiles from high density tracers such as HCO+ J=1-0
show a red-shifted-absorption asymmetry reminiscent of gas infall. The presence of both mechanical and radiative input makes the region an interesting dynamics laboratory to study how star formation is proceeding through the cloud.

Goncalves, Daniela
University of Toronto
Evidence of dust evolution in the North Celestial Pole Loop
We present dust emissivities for regions in the direction of the North Celestial Pole which are associated with different velocity gas (local and intermediate velocity clouds). These emissivities were obtained via spatial correlation analysis using thermal infrared dust emission maps (IRAS) and HI column densities derived from 21-cm emission observations done with the Green Bank Telescope (GBT). Variations in the size distribution of dust grains (which can be inferred from the excess of 60 relative to the 100 micron dust emissivities) are indicative of dust evolution.

Groves, Brent
Leiden Observatory
The Controlling Parameters of Starburst SEDs
I present a new series of model templates, which, when matched to observed
Spectral Energy Distributions (SEDs), provide details on the physical
conditions in a Starburst galaxy. These templates, based on the codes
Starburst99 and Mappings, depend upon parameters such as star-formation rate,
metallicity, and a new 'compactness' parameter, C. This C parameter
characterizes the specific intensity of the radiation field at ionization fronts
in HII regions, and controls the shape of the far-IR dust re-emission, often
referred to loosely as the dust `temperature'. I demonstrate how each of
these parameters affect the IR SED, including the PAH features. I also
show examples of the excellent fits obtained
to the full UV- FIR SEDs of well known Starbursting galaxies such as Arp220,
and also to the more detailed IRS Spectra of several Starbursts.

Gruendl, Robert
University of Illinois
A Complete Inventory of High- and Intermediate-Mass YSOs in the LMC
We have used archival Spitzer observations of the Large Magellanic Cloud (LMC) comprised mostly of observations by the SAGE Legacy program to search for high- and intermediate-mass YSOs in the LMC. We then use optical and near-IR observations to minimize the contamination of this sample by evolved stars with IR excesses, such as Asymptotic Giant Branch (AGB) and post-AGB stars, and extended sources, such as background galaxies and nebular emission knots. The resulting sample of YSOs is unique in that they all have a common, well-established distance (50 kpc) and are close enough that both existing and follow-up observations can be used to better establish their nature, physical properties, and interstellar environment.

We will present the methodology used to identify these YSO candidates and show examples where the combination of Spitzer IRAC and MIPS observations along with near-IR and optical observations are used to more precisely assess the physical properties of some YSO candidates.

Guillard, Pierre

Institut d'Astrophysique Spatiale (IAS)

The Stephan's Quintet: a beautiful case of H2 formation in shocks

Recently, Spitzer IRS (Infra-Red Spectrometer) observations led to the unexpected detection of extremely bright mid-IR H2 rotational line emission (Appleton et al. 2006) from warm gas towards the group-wide shock in Stephan's Quintet (hereafter SQ). This first result was quickly followed by the detection of bright H2 line emission from more distant galaxies (Egami et al. 2006, Ogle et al. 2007) and from the NGC 1275 and NGC 4696 cooling flows (Johnstone et al. 2007).

Because of the absence or relative weakness of star forming signatures (dust features, ionized gas lines) in the mid-infrared Spitzer spectra, the H2 emission must be powered by large-scale shocks, associated with galaxy interactions but also possibly with gas infall and AGN feedback. But how can we explain such a huge amount of molecular gas coexisting with a hot plasma? How come there is no (or very few) star formation associated with H2?

I will focus this talk on SQ, a group of four interacting galaxies. The shock is created by the galaxy NGC7318b which is colliding with a tidal stream at a relative velocity of about 1000 km/s. SQ is then a unique object where one can study the physics of galactic wide shocks. I will present the results of a model capable of interpreting the observations. Two key-points of our calculations of the physical and chemical evolution of the shock-heated dusty plasma will be emphasized: dust destruction and the inhomogeneity of the galaxy and intragroup gas. Schematically, low density gas is shocked at high speed. It becomes the X-ray emitting gas where dust is destroyed. Higher density gas is heated to lower temperatures and the dust survives. In the context of the SQ shock, this gas had time to cool and become molecular.

In the near future, this model will be extended to more distant objects belonging to this newly discovered and potentially important population of H2-bright galaxies. In particular, these H2 mid-IR lines appear to be a powerful diagnostic of unexplored steps in galaxy evolution.

Heiner, Jonathan
Kapteyn Astronomical Institute

PDR-Produced HI in SFRs of M33

We report our latest findings on the volume densities of molecular hydrogen in Giant Molecular Clouds (GMCs) associated with photodissociation regions (PDRs) in the nearby galaxy M33, using HI continuum, FUV- and metallicity data.

The morphology of the atomic hydrogen distribution is similar to what is expected for PDRs, since the HI is seen surrounding bright FUV sources. Potential PDRs that we detect, in which dissociating photons dominate the radiation field, have sizes in the order of 100 parsec. Complexes of young, hot stars are responsible for these PDRs. They create a 'blanket' of photodissociated HI.

The balance equation governing the photodissociation process needs the ultraviolet luminosity incident on the surface of the GMC and the local dust-to-gas ratio together with the HI column density in order to calculate the volume density of molecular hydrogen.

Verification of the PDR scheme that we are testing depends ciritically on the spatial resolution of the M33 data. To this end we investigated the potential PDRs of M33 both at a resolution of about 100 parsec as well as 30 parsec, using new high resolution M33 radio data kindly provided by David Thilker and Robert Braun. We also used publicly available Galex UV data at a comparable resolution. Earlier results for M81 and M83 had the right resolution to apply our method, but lacked the spatial resolution to truly discern any structure.

Heitsch, Fabian
University of Michigan

Cooling, Gravity and Geometry: Flow-Driven Molecular Cloud Formation

Converging flows of atomic hydrogen provide a natural mechanism
to form highly structured -- and turbulent -- molecular clouds,

due to a combination of strong thermal and dynamical instabilities.
Specifically the dynamical instabilities can lead to a
focusing of the incoming gas streams, and thus provide a
very efficient mechanism to form massive protostellar cores
of a few 100~M$_\odot$ within 10~Myr, at flow parameters
typical for the Galactic disk. I will discuss the relevance
of this mechanism for massive star formation, including
its predictions of where massive cores would form in
molecular clouds, and the resulting consequences on stellar feedback.

Hewitt, John
IPAC/Northwestern
Spitzer Spectroscopy of Supernova Remnants Interacting with Molecular Clouds
Supernova remnants have a formidable impact on the
dynamics, chemistry and evolution of their local environments. However a deep understanding of shock physics, even the nature of J- or C-type shocks, has remained unclear from observations. Infrared emission from these supernova remnants is rich in atomic fine-structure and molecular rovibrational lines which are crucial to understanding these shock interactions. With Spitzer IRS and MIPS-SED we have obtained sensitive, high-resolution spectroscopy between 5.2 and 95 microns for a large sample of 14 interacting remnants. Here we present results for a few of the most interesting remnants from our survey. In particular, the excitation rates of molecular hydrogen allow us to determine the gas temperature and density as well as discriminate between shock type and age. Evidence for shock processing of dust and PAHs is also considered.

Hidalgo-Gamez, Ana M.
ESFM-IPN
Diffuse Ionized gas in nearby irregular galaxies
The Diffuse Ionized Gas, defined as a low-density ionized gas, is very well known in the Milky Way as the Reynolds layer. Their characteristics are very well stablished, as the low value of the
[OIII]/Hb ratio, or the very high values of the [SII]/Ha and specially, the [NII]/Ha ratios. From our study of a total of 10 nearby irregular galaxies we can concluded that these characteristics are very different in the DIG of irregular galaxies. Moreover, the ionization sources are also different in the Milky Way and the irregular galaxies. The latter needs no other source of ionization but photons escaped from the classical HII regions, but for few galaxies where other ionization source are needed in order to obtain the line ratios observed.

Hines, Dean
Space Science Institute
Spitzer Observations of IC433
We present MIPS imaging and IRS spectroscopic data obtained by the Spizer Space Telescope of the well known interacting supernova remant (SNR) IC443. The morphology of the SNR at 24, 70 and 160um resembles even more a "close loop" or shell than the ground base optical and NIR images, and in this sense is remarkably different. The Long-Hi IRS spectra, obtained at 4 different position across the remanant, display strong atomic fine structure lines of [NeII] 12.8um, [Ne III] 15.6um, [Fe II] 26um and [SiII] 34.8um, among others, and consistent with shock velocities ~60-90 km/s. The pure rotational H2 lines S(0), S(1) and S(3) are also present in all pointings and the predicted excitation temperatures range from 300 to 650 K.

Hinz, Joannah
University of Arizona
The Spatial Distribution of Cold Dust in Nearby Galaxies
We present results from the Spitzer MIPS instrument regarding the spatial distribution of cold dust emission in a variety of nearby galaxies. Large masses of cold dust can be observed surrounding objects of varying physical size and morphological type, including galaxies quite low in mass. In several cases, the cold dust emission represented by the MIPS 70 and 160 micron images extends beyond

the optical and near-infrared disks of galaxies. The amount of detectable cold dust emission is likely dependent on the amount of diffuse, nonionizing ultraviolet photons produced by the young stellar population. Therefore, many more galaxies with lower rates of star formation may have large amounts of very cold dust that escape detection. The existence of such cold dust halos allows us to probe issues regarding the assembly, storage, and retention of dust in disk galaxies and to better understand how the dust interacts with its environment. For instance, tracing gas-to-dust ratios far into disks allows us to distinguish between methods of dust production and transportation, and comparing with other wavelengths enables us to locate the sources of dust heating.

Holwerda, Benne
Space Telescope Science Institute
The Vertical Dust Structure in Spiral Disks
The halo of NGC 891 has been the subject of studies for more than a decade. One of its most striking features is the large asymmetry in H-alpha emission. We have taken a quantitative look at this asymmetry at different wavelengths for the first time. We propose that NGC 891 is intrinsically almost symmetric, as seen in Spitzer observations, and the large asymmetry in H-alpha emission is mostly due to dust attenuation. We quantify the additional optical depth needed to cause the observed H-alpha asymmetry. A comparison of large strips on the North East side of the galaxy with strips covering the same area in the South West we can quantify and analyze the asymmetry in the different wavelengths. From the 24 ?m emission we find that the intrinsic asymmetry in star formation in NGC 891 is small i.e., approximately 30%. The additional asymmetry in H-alpha is modeled as additional symmetric dust attenuation which extends up to ? 40??(1.9 kpc) above the plane of the galaxy with a mid-plane value of tau=0.8 and a scale height of 0.5 kpc. This observational technique offers the possibility to quantify the effects of vertical ISM disk stability as an explanation for dust lanes in massive galaxies (Dalcanton et al. 2004).

Holwerda, Benne
Evolution and Extent of Disk Opacity
The Opacity of Spiral Disks
The opacity of a spiral disk due to dust absorption influences every measurement we make of it in the UV and optical. Two separate techniques directly measure the total absorption by dust in the disk: calibrated distant galaxy counts and overlapping galaxy pairs. The main results from both so far are a semi-transparent disk with more opaque arms and a relation between surface brightness and disk opacity.

In the Spitzer era, SED models of spiral disks add a new perspective on the role of dust in spiral disks. Combined with the overall opacity from galaxy counts, we can derive a typical optical depth and size of the dusty ISM clouds: 0.4 and 60 pc. respectively. Current work on galaxy counts is in the ACS fields of M51, M101 and M81.

Occulting galaxies offer the possibility of probing the history of disk opacity from higher redhift occulting pairs. Evolution in disk opacity could influence distance measurements (SN1a distances, Tully-Fisher relation). Here we present first results from spectroscopically selected occulting pairs in the SDSS. The redshift range for this sample is limited but does offer a first insight into disk opacity evolution as well as a reference for higher redshift measurements.

Holwerda, Benne
Space Telescope Science Institute
Spitzer's View of Edge-on Spirals: ISM Disk Stability
Edge-on spiral galaxies offer a unique perspective on disks. One can accurately determine the height distribution of stars and ISM and the line-of-sight integration allows for the study of faint structures. The Spitzer IRAC camera is an ideal instrument to study both the ISM and stellar structure in nearby galaxies; two of its channels trace the old stellar disk with little extinction and the 8 micron channel is dominated

by the smallest dust grains (Polycyclic Aromatic Hydrocarbons, PAHs).

Dalcanton et al. (2004) probed the link between the appearance of dust lanes and the disk stability. In a sample of bulge-less disks they show how in massive disks the ISM collapses into the characteristic thin dust lane. Less massive disks are gravitationally stable and their dust morphology is fractured. The transition occurs at 120 km/s for bulgeless disks.

Here we report on our results of our Spitzer/IRAC survey of nearby edge-on spirals and its first results on ISM disk stability.

Hora, Joseph
Harvard-Smithsonian Center for Astrophysics
Planetary Nebulae: Exposing the Top Polluters of the ISM

The high mass loss rates of stars in their asymtotic giant branch (AGB) stage of evolution is one of the most important pathways for mass return from stars to the ISM. In the planetary nebulae (PNe) phase, the ejected material is illuminated and can be altered by the UV radiation from the central star. PNe therefore play a significant role in the ISM recycling process.

We will briefly summarize the results of observations that have been carried out by several teams using the Spitzer instruments to study the gas and dust emission from PNe in the Milky Way and nearby galaxies. We will also present new results from our program on Galactic PNe, including IRAC and IRS observations of NGC 6720 in the ring and halo of that nebula.

Howk, J. Christopher
Univ. of Notre Dame
Extraplanar Dust in Spiral Galaxies

Extraplanar matter in the thick disks of spiral galaxies is a tracer of energetic outflow and circulation driven by star formation in the underlying thin disk, i.e., of feedback. It is quite clear now that the processes that eject gas from the thin disks of galaxies also operate on dust. I'll discuss Spitzer/IRAC observations of PAH or small grain emission from interstellar material in the thick disks of several edge-on spiral galaxies. Our Spitzer 8 micron images reveal extended emission, both smooth and filamentary, to heights 2-4 kpc from the planes of galaxies. The 8 micron emission traces components associated with both the extraplanar dust seen in high-resolution optical images and the extraplanar diffuse ionized gas in these galaxies. There is some evidence for direct connection of some of the filamentary structures to the underlying disk. These PAHs or small grains appear to be a common constituent of extraplanar material in spiral galaxies – the processes that circulate material from the thin interstellar disks of galaxies do not destroy these very small grains. I'll comment on the importance of these grains to the physics of the thick disk ISM.

Im, Myungshin
Seoul National University
MIR Emission from Early-Type Galaxies in Merging Clusters: Results from AKARI Mission Program, CLEVL

The extreme environment of merging clusters provides an excellent opportunity to study how the environment affects the evolutionary process of galaxies. As a part of the AKARI Mission Program, CLuster of Galaxies EvoLution Survey (CLEVL), we have conducted a MIR imaging survey of low redshift merging galaxy clusters with 6 contiguou bands ranging from 2-24 micron. The crucial 11 & 15 micron images, which nicely fill in gaps left in the Spitzer surveys, have been obtaint to sample the PAH features from star forming cluster members and dust emissoin from AGB stars to trace non-starforming, moderately old galaxies. We find that the number of galaxies MIR excess is significant in some clusters. The spatial distribution of these MIR-excess galaxies, either in star forming state, or in post-starburst stage, are also investigated.

Ingalls, James
Spitzer Science Center

PAHs in Low-Extinction Galactic Clouds: Mostly Ionized?

Using the Spitzer IRS, we have detected the faintest PAH emission spectra in Galactic clouds to date. The integrated intensities from PAH bands at 6.6, 7.7, and 11.3 microns measured towards 11 translucent (Av = 1-5; no internal UV sources) high Galactic latitude molecular clouds are linearly correlated with the ionized carbon [C II] integrated intensity measured with the ISO LWS. The 11.3/7.7 micron intensity ratio, which may be related to gas heating (via its inverse correlation with PAH ionization fraction), appears also to be proportional to [C II], which measures the gas cooling. Many of these translucent clouds, whose interiors are cold (T < 100K) and neutral (H I and H2), and which are only exposed to the background interstellar radiation field (ISRF), surprisingly appear to have PAH populations that are mostly ionized. In fact, we measure PAH intensity ratios similar to those in dense UV photon-dominated regions (PDRs) in the Galaxy, or in Seyfert and starburst external galaxies. The 6.2 micron feature is not even detectable in regions with the lowest values of [C II] intensity, suggesting that the smallest PAHs do not survive in the ISRF unless shielded by about 1 magnitude of visual extinction.

Ishihara, Daisuke
University of Tokyo

Initial results from AKARI mid-infrared all-sky survey

AKARI (formerly called ASTRO-F) is the first Japanese astronomical
infrared satellite mission
orbiting around the Earth in a sun-synchronous polar orbit at the
altitude of 700km.

One of the major observation programs of the AKARI is an all-sky survey
in the mid- to far-infrared spectral region with 6 photometric bands.
The all-sky survey observations were carried out from May 8 2006 to August 26 2007.
More than90% of the entire sky was observed at least twice during this period.

The AKARI mid-infrared survey was carried out
with the 9micron and 18micron bands
with the sensitivities of about 80 and 130mJy (5sigma per scan), respectively.

The spatial resolution is about 10 arcseconds at both bands.
The 9 micron band probes the UIR bands effetively, whereas the
20 micron band traces the thermal emission from warm dust grains.

We will present a short summary of the mid-infrared part of the
AKARI all-sky survey and report some initial results
to demonstate its great potential in star-forming regions in our Galaxy.
Point source catalog are planned to be released to the public within 2 years.

Jarrett, Thomas
SSC/IPAC

The Impact and Fate of the ISM in Compact Groups of Galaxies

Compact groups of galaxies provide a unique environment to study the evolution of the ISM and mechanisms by which star formation occurs amid continuous gravitational encounters. We present Spitzer, 2MASS, and HI observations of a sample of 12 Hickson Compact Groups (HCGs) that include a total of 45 galaxies. The galaxies in this sample have observed infrared characteristics that are distinctly different from the sample of galaxies in the Spitzer FLS or SINGS. Most notably, HCG galaxies exhibit a "gap" in infrared color space that is sparsely populated and which is not seen in either the FLS or SINGS. This gap may suggest a rapid evolution of galaxy properties in response to dynamical effects in HCGs. Moreover, there are striking trends seen between the ratio of HI mass to dynamical mass for an entire group and the infrared colors of the individual member galaxies. These trends suggest that the constituent galaxies in compact

groups are related to the type of group in which they reside. The results of this project can provide insight for the earlier universe when environments similar to those found in compact groups of galaxies were common.

Joblin, Christine
CESR, Université Toulouse 3 et CNRS
A global picture of the physical and chemical evolution of the mid-IR emitters : from Spitzer to the laboratory
The analysis of mid-IR spectro-imagery data has in the recent years provided more insights into the physics and chemistry of very small dust particles in photodissociation regions. These particles are found to be composed of very small grains (VSGs) and polycyclic aromatic hydrocarbons (PAHs) that are produced by the processing of VSGs at the surface of PDRs [1,2]. The strong gradients in the abundances of these particles are found to impact on the formation and excitation of H2 in these regions.
I will provide a global picture of the evolution of the very small dust particles and its implication on chemistry in both interstellar and circumstellar environments. PAH clusters [3] and nanograins made of Fe atoms and PAH units [4] have been proposed as VSG candidates. I will illustrate the interplay between IRS/Spitzer observations and studies in the laboratory on the fundamental properties of VSG candidates and PAHs including their possible role in H2 formation.

[1] Rapacioli M., Joblin C., Boissel P., 2005, A&A 429, 193
[2] Berne O., Joblin C., Deville Y., Smith J.D., Rapacioli M., Bernard J.-P., Thomas, J., Reach W. and Abergel A., 2007, A&A 469, 575
[3] Rapacioli M., Calvo F., Joblin C., Parneix P., Toublanc D., Spiegelman F., A&A 460, 519
[4] Simon, A. and Joblin, C., J. Phys. Chem. A (2007), DOI: 10.1021/jp072506a

Johnson, Benjamin
IoA, Cambridge
Early Results from the Spitzer-SDSS-GALEX Spectroscopic Survey
I will present recent results from the Spitzer-SDSS-GALEX Spectroscopic Survey (SSGSS). SSGSS is a Spitzer Legacy program of IRS observations of 100 galaxies uniformly selected from the SDSS (median redshift ~ 0.08). These IRS observations include low-resolution 5-40 micron spectroscopy, 16 micron photometry, and for 36 galaxies high resolution 10-19 micron spectroscopy. This comprehensive UV through IR imaging and spectroscopy of a representative sample of galaxies in the local universe will provide an ideal dataset for the testing of models that self consistently treat stellar populations, dust absorption, and dust emission. IR indicators of PAH abundance, dust tempertature and luminosity, and AGN activity derived from the SSGSS data may be compared to optical and UV indicators of star formation, stellar mass, dust attenuation, metallicity, and AGN activity. Such comparisons will serve to calibrate the IR indicators and to improve the understanding of the UV/optical indicators in the presence of attenuation.

Johnson, Kelsey
University of Virginia
The Infrared Properties of Hickson Compact Groups
Compact groups of galaxies provide a unique environment to study the mechanisms by which star formation occurs amid continuous gravitational encounters. We present 2MASS and Spitzer IRAC/MIPS observations of a sample of 12 Hickson Compact Groups that includes a total of 45 galaxies. The infrared colors of the galaxies in this sample span a range of parameter space, and some trends are apparent in the data. The near-infrared colors of the sample galaxies are largely consistent with being dominated by slightly reddened normal stellar populations. There is also some evidence for a K-band excess in a few cases, which likely indicates the presence of hot dust at or near the sublimation temperature associated with active galactic nuclei or star formation activity. Galaxies that have the most significant PAH and/or hot dust emission also tend to have larger amounts of extinction and/or K-band excess and stronger 24 micron emission, all of which suggest ongoing star formation activity. We separate the 12 HCGs in our sample into three types based on the ratio of the group H I mass to dynamical mass. We find evidence that galaxies in the most gas-rich groups tend to be the most actively star forming. Galaxies in the most gas-poor groups tend to be tightly clustered around a narrow range in colors consistent with the integrated light from a normal stellar population. We interpret these trends as indicating that galaxies in gas-rich groups experience star

formation and/or nuclear actively until their neutral gas is consumed, stripped, or ionized. The galaxies in this sample exhibit a "gap" between gas-rich and gas-poor groups in infrared color space that is sparsely populated and not seen in the Spitzer FLS sample. This gap may suggest a rapid evolution of galaxy properties in response to dynamical effects. These results suggest that the global properties of the groups and the local properties of the galaxies are connected.

Joshi, Umesh
Physical Research Laboratory, Ahmedabad, India
Interstellar extinction across the Galactic Bulge
Interstellar extinction across the Galactic Bulge is studied. Earlier studies have provided lower limits to areas of high extinction in these regions. Present work with GLIMPSE-II data supports the intermediate extinction derived from near-infrared surveys such as DENIS, 2MASS and complements these surveys providing complete extinction values for the regions where the near-infrared data give only the lower limits. Our extinction map shows maximum values of A_{V} up to 80^{m}. We also present extinction coefficients for each of the IRAC bands for the area surveyed by GLIMPSE-II.

Kaneda, Hidehiro
ISAS/JAXA
AKARI Observations of the ISM in Nearby Galaxies
We present initial results of our AKARI observations of nearby galaxies, which have been carried out in part of the AKARI mission program "ISM in our Galaxy and Nearby Galaxies" (ISMGN; PI: H. K.); the aim of this program is to perform systematic studies on interstellar dust and gas in various environments of our Galaxy and nearby galaxies.
About 50 nearby galaxies have been observed, for most of which near- to far-infrared images in the 10 photometric bands centered at 3, 4, 7, 11, 15, 24, 65, 90, 140, and 160 micron as well as 2-14 micron low-resolution spectra are obtained. Our data, especially the 11 and 15 micron imaging, the far-infrared 4-band imaging, and the near-infrared spectral data will be complimentary to the Spitzer data of nearby galaxies such as those from the SINGS legacy program.
We have so far studied in detail the spatial distributions of cool and warm interstellar dust for the face-on spiral M101, dust ring structures for the edge-on spirals NGC2841 and NGC2976, and properties of UIR bands for the face-on spiral NGC6946 and the giant elliptical NGC1316. In addition to these results, we will report the latest results of systematic observations of nearby elliptical and dwarf galaxies; for the former, we will include Spitzer/IRS results obtained from our GO1 and GO3 programs, which will also be complemented by the AKARI data.

kenney, jeff
yale university
Spitzer Observations of Environmental Effects on Virgo Cluster Galaxies
We present initial results from the Virgo Cluster Spitzer survey which includes MIPS and IRAC observations for a carefully selected sample of 44 Virgo cluster spiral and peculiar galaxies.

We combine the H-alpha and 24um maps to produce star formation maps and explore the effects of interactions on star formation. Examples of tidally triggered central starbursts, and ram-pressure induced star formation at the outer edges of stripped gas disks are found. Star-forming regions with large ratios of H-alpha to 24um emission are observed at the edges of some galaxies, probably due to ram pressure sweeping of the dust away from star forming regions. Large H-alpha-to-24um ratios at galaxy edges may be a good diagnostic of ongoing ram pressure.

Radio continuum emission from galaxies is a sensitive probe of ongoing ICM pressure on a galaxy's ISM, and is a great tool for distinguishing between active and past stripping. We use the Spitzer 70um maps and the FIR-radio correlation to predict what the radio

continuum distribution would be in the absence of ICM pressure. Differences between the observed and predicted radio maps show "radio deficit" regions near the leading edges of several galaxies, and "radio excesses" on the trailing side, clearly indicating ongoing ICM-ISM interactions. Galaxies with local "radio deficits" have globally enhanced radio emission (relative to the FIR emission), suggesting that ICM-ISM interactions accelerate cosmic ray electrons.

Comparisons of 8um PAH images with B-I ``dust extinction'' maps constrain interaction models by clarifying the ISM geometry. One of the largest Virgo spirals with clear evidence for ongoing ICM-ISM stripping is NGC 4569, in which all disk ISM tracers (HI, 8um, H-alpha) are sharply truncated at 30% of the optical radius.
Anomalous arm-like features of 8um, HI and H-alpha to the west of the truncated disk arise from gas that was stripped from the disk by ram pressure. A comparison of the relatively strong 8um dust/PAH emission with the relatively weak associated dust extinction in the B-I image indicates that the anomolous western dust and gas lies behind the stellar disk, and therefore is clearly stripped from the disk.

Klein, Randolf
UC Berkeley
MIPS Photometry and Spectroscopy of the ISM in Protoclusters
The onset of massive star formation and the initial conditions of the molecular cores for massive star formation are unclear. The quest is on for High-Mass Protostellar Objects (HMPOs) and earlier phases. HMPOs would be embedded in a forming cluster, a protocluster, as massive stars only form in clusters. We observed protocluster candidates with the MIPS instrument to constrain their spectral energy distribution (SED) in the far infrared (FIR). The resolution Spitzer provides is crucial to disentangle the contributions of different clumps which were resolved at other wavelength, but not in the FIR. We will show who the Spitzer observations allowed us to improve previous luminosity estimates by e.g. finding evidence for outside heating or just resolving the FIR emission. The data lead to a better understanding of energy budget of the cloud cores in these star-forming regions and constrain the nature of the young stellar objects in these protocluster candidates.

Koda, Jin
Caltech
ISM Evolution in M51
The entire M51 disk is observed in CO(1-0) line with the CARMA interferometer and Nobeyama 45m telescope. With the unprecedented high image fidelity and spatial resolution, we detect many giant molecular clouds (GMCs) both on spiral arms and in interarm regions. Associations of giant molecular clouds (GMAs) are found only on spiral arms, and thus, they are unbound, short-lived structures. Molecular gas fraction is high even in interarm regions. Therefore, the GMA destruction is caused not by stellar feedback, which is likely to destroy molecules as well as GMAs and GMCs. I will compare the observed results with our hydrodynamic simulations. I will discuss dynamically-driven ISM evolution -- strong shear motions in spiral arms cause GMA destruction and trigger ISM evolution.

Kroetz, Peter
University of Cologne
Direct Observations of Cold Molecular Hydrogen with Infrared Heterodyne Spectroscopy
Cold molecular hydrogen so far is virtually invisible and has to be traced by signatures like CO which is often a difficult task and not a generally applicable method. Direct observations could provide answers for many fundamental questions in astrophysics. For example, H2 is a candidate for dark matter and it is decisive in star formation and astrochemistry. We're developing a tuneable heterodyne infrared spectrometer (THIS) which will be capable to observe cold molecular hydrogen in absorption against warm background sources. The next target will be ground-based
observations of the ground state transition of ortho-H2 at 17 micron. Ultra high spectral resolution of up to 10^7 will enable to peak through telluric lines and retrieve dynamical information.
Future applications are observations of para-H2 at 28 micron onboard SOFIA.

Lee, Youngung
Korea Astronomy and Space Science
13CO Survey of Outer Galaxy

A survey prjoect towards the second quadrant of the Galactic Plane is presented using a multibeam array receiver system of Taeduk Radio Astronomy Observatory(TRAO). The initial targe region is from l=120 to 137 degree, and from b=-1 to +1, covering 34 square degree regions. The velocity resolution would be 1 km/s after smoothing from the original reslution of 0.64 km/s (234.4 kHz) in the transition of J=1-0 of 13CO. A fifteen-beam array receiver system has been purchased from Five College Radio Astronomy Observatory(FCRAO), and is being reinstalled on 14m telescope of TRAO. The survey region is a part of the Outer Galaxy Survey (OGS), and would be an extension of Bell Laboratories 13CO Galactic Plane Survey. By combinging with the exisiting 12CO database of OGS, we will derive physical properties of identified molecular clouds, and will conduct an statistical analysis of the Outer Galaxy molecular clouds.

Linsky, Jeffrey
JILA/University of Colorado and NIST
Structure, dynamics, and physical properties of the real ISM in the local neighborhood

We present a detailed empirical dynamical model of the local
interstellar medium that we believe is a useful prototype for interstellar gas in the Milky Way disk.
From high-resolution absorption line spectra in the ultraviolet and
visible, we have obtained 270 radial-velocity measurements for 157 sight lines
to stars located within 100 parsecs. This extensive data set allows us to
piece together a realistic, detailed model of the structure, dynamics, and
physical properties of the partially-ionized gas within the Local Bubble. We
have identified velocity vectors and projected morphologies of 15 warm gas
clouds located within 15 parsecs of the Sun. These clouds show a range of
gas temperatures, turbulent velocities, and metal depletions. Cloud-cloud
collisions may be responsible for the filamentary morphologies found in about
1/3 of the clouds. Large amplitude scintillation seen at radio wavelengths
toward several quasars is produced by scattering screens located at cloud boundaries and may result from the
turbulence produced by collisions between the clouds. We show that a
cold dense cloud located inside of the Local Bubble is likely compressed and shielded by surounding warm clouds.

Coauthor: Seth Redfield, Department of Astronomy and McDonald observatory, University of Texas and Hubble Fellow.

Lockman, Felix
NRAO
Dust in the Galactic ISM at high latitudes: the FIR-HI correlation

Observations of the HI emission over wide areas at high
Galactic latitude combined with the FIR emission in the same direction are now providing interesting diagnostics of the relationship between dust and gas in the Milky Way. We have been using the high sensitivity of the 100 meter Green Bank Telescope in the 21cm HI line to explore the FIR emissivity in several "foreground" fields. The kinematic information available in
the HI profiles makes it possible to disentangle FIR emission from overlapping components on the sky. We present results
on the Spitzer Extragalactic First Look Survey field and a
field in Bootes in which we exploit Spitzer observations as well. We find evidence for the presence of molecular hydrogen in some directions at neutral hydrogen column densities lower than the expected threshold. In Bootes we find an otherwise unremarkable HI filament with twice the FIR emissivity as other gas, implying significant processing of the grains, and/or enhanced heating.

Marengo, Massimo
Harvard-Smithsonian CfA
The Detection of Circumstellar Emission around Classical Cepheids with Spitzer
Marengo, M., Evans, N.R., Barmby, P., Bono, G., Welch, D.L. & Romaniello, M.

Our Spitzer Space Telescope survey of nearby classical Cepheids has revealed for the first time an infrared excess likely associated with warm (~ 500K) circumstellar dust around 7 short- and long-period Cepheids. This excess may be an indication of currently active mass loss processes, potentially addressing a discrepancy between Cepheids measured masses and the mass derived from evolutionary and pulsational models. Our sample of 29 Pop I Cepheids include a range of mass, luminosity, pulsational amplitude and binary status, all of which could influence mass loss.

Some of our targets (among which the class prototype delta Cep) show extended nebular emission in IRAC and/or MIPS bands, on spatial scales up to thousands of AU. This emission, centered on the star, may shed new light on the mass loss experienced by intermediate-mass stars when moving from H to He burning phases and on their complex interactions with the Galactic ISM.

Funding for this work was provided by Spitzer grant 1288762.

Markwick-Kemper, Ciska
University of Manchester
The Spitzer legacy of SAGE-Spectroscopy: The life cycle of dust and gas in the Large Magellanic Cloud
SAGE, Surveying the Agents of Galactic Evolution, mapped the entire Large Magellanic Cloud (LMC) with IRAC and MIPS. We are following this successful Spitzer Legacy program with SAGE-Spec, a Legacy program to obtain IRS and MIPS-SED spectroscopy of a multitude of objects identified from the SAGE observations, including interstellar environments, young stars and evolved stars. The first observations are expected in early 2008.

The SAGE legacy will be further leveraged by the comprehensive SAGE-Spec program, which encompasses IRS and MIPS SED spectroscopy of dust with the goal to determine the composition, origin, evolution, and observational characteristics of interstellar dust and its role in the LMC. Analysis of the spectra will yield composition and abundance of the dust compounds in different LMC objects, including AGB stars, post-AGB, Planetary Nebulae, young stellar objects, HII regions and the general diffuse ISM and provide a quantitative picture of the dust lifecyle. Besides dust features, the spectra will also contain molecular and atomic emission and absorption lines, providing the diagnostics to determine physical parameters such as temperature, density and radiation field - all important to the formation and processing of dust, and understanding the life cycle of matter. A legacy to the community will be delivered in the form of a complete spectral catalog and spectral feature maps of extended regions. In addition, SAGE-Spec will also provide critical underpinning for the SAGE survey by linking observed IRAC and MIPS colors of LMC objects to the infrared spectral type of the object.

Markwick-Kemper, Ciska

University of Manchester

Dust composition in Broad Absorption Line quasars

We present Spitzer IRS spectroscopy of a sample of Broad Absorption Line Quasars found at varying redshifts (z = 0.04 to 2.2), in addition to the spectrum of PG 2112+059 (Markwick-Kemper et al., 2007, ApJL, in press). All of the objects in our sample show the presence of silicate bands in emission at ~10 micron (and ~18 micron for the objects with z < 1), although the band shapes vary significantly over the sample. We have made an inventory of the dust components contributing to the appearance of the silicate feature, and report a large range of grain properties, varying from source to source. In particular, we focus on the silicate composition and degree of crystallinity, but we also determine the amount of more primitive condensates present, such as aluminum- and magnesium-oxide. In some objects a clear contribution of polycyclic aromatic hydrocarbons (PAHs) is also present in the spectra. The dust composition will provide us with useful constraints on the formation history of the grains, and we will use this information to determine the likelihood of dust formation in the quasar winds. These dusty winds may represent the actual physical form of the "torus", and therefore the dust composition analysis offers insight into the Unified Model for active galaxies.

Marleau, Francine

SSC, Caltech

Discovery of Highly Obscured Galaxies in the Zone of Avoidance

We report on the discovery of twenty-five previously unknown galaxies in the Zone of Avoidance. Our systematic search for extended extra-galactic sources in the GLIMPSE and MIPSGAL mid-infrared surveys of the Galactic plane has revealed two overdensities of these sources, located around l ~ 47 and 55 deg and |b| < 1 deg in the Sagitta-Aquila region. These overdensities are consistent with the local large-scale structure found at similar Galactic longitude and extending from b ~ 4 to 40 deg. We show that the infrared spectral energy distribution of these sources is indeed consistent with those of normal galaxies. Photometric estimates of their redshift indicate that the majority of these galaxies are found in the redshift range z = 0.01 - 0.05, with one source located at z = 0.07. Comparison with known sources in the local Universe reveals that these galaxies are located at similar overdensities in redshift space. These new galaxies are the first evidence of a bridge linking the large-scale structure between both sides of the Galactic plane at very low Galactic latitude and clearly demonstrate the feasibility of detecting galaxies in the Zone of Avoidance using mid-to-far infrared surveys.

Marsden, Gaelen

University of British Columbia

BLAST measurement of cold dust towards the Cas A Super Nova remnant

We present BLAST observations at 250 μm, 350 μm and 500 μm of the supernova remnant Cassiopeia A (Cas A)and its surroundings. The BLAST passbands, and their careful relative calibration allow precise determination of the column density and temperature of cold (T<40K) dust. We find that the SED in the direction of Cas A is best fit by a two-temperature modified black-body function, whilst the cloud knot region can be fit by a single temperature modified blackbody. The temperature of this cloud knot region

is found to be the same as the cold component of the fit in the direction of Cas A. This suggests that the cold dust emission seen in the direction of Cas A is associated with an extended foreground cloud structure, rather than with the remnant. This seriously challenges the argument for significant amounts of cold dust production in SNe and therefore changes our view of how dust might be produced in the early universe.

Marshall, Douglas
Université Laval
New insights into the dustlanes of the Milky Way
Trails of dust inside galactic bars are easily observable in external galaxies. However, information on the dust lanes of the Milky Way is harder to obtain due to our position within the Galactic disc. By comparing the distribution of dust and gas in the central regions of the Galaxy, we aim to obtain new insights into the properties of the offset dust lanes leading the bar's major axis in the Milky Way.

On one hand, the molecular emission of the dust lanes is extracted from the observed CO l-b-V distribution according to the interpretation of a dynamical model. On the other hand, a three dimensional extinction map of the Galactic central region constructed using near-infrared observations from 2MASS is used as a tracer of the dust itself and clearly reveals dust lanes in its face-on projection. Comparison of the position of both independent detections of the dust lanes is performed in the (l,b) plane.

These two completely independent methods are used to provide a coherent picture of the dust lanes in the Milky Way bar. In both the gas and dust distributions, the dust lanes are found to be out of the Galactic plane, appearing at positive latitudes for $l>0°$ and at negative latitudes for $l<0°$. However, the amplitude of the tilt is more pronounced for the molecular gas than for the dust resulting in the dust lying closer to the Galactic plane, on average, than the molecular gas. This suggests the presence of a vertical gradient in the bar's dust to gas mass ratio.

This type of study may be generalised to other stellar observations - work is currently underway to perform similar 3D studies of the ISM in the Galactic plane using the GLIMPSE point source catalog.

Martin, Peter
CITA
Mapping the complex structure of the cool ISM using the Balloon-borne Large Aperture Submillimeter Telescope
A number of Galactic plane surveys in star-forming regions like Cyg X with the Balloon-borne Large Aperture Submillimeter Telescope (BLAST) have revealed the stunning complexity of the interstellar medium as imaged in this new spectral window (250, 350, 500 microns). BLAST reveals the cool dust emission from previously detected protostars, and with unique spectral coverage near the peak of the spectral energy distribution, tightly constrains the temperature. But BLAST also sees dust so cold that its presence is missed even in far-infrared emission, including structures such as infrared dark clouds. Unlike surveys from the ground at slightly longer wavelengths, mapping with BLAST is not heavily spatially filtered, so that the hierarchy of larger-scale cold structures in the embedding molecular clouds in captured as well. As intended, these BLAST surveys provide striking realizations of the great potential anticipated for the submillimeter imaging to be carried out using the SPIRE camera on the Herschel Space Observatory.

Martini, Paul
The Ohio State University
The Evolving ISM at the End of the Hubble Sequence
Recent observations have shown a profound difference in the ISM of late-type disk galaxies with circular velocities greater and less than 120 km/s. While the more rapidly rotating disks possess the same thin planar dust characteristic of other spirals, late-type disks with lower circular velocities lack the strong color gradients indicative of narrow dust lanes. We present HST observations a sample of late-type disks above and below this circular velocity to study the dust morphology as revealed by contrast enhancement techniques. These data also provide exquisite resolution to search for pseudobulges and nuclear star formation, signposts of secular evolution than may require a cold component of the ISM to form.

Matsumoto, Hiroko
The University of Tokyo
Mid-Infrared Observations of the Dwarf Galaxy NGC1569 with AKARI

We report the results of recent near- to mid-infrared imaging and spectroscopic observations of the starburst dwarf galaxy NGC1569 with the Infrared Camera (IRC) on board AKARI. NGC1569 is a dwarf galaxy located at about 2.2Mpc that is known to contain several super star clusters (SSCs). It is suggested that accretion from a HI cloud located at about 5kpc from the galaxy may have triggered the starburst 10-20Myr ago. Supernovae resulting from the starburst create hot bubbles, part of which are seen as filaments in Halpha and X-ray.

Mid-infrared imaging observations with 4 bands of the IRC (7, 11, 15, and 24um) indicate that SSCs are faint at 7 micron (S7 band) relative to other 3 bands, while a filament is clearly seen at S7. Since the S7 band efficiently probes the 6.2um and the 7.7um band emissions, which are attributed to polycyclic aromatic hydrocarbons (PAHs), the filament should contain an appreciable amount of PAHs. Follow-up observations of near- to mid-infrared spectroscopy (2-13um) with the IRC indeed confirm the presence of the 6.2, 7.7, 8.6, and 11.2um band features in the filament. The spectrum has a strong 11.2um band relative to other bands and is not much different from that of SSC A taken with IRS on Spitzer. The presence of PAHs suggests that the filament is created from ejection of materials from the galaxy rather than injection from the HI cloud, whereas survival and processing of PAHs in the ejection process indicates a quite 'refractory' nature of PAHs.

Matthews, Lynn D.
Harvard-Smithsonian CfA
Discovery of Corrugations in the Disk of the Nearby Spiral Galaxy IC2233

The HI gas and other Population I tracers in the disk of the Milky Way have long been known to exhibit deviations from the mean plane in the form of a regular pattern of vertical displacements or ``corrugations''. The origin of these corrugations has been a longstanding puzzle, and little has been known about the presence of this phenomenon in external galaxies. Using data from the Very Large Array, we recently discovered the first example of a corrugated structure in the HI disk of an external galaxy--- the isolated, edge-on Sd spiral IC2233. The HI undulations in IC2233 are visible as a remarkably regular pattern of positive and negative displacements with a wavelength of ~150" (7 kpc) and an amplitude that increases with distance from the center of the galaxy, reaching a maximum of ~3" (~150 pc). Analyzing new data from Spitzer and GALEX, we confirm that these corrugations also affect the dust and young stellar populations of the galaxy, but are not as readily traceable in the old stars. We will discuss how these multi-wavelength observations constrain the possible origins of the corrugations. We will also show results from the analysis of the vertical structure of two additional galaxies based on multi-band Spitzer data.

Mattioda, Andrew
NASA Ames
The First Far-Infrared Spectra of Matrix-Isolated Large PAHs

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The mid-infrared (IR) spectra of a large majority of astronomical sources are dominated by a family of emission features falling around 3.3, 6.2, 7.7, and 11.2 µm. These features, formerly referred to as the Unidentified Infrared (UIR) Bands, are generally thought to originate in polycyclic aromatic hydrocarbons (PAHs) and closely related species. In addition to dominating the 3-20 µm region of the spectrum, they carry some 20 to 40% of the total IR luminosity from most of these objects. As such, this material tracks and moderates a wide variety of astronomical processes making this spectrum an important probe of the cosmos.
Apart from these characteristic bands in the Mid-IR, PAHs also have bands spanning the Far-IR (FIR) (20 to 1000 µm) region and these PAH FIR features should be present in astronomical sources as well. At present the FIR spectral characteristics are known only for a few neutral small PAHs trapped in salt pellets or oils at room temperature, conditions that are far from that relevant to astrophysics. This presentation will provide the first experimental measurements of the FIR spectral properties of several large, neutral PAHs. The FIR spectra of PAHs: C24H12, C32H14, and C48H20, isolated in a Krypton matrix, will be described. The experimental data will be compared with theoretical spectra, focusing on the nature of the vibrations responsible for the FIR bands and some astrophysical implications will be discussed.

McCollum, Bruce
SSC

A Large Dust Lobe Associated with the Symbiotic BI Crucis

Spitzer IRAC and MIPS images reveal a large, shell-like dust
emission feature approximately five arc minutes in diameter which appears to be a unipolar lobe associated with and connecting to the D-type symbiotic BI Crucis. Much smaller optical lobes are already known to be associated with some bipolar PNe including BI Crucis. However, this is the first extended structure found in the IR which is associated with a bipolar PNe. The IR lobe of BI Crucis is approximately five times larger in arc minutes than the star's optical lobe. The lobe's position is consistent with that of the elongated optical lobe. Published distance estimates
imply that the IR lobe is approximately two to four times larger
physically than the largest such optical bipolar PNe feature known. The large disparity between IR and optical lobe sizes, along with what appear to be multiple intersecting arcs, suggest that BI Crucis may have undergone multiple mass-loss episodes. A trend of rapidly increasing brightness toward longer wavelengths suggests a greater abundance of relatively colder and older
dust.

McGehee, Peregrine
IPAC

The SDSS High Latitude Cloud Survey

The high latitude clouds (|b| > 30) are primarily translucent molecular clouds and diffuse Galactic cirrus with the majority of them seen at high latitude simply due to their proximity to the Sun. The rare exceptions are those, like the Draco and other intermediate or high velocity clouds, found significantly above or below the Galactic plane. To date, star formation has only been verified in MBM 12 and MBM 20, which are two of the densest high latitude molecular clouds.

We present results from an ongoing study of high latitude clouds based on the Sloan Digital Sky Survey (SDSS) and the Two Micron All-Sky Survey (2MASS). This study consists of two major efforts, the first to provide a 3-D mapping of the interstellar dust using a color-excess technique, the second to identify candidate low-mass Classical T Tauri stars in the field.

Meier, David S.

NRAO - Socorro

The Localized Interplay Between Star Formation and Gas Chemistry in Nearby Starburst Galaxies

Massive star formation associated with starbursts inject large amounts on momentum and energy into the surrounding molecular ISM, profoundly effecting its chemical state. Hence locations, abundances and excitation of various chemical species are sensitive probes of the state of the molecular gas and its connection to the evolution of a starburst. We present high spatial resolution (~25-75 pc) imaging surveys of the nuclear chemistry in the nearby, starburst spirals, IC 342 and Maffei 2. Observations of species including the CO isotopologues, HCN, HNC, C2H, CN, HC3N, C34S, N2H+, CH3OH and HNCO obtained with the OVRO, BIMA and VLA interferometers are discussed. Strong chemical differentiation is observed on GMC scales in both nuclei, with the bulk of the differentiation resulting from the distinct morphologies of hydrocarbons, like C2H, HNC and HC3N, from saturated species like CH3OH. C2H is found to be a privileged traced of the locations of PDRs in these external galaxies, with PDRs highly confined (~50 pc scales) in IC 342 but somewhat less so in Maffei 2. CO isotopologue ratios provide direct evidence of ISM enrichment from massive star ejecta in these same locations. The morphology of C2H, along with resolved maps of gas excitation from 13CO and HC3N demonstrate that the influence of massive star formation remains confined to the immediate (young) starburst environment. At these very localized PDR sites star formation in both nuclei is observed to inject enough energy/momentum to deflect molecular clouds radially outward. Grain species such as CH3OH and SiO show that the presence of large scale shocks are common in spiral nuclei, but their locations do not correlate with star formation or where it interacts with the molecular gas. Unlike commonly observed in the Galactic disks, these shocks are not associated with newly formed stars. Instead they originate from orbital resonances in the nuclear potential. Complimentary Spitzer IRS maps of IC 342 and Maffei 2 are also compared to the distribution of molecules to relate dust properties to the gas phase chemistry.

Meijerink, Rowin

UC Berkeley

Probing Atomic and Molecular Gas in Protoplanetary Disks

Disks play a crucial role in planet and star formation. Although most of the disk mass is initially gaseous, there is observationally little known about the gas. Most of the observations are of the dust, such as scattered light images, interferometric measurements and SEDs. X-rays, which are produced by Young Stellar Objects, interact with the upper layers of the surrounding protoplanetary disk and are expected to dominate the thermal and chemical balance. Strong NeII 12.81 mum is predicted for these disks, which is consistent with recent Spitzer observations. Predictions are also made for the observability of complementary diagnostics, such as atomic forbidden and fine-structure lines of CI, CII, OI and SI, and molecular rotational lines of H2O, which trace other parts of the disk.

Muno, Michael

Caltech

Chandra Observations of Stellar Life Cycles in the Galactic Center

We present the results of Chandra observations of the inner 2 by 0.8 degrees of the Galaxy, and a comparison to radio, near infrared, and mid-infrared observations. The X-ray emission highlights the locations of massive stars, compact stellar remnants, and hot plasma that is produced by stellar winds and supernovae. Comparing catalogs of X-ray and infrared point sources, we identify ~60 new candidate OB stars, several of which have been confirmed spectroscopically. Examining the diffuse emission, we identify emission lines from He-like silicon, sulfur, and iron. We use this emission to estimate the mechanical energy input into the ISM by young stars. These measurements provide important steps for understanding the fate of mass channeled into the Galactic center, namely how much is converted into stars, how much is ejected as a Galactic wind, and how much can ultimately be devoured by the central supermassive black hole.

Murphy, Eric

SSC/Caltech

Connecting Far-Infrared and Radio Morphologies of Disk Galaxies: Cosmic-Ray Electron Diffusion After Star Formation Episodes

We present results on the interstellar medium (ISM) properties of 29 galaxies based on a comparison of {\it Spitzer} far-infrared and Westerbork Synthesis Radio Telescope (WSRT) radio continuum imagery.
Of these 29 galaxies, 18 are close enough to resolve their

star-forming disks at $\la$1~kpc scales at 70~$\micron$ and 22~cm.
We extend the Murphy et al. 2006a,b approach of smoothing infrared images to approximate cosmic-ray (CR) electron spreading and thus reproduce the appearance of radio images.

Using a wavelet analysis we decompose each 70~$\micron$ image into one component containing the star-forming {\it structures} (spatial scales $<$1~kpc) and a second one for the diffuse {\it disk} (spatial scales $\geq$1~kpc).
The components are smoothed separately, and their combination compared to the 22~cm radio image corrected for thermal radio emission; the scale-lengths are then varied to achieve the best match between the radio and smoothed infrared images.
We find that late-type spirals having high amounts of ongoing star formation activity benefit most from the two-component method.
We also find that the disk component dominates the appearance and
smoothing scale-lengths of galaxies having low star formation
activity, whereas the structure component dominates at high star
formation activity.

We argue that this result arises from an age effect rather than from differences in CR electron diffusion due to varying ISM parameters.
The CR electron population in actively star-forming galaxies
is significantly younger at 50 Myr than the bulk of the CR electron population associated with the disk component.
This sets the time scales for these episodes of enhanced star
formation activity.
The sample Irregulars are found to have anomalously low best-fit
scale-lengths for their surface brightnesses compared to the rest of the sample spirals which we attribute to enhanced CR electron escape.

Murphy, Eric
SSC/Caltech
Environmental Effects in Clusters: Modified Far-Infrared--Radio Relations within Cluster Galaxies
We present a study on the effects of the intracluster medium (ICM) on the interstellar medium (ISM) of 10 Virgo cluster galaxies included in the Virgo in Atomic gas (VIVA) survey using {\it Spitzer} far-infrared (FIR) and VLA radio continuum imaging.
Relying on the FIR-radio correlation {\it within} galaxies we use our infrared data to create model radio maps which we compare to the observed radio images.
For 6 of our sample galaxies we find regions along their outer edges that are highly deficient in the radio compared with our models.
We also find FIR emission, as observed, detected slightly beyond the radio disk along these outer edges.
We believe these observations are the signatures of ICM ram pressure.
For NGC~4522, a well studied example of a galaxy affected by ram
pressure, we find the radio deficit region to lie just exterior to a region of high radio polarization and flat radio spectral index; the total radio continuum in this region appears only moderately enhanced.
This scenario appears consistent for other galaxies with radio
polarization data in the literature.
We also find that galaxies having local radio deficits appear to have enhanced global radio fluxes; the global FIR/radio ratios of these galaxies lie systematically below the average value found among field galaxies and show a decrease with increasing severity of the observed radio deficiencies.
Our preferred physical picture is that the observed radio deficit
regions arise from the ICM wind sweeping away low density CR electrons and the associated magnetic field.
While some CR electrons are swept downstream, thereby creating
synchrotron tails observed for some of our galaxies, CR particles
are also re-accelerated by ICM-driven shocklets behind the observed radio deficit regions.
The high radio polarization and lack of coincidental signatures
in the total synchrotron power in these regions arises from shear as the ICM wind drags and stretches the magnetic field.

Neufeld, David
Johns Hopkins University
Probing warm molecular hydrogen with Spitzer/IRAC
IRAC maps of shock-heated interstellar gas - extracted from the Spitzer archive - are often strikingly similar to spectral line maps of the H2 pure rotational transitions that we have obtained with Spitzer's IRS instrument. For many of the sources we observed, IRS spectroscopy indicates that IRAC Bands 3 and 4 are indeed dominated by the H2 v=0-0 S(5) and S(7) transitions, respectively, and modeling of the H2 excitation suggests that Bands 1 and 2 are dominated by H2 v=1-0 O(5) and v=0-0 S(9). We will discuss how the IRAC band ratios in sources with H2-dominated mid-IR spectra can be used to constrain the physical nature of the warm molecular gas responsible for the emission.

O'Halloran, Brian
George Mason University
Tracing the [FeII]/[NeII] ratio and its relationship with other ISM indicators within star forming dwarf galaxies: a Spitzer IRS archival study.
Archival Spitzer observations of 41 starburst galaxies that span a wide range in metallicity reveal for the first time a correlation between the [FeII]/[NeII] 26.0/12.8 μm ratio and the electron gas density, with the [FeII]/[NeII] ratio decreasing with increasing gas density. We also find a strong correlation between the gas density and the PAH peak to continuum strength. Using shock and photoionization models, we explore the true nature of the driver of the [FeII] emission, and by extension, of the [FeII]/[NeII] ratio in a wide range of dwarf galaxy environments. Assuming that the [FeII]/[NeII] ratio is truly a tracer of shocks, we also explore the effect of the passage of shocks on other ISM indicators.

Ocaña Flaquer, Breezy
IRAM
Molecular gas and dust in nearby radio galaxies
Powerful radio-AGN are normally hosted by massive elliptical galaxies which are usually very poor in molecular gas. Nevertheless the central black hole needs molecular gas to feed the nuclear activity. Thus it is important to study the origin, the distribution and the kinematics of the molecular gas in such objects.
We have performed at the IRAM-30m a survey of the CO(1-0) and CO(2-1) emission in the most powerful radio galaxies of the Local Universe, selected only on the basis of their radiocontinuum fluxes. The main result of that survey is the very low content in molecular gas of such galaxies compared to Seyfert galaxies. The median value of the molecular gas mass is 4x10^8 solar masses. Moreover, the CO spectra indicate the presence of a central molecular gas disk in these radio galaxies. Our results contrast with previous surveys, mainly selected through the FIR emission, with a larger mass of molecular gas observed. The first results indicate that minor mergers are good candidates to fuel the central part of the radio galaxies of our sample.
We complement the CO survey with photometric data of Spitzer (both the Infrared Array Camera -IRAC, and the Multi-band Imager Photometer for Spitzer -MIPS) with the purpose of studyng the dust (Spectral Energy Diagram (SED), morphology) and its relation with the molecular gas and the AGN.

Ogle, Patrick
Spitzer Science Center
Extreme H2 Emission Galaxies
We have discovered a new class of radio galaxies with very luminous pure-rotational H2 emission lines from warm, shocked molecular gas. In spite of having large masses of molecular gas, with high surface densities in the central few kiloparsecs, these galaxies have

very low star formation rates and weak AGNs. In some sources, up to 10% of the total IR emission is in the H2 lines. We believe that the H2 emission is powered by accretion of molecular gas stripped by via collisions with nearby companion galaxies. Star formation may be suppressed by shock heating and turbulence in the disturbed ISM of these massive, interacting galaxy systems.

Okada, Yoko
Department of Infrared Astrophysics, Institute of
Si and Fe depletion in Galactic star-forming regions

We report the results of the mid-infrared spectroscopy of 14 Galactic star-forming regions with the high-resolution modules of the Infrared Spectrograph (IRS) on board the Spitzer. We detected [SiII] 35 micron, [FeII] 26 micron, and [FeIII] 23 micron as well as [SIII] 33 micron and H2 S(0) 28 micron emission lines. According to the intensity of [NII] 122 micron or 205 micron and [OI] 146 micron or 63 micron reported by previous observations in four regions, we derived the ionic abundance Si+/N+ and Fe+/N+ in the ionized gas and Si+/O0 and Fe+/O0 in the photodissociation gas. For all the targets, we derived the ionic abundance of Si+/S2+ and Fe2+/S2+ for the ionized gas. Based on photodissociation and HII region models the gas-phase Si and Fe abundance are suggested to be several tens of percent and several percents of the solar abundance, respectively. Since the [FeII] 26 micron and [FeIII] 23 micron emissions are weak, the high sensitivity of the IRS enables to derive the gas-phase Fe abundance widely in star-forming regions. The gas-phase Si abundance is much larger than that in cool interstellar clouds and that of Fe, and we discuss possible mechanisms to account for the observed trend; mantles which are photodesorpted by UV photons, organometallic complexes, or small grains.

Onaka, Takashi
University of Tokyo
The 22 micron emission feature in supernova remnants and massive starforming regions

Spitzer/IRS observations have confirmed the presence of the broad emission feature around 22 micron in the Carina nebula suggested by ISO/SWS observations. They have indicated that the feature peak is located around 23 micron and its intensity peaks near the ionization front. It has been suggested that the feature may originate from dust grains formed in supernovae since a similar feature has also been reported in Cas A SNR. IRS observations of
Cas A confirm the feature, but it seems to peak at a little shorter wavelength (about 21 micron) relative to that seen in the Carina nebula. The IRS spectrum of Kepler SNR, on the other hand, shows a very broad feature around 19--20 micron. IRS spectra of some HII regions also show a broad emission feature
similar to the Carina spectrum. These results suggest that dust grains relating to SNe or massive star-formation have a feature around 20--23 micron, which are not exactly the same species, but should have similar compositional characteristics. Possible band carriers, ranging from Ca-proto silicate to nano-diamond, are examined. The feature should be significant for the investigation of recent star-formation activities in external galaxies.

Onaka, Takashi
University of Tokyo
AKARI Large Area Survey of the Large Magellanic Cloud

We present the results of the large area survey observations of the LMC with the AKARI infrared satellite. In addition to the all-sky survey observations at 9, 18, 65, 90, 140, and 160 micron, about 10 square degree region of the LMC has been observed in pointed observations with the Infrared Camera (IRC) on board AKARI at 3, 7, 11, 15, and 24 micron bands. Together with these imaging observations, 2--5 micron low-resolution slit-less spectroscopy was

also carried out for the same area. These data, particularly the 11 and 15 imaging and near-infrared spectral data, complement the SAGE observations and will provide significant information to the various fields of the LMC research. We report the latest status of the AKARI LMC observations together with some early results.

Ott, Juergen
NRAO/Caltech

The ATCA Galactic Center Ammonia Survey - Temperature Maps of the Central Molecular Zone of the Milky Way

The Galactic Center region is obviously the most nearby core of a galaxy and is subject to extreme physical conditions, e.g., it contains the most nearby massive black hole Sgr A* and the very prominent star forming region Sgr B2. One of the major components of the ISM in the Galactic Center Region is molecular gas. The dense gas is responsible for the abundant formation of stars which, in turn, feed back large amounts of mechanical energy and strong UV radiation to the ISM. One of the parameters that regulate and are sensitive to those processes is the temperature. We are using the ammonia inversion transitions to map the temperature of the dense molecular gas in the Central Molecular Zone of the Milky Way. Or observations are two-fold: a Mopra single dish (resolution 2.4', about 6pc), very wide field map of the inner 4 degrees (600pc), and an interferometric ATCA mosaic (resolution 27", about 1 pc) of the inner 1 degree (150pc) between Sgr A* and Sgr B2. Both surveys are multi-line ammonia surveys covering the (1,1) through (9,9) lines (Mopra), and (1,1) lines and (2,2) lines (ATCA), respectively. We are therefore able to map very large temperature range from tens to hundreds of K. In general we find that the temperatures of the interferometric map hover around 50 K. A very prominent temperature gradient stretches across Sgr B2 (ranging from >100 to ~30K), with high temperatures away from the Galactic Center. Also gas around Sgr A* appears to have many more hot spots than further away. A decomposition in individual molecular clouds reveals about 3000 individual complexes. The decomposition is used to derive the clump mass function which is flatter than in other Galactic star forming regions. The very high velocity dispersions and the relatively high temperatures also lead to considerable P/k overpressures of ~10^6-9 K cm-3.

Paladini, Roberta
SSC

The luminosity function of compact Galactic HII regions with MIPSGAL 24um and 70um data

We present the infrared luminosity function of ~500 compact Galactic HII regions selected from the Paladini et al. (2003) radio catalog. For these sources, kinematic distances are available from radio recombination line data. The considered data set is the largest used so far for this kind of analysis, and it is characterized by an unprecedented level of completeness with respect to previous samples. The luminosity function is constructed from 24 and 70um "MIPSGAL" data. The comparison with the corresponding radio luminosity function will also be shown.

Pavel, Michael
Boston University
Polarimetry of Galactic Bubbles
The Galactic Plane Infrared Polarization Survey (GPIPS) has completed its second season of H-band (1.6 micron) data collection using the Mimir near-infrared instrument in linear polarimetry imaging mode on the 1.8m Perkins Telescope outside Flagstaff, Arizona. This key project for the Perkins Telescope seeks to answer important questions about the nature of the magnetic field and the aligned dust grains used to trace the field for small-scale star-forming regions, medium scale molecular and atomic cloud regions, and large-scale spiral arm and interarm regions. One of the goals for this season was to obtain polarimetry around a sample of the recently discovered galactic bubbles in GLIMPSE. These bubbles have high eccentricities that suggests some astrophysical phenomenon is preferentially elongating them. Linear polarimetry of stars inside and outside the bubbles will trace the galactic magnetic field and its interaction with these bubbles. This will help elucidate the interaction of the galactic magnetic field with other dynamic forces.

Peeters, Els
UWO; SETI Institute
The Infrared Spectra of very large, compact, symmetric polycyclic aromatic hydrocarbons (VLPAHs)
Charles W. Bauschlicher(1), Jr., Els Peeters(1,2,3), Louis J. Allamandola(1)

(1) NASA-Ames Research Center, Moffett Field, CA
(2) SETI Institute, Mountain View, CA
(3) University of Western Ontario, Canada

The mid-infrared spectra of seven very large PAHs (VLPAHs), with C number ranging from 54 to 130, have been determined computationally using Density Functional Theory (DFT). Trends in the dominant band positions and intensities for the major PAH bands as a function of PAH size, charge (neutral, cation, and anion forms) and geometry are discussed.

The CH strectching and CC stretching bands for these compact VLPAHs are similar to those of the smaller PAHs previously studied and hence support our earlier conclusions: i) the astronomical 3.29 um band likely originates from neutral and negatively charged PAHs and ii) astronomical PAHs must incorporate nitrogen to reproduce the class A 6.2 um PAH band.

In contrast, the CC and CH in-plane vibrations of the largest of the PAH cations and anions considered here produce strong bands close to 7.8 μm and 8.5 μm. This suggests that the astronomical 7.7 um band complex is produced by a mixture of small and large PAH cations and anions, with small PAHs contributing more to the 7.6 μm component and large PAHs more to the 7.8 um component. Moreover, Peeters et al. (2002) found a correlation between the peak position of the astronomical 7.8 um component and the peak of the 8.6 um band. The similarity in behavior of these two bands in the compact VLPAH spectra suggests that large, cationic and anionic PAHs contribute strongly to the 7.8 and 8.6 um astronomical features, with the specific peak position and profile reflecting the local PAH cation-to-anion concentration ratio and the relative intensities reflecting PAH size.

For the CH out-of-plane bending vibrations, the duo hydrogen bands couple with the solo vibrations and produce bands that fall at wavelengths slightly different than their counterparts in smaller PAHs. One of these duo modes shifts to ~12.8 um, the position normally associated with trio hydrogens. Thus, the number of trio hydrogens deduced with respect to solo and duo hydrogens of the emitting astronomical PAH population must be reduced, altering previously deduced PAH structures (Hony et al. 2001) in favor of more compact and symmetric forms. Finally, the overlap between the duo and trio bands in neutral PAHs may reproduce the puzzling,

blue-shaded profile of the 12.8 um emission band.

Pelkonen, Veli-Matti
Helsinki University Observatory
Two views on dust: polarized thermal dust emission and near-infrared scattering
In the first part of the poster we present some results of our ongoing modelling of the polarized thermal dust emission from cloud cores. In our radiative transfer calculations we record the direction-dependence of the incoming radiation, thus allowing us to calculate the anisotropy of the radiation, which should play a major part in the efficiency of the radiative torques. Radiative torque mechanism is widely considered to be a quite promising explanation for the grain alignment in clouds. In addition to the anisotropy, we show the derived polarization map and compare our results with previous studies.

In the second part of the poster we discuss the use of near-infrared diffuse surface brightness maps, arising from scattered light, as a tracer of dust column density in clouds with A_V in the range $1 - 15^m$. We present our SOFI NTT -observations of a quiescent filament in the Corona Australis molecular cloud, and compare the derived dust column densities to the result derived from the extinction of the background stars.

Petric, Andreea
Spitzer Science Center Caltech
A Spitzer Space Telescope Infrared Spectrograph Survey of Warm Molecular Hydrogen in Luminous Infrared Galaxies
Luminous Infrared Galaxies (LIRGs) emit above 1011 in IR, and at about 1/2 of their space density exceed that of optically selected galaxies. LIRGs are primarily interacting or merging disk systems undergoing starbursts and creating/fueling central AGN. Both star-formation and accretion of material onto an AGN are facilitated by molecular hydrogen which acts as a coolant. We compare the temperatures and masses of the warm (T~200-1000K) molecular gas as inferred from the H2 line flux ratios and line strengths to those of Ultra Luminous Infrared Galaxies (Higdon et al. 2006) and also to the total (cold) gas masses as traced by CO. The fraction of warm to cold molecular gas may be an indirect indicator of the evolutionary stage and as such it can be tied to the activity state in a crude test of the model wherein merging galaxies pass through a starburst phase on their way to become QSOs.

Pfenniger, Daniel
Geneva Observatory
Molecular gas in high-velocity clouds
We report a new search for 12CO(1-0) emission in high-velocity clouds (HVCs) performed with the IRAM 30 m telescope. This search was motivated by the recent detection of cold dust emission in the HVCs of Complex C. Despite a spatial resolution which is three times better and sensitivity twice as good compared to previous studies, no CO emission is detected in the HVCs of Complex C down to a best 5 sigma limit of 0.16 K km/s at a 22" resolution. The CO emission non-detection does not provide any evidence in favor of large amounts of molecular gas in these HVCs and hence in favor of the infrared findings. We discuss different configurations which, however, allow us to reconcile the negative CO result with the presence of molecular gas and cold dust emission.

Povich, Matthew
University of Wisconsin-Madison
A Giant Molecular Cloud That Hasn't Quit: The Distributed, Ongoing Star Formation of M17
I present a sample of 269 candidate young stellar objects (YSOs) within a 0.5-degree radius of the M17 HII region. These candidate

YSOs were found by fitting model spectral energy distributions (SEDs) to point-source fluxes from the GLIMPSE Archive, combined with MIPSGAL 24 and 70 um photometry and MSX point-source fluxes for the brightest objects. The vast majority of this YSO sample lies outside the M17 HII region, where high diffuse mid-IR background emission dramatically reduces the IRAC point source sensitivity. YSOs in the earliest stages of formation are distributed throughout the M17 giant molecular cloud and out to a distance of ~14 pc from NGC 6618, the central ionizing cluster of M17. Some YSOs appear to be located beyond the previously measured extent of the molecular gas. The GLIMPSE YSO sample reproduces an IMF with a Salpeter slope that is complete above a limiting stellar mass of ~3 Msun in the molecular cloud region, implying that, down to the hydrogen-burning limit of ~0.1 Msun, 3000-4000 stars are currently in the process of forming in the molecular cloud. This represents a largely distinct population from the 8,000-10,000 young stars inferred to lie within or near NGC 6618 based upon high-resolution Chandra imaging of M17 in X-rays (Broos et al. 2007). I discuss this ongoing star-formation in M17 in terms of the star formation rate and star formation history of this region.

Rand, Richard
University of New Mexico
IRS Spectroscopy of the Gaseous Halo of NGC 891

We present IRS SH spectra at one disk position and two positions at a height of 1 kpc from the disk in the edge-on spiral NGC 891, with the primary goal of studying halo ionization. Our main result is that the [Ne III]/[Ne II] ratio, which provides a measure of the hardness of the ionizing spectrum free from the major problems plaguing optical line ratios, is enhanced in the extraplanar pointings relative to the disk pointing. Using a 2D Monte-Carlo-based photo-ionization code, we find that this trend cannot be reproduced by any plausible photo-ionization model, and that a secondary source of ionization must therefore operate in gaseous halos. We explore whether shocks may play a role. We also present the first spectroscopic detections of extraplanar PAH features in an external galaxy. If they are in an exponential layer, very rough emission scale-heights of 320-530 pc are implied for the various features. The 17.4 micron feature is significantly enhanced in the extraplanar gas compared to the other features, possibly indicating a preference for larger PAHs
in the halo.

Rho, Jeonghee
California Institute of Technology
Spitzer and ISO observations for Studying Interactions of SupernovaRemnants with Insterstellar Medium: Molecular Hydrogen, Polycyclic Aromatic Hydrocarbons and Shock-Processed Dust

We review Spitzer and ISO infrared observations of supernova remnants (SNRs) in our Galaxy, the Magellanic Clouds and nearby galaxies. Supernovae are the critical sites of reprocessing of the interstellar medium through dust formation, heating and cooling of dust and gas, and dust destruction, affecting star formation rates and galaxy evolution. High-sensitivity and high-resolution Spitzer observations finally allow us to unambiguously identify large samples of infrared emitting SNRs and characterize shock processing of dust and molecules. Spitzer IRS, MIPS SED and near-infrared observations towards about 20 SNRs reveal a large population of SNRs emitting molecular hydrogen (H2) and [O~I] lines, implying interaction with dense clouds and presence of warm molecules and dust at the shock fronts. While previously shocks of Orion, SN, and HH objects show similar excitation temperatures, we observe variation in excitation temperatures of H2, SNR by SNR. Polycyclic aromatic hydrocarbons (PAH) which have previously believed to be destroyed by the SN shocks are detected with Spitzer and we find larger PAHs are survived behind the shocks. We will discuss H2 formation rates, nature of J or C-types shocks with time-dependent

shock models, the properties and correlation of H2 molecules, PAH, and small and large grain population. Finally, we will present searches for star formation activities in and near the SNRs with Spitzer and MSX data.

Rodriguez, Monica
STScI
A study of the Radio Continuum - Far Infrared correlation at small scales in the Galaxy
We present a study of the behavior of the Radio Continuum (RC) - Far Infrared (FIR) correlation on scales corresponding to the size of small molecular clouds. This was done by comparing the spatial distribution of RC emission and FIR emission from a sample of 24 regions, distributed within the range 79 < l < 174
in the Galaxy. We have examined the 408 and 1420 MHz mosaic images of the sample, from the Canadian Galactic Plane Survey (CGPS), which later were compared with images at 60 and 100 μm from the IRAS Galaxy atlas. We also have mapped the spectral index distribution and its associated uncertainty for each region. A good correspondence between the RC and the FIR emission for the majority of the regions (~ 2/3 of the sample) is indeed observed. However, from our preliminary results on the nature of the RC emission we found that those regions that show strong correlation to small scales are the same regions where the thermal fraction of the RC emission is high. This leads the conclusion that such kind of objects could not contribute to the RC-FIR correlation.

This research makes use of data from the Canadian Galactic Plane Survey.

Rubin, Robert
NASA Ames Research Center
Observations of M33 \ion{H}{2} Regions: the Ne/S ratio, metallicity, and ionization variations
We have observed emission lines of
[\ion{S}{4}] 10.51,
H(7--6) 12.37,
[\ion{Ne}{2}] 12.81,
[\ion{Ne}{3}] 15.56,
and [\ion{S}{3}] 18.71~μm
in a number of extragalactic \ion{H}{2} regions with the
{\it Spitzer Space Telescope}.
A previous paper presented our data and analysis for the substantially face-on spiral galaxy M83.
Here we report our results for the local group spiral galaxy M33.
The nebulae selected cover a wide range of galactocentric radii (R$_G$).
The observations were made with the Infrared Spectrograph with the short wavelength, high resolution module.
The above set of five lines is observed cospatially,
thus permitting a reliable comparison of the fluxes. From the measured fluxes,
we determine the ionic abundance ratios including
Ne^{++}/Ne$^+$, S^{3+}/S^{++}, and S^{++}/Ne$^+$
and find that there is a correlation of increasingly higher ionization with larger R$_G$.
By sampling the dominant ionization states of Ne (Ne$^+$, Ne^{++}) and S (S^{++}, S^{3+}) for \ion{H}{2} regions, we can estimate the Ne/H, S/H, and Ne/S ratios.
We find from linear least-squares fits that there is a decrease in metallicity with increasing R$_G$:

d~log~(Ne/H)/dR$_G$~= -0.058 ± 0.014 and
d~log~(S/H)/dR$_G$~= -0.052 ± 0.021~dex~kpc^{-1}.
There is no apparent variation in the Ne/S ratio with R$_G$.
Unlike our previous similar study of M83, where we conjectured that
this ratio was likely an upper limit, for M33
the derived ratios are a robust indication of Ne/S.
This occurs because the \ion{H}{2} regions have lower metallicity and
higher ionization than those in M83.
Both Ne and S are primary elements produced in α-chain reactions,
following C and O burning in stars,
making their yields depend very little on the stellar metallicity.
Thus, it is expected that Ne/S remains relatively constant throughout a galaxy.
The median (average) Ne/S ratio derived for 23 \ion{H}{2} regions in M33 is
16.3 (16.9), just slightly higher than the Orion Nebula value of 14.3.
These values are in sharp contrast with the much lower Ne/S ratios
predicted by galactic chemical evolution models as well as the
controversial solar value.

Our observations may also be used to test
the predicted ionizing spectral energy distribution of various
stellar atmosphere models.
We compare the ratio of fractional ionizations
$<$Ne^{++}$>$/$<$S^{++}$>$,
$<$Ne^{++}$>$/$<$S^{3+}$>$, and
$<$Ne^{++}$>$/$<$Ne$^+$$>$
vs.\
$<$S^{3+}$>$/$<$S^{++}$>$
with predictions made from our photoionization models using several of the
state-of-the-art stellar atmosphere model grids.
The trends of the ionic ratios established from the prior M83 study
are remarkably similar, but continued to higher ionization with the
present M33 objects.

Ruffle, Paul
NRAO

Out at the Galactic Edge: Observations and Chemical Modelling of Edge Cloud 2

Edge Cloud 2 (EC2) is a molecular cloud, about 35 pc in size, with one of the largest galactocentric distances known to exist in the Milky Way. I present observations of a peak CO emission region in the cloud and use these to determine its physical characteristics. I calculate a gas temperature of 20 K and a density of n(H2) ~ 10^4 cm^-3. Based on my CO maps, I estimate the mass of EC2 at around 10^4 M_sun and continuum observations suggest a dust-to-gas mass ratio as low as 0.001. Chemical models have been developed to reproduce the abundances in EC2 and they indicate that: heavy element abundances may be reduced by a factor of five relative to the solar neighbourhood (similar to dwarf irregular galaxies and damped Lyman alpha systems); very low extinction (Av < 4 mag) due to a very low dust-to-gas ratio; an enhanced cosmic ray ionisation rate; and a higher UV field compared to local interstellar values. The reduced abundances may be attributed to the low level of star formation in this region and are probably also related to the continuing infall of low metallicity halo gas since the Milky Way formed. I find that shocks from the old supernova remnant GSH 138-01-94 may have determined the morphology and dynamics of EC2. Finally, I note that because of its unique environment, EC2 provides an opportunity to study supernova triggered star formation, similar to that which occurred during the formation of our Galaxy.

Sakon, Itsuki
University of Tokyo

Properties of UIR bands in NGC6946 based on mid-infrared imaging and spectroscopy with Infrared Camera on board AKARI

We present our latest results on the mid-infrared imaging and spectroscopic observations of the nearby late-type spiral galaxy NGC6946 with the Infrared Camera (IRC) on board AKARI. Based on the mid-infrared imaging with the S7(7micron) and S11(11micron) bands, we have found that the S7/S11 ratios have
larger values in the arm region, in which many of the star forming regions are contained, than in the interarm region. Along the slit for mid-infrared spectroscopy we obtained both the spectra of an interarm and a star forming region on the arm of NGC6946. The obtained mid-infrared spectra of both regions
show a series of the distinct ubiquitous infrared (UIR) bands at 6.2, 7.7, 8.6, and 11.2 micron and we find clear variations in the relative band strengths of these features such that the strengths of the 6.2, 7.7, and 8.6 micron bands are larger relative to the 11.3micron band in the star forming region on the arm than in the interarm region even if the interstellar extinction of Av=3 mag towards the star forming region is taken into account. The increase in the 6.2 micron and 7.7 micron features relative to the 11.2μm feature in the star forming region is consistent with the ionization model of PAHs. We find that the ratio of the UIR features to the plateau emission under the 7.7 micron and 8.6 micron features and/or the ratio of 7.6/7.8 components in "7.7 micron" broad feature increases
in the star forming region compared to the interarm region.
We suggest that this variation can be accounted for
by the hypothesis that small free-flying PAHs are efficiently produced in the star forming region as a consequence of the photo evaporation of PAH clusters. The present results suggest that the ratios of 6.2 micron/11.2 micron, 7.7 micron/11.2 micron, and 8.6 micron/11.2 micron may be used as direct and efficient tools to measure the on-going star formation activity in remote galaxies if these ratios and their variations are well examined and established for a large sample in addition to the presence-or-absence appearance of the UIR bands.

Sandstrom, Karin
U. C. Berkeley

S^4MC Observations of Dust in the Small Magellanic Cloud Supernova Remnant 1E 0102.2-7219

The quantity and composition of dust produced in core-collapse supernovae is a matter of much debate. Observations of dust around quasars at high redshift have been explained via models invoking efficient dust production, with typical yields of about 0.1 Solar masses of dust per supernova. Observations by Stanimirovic et al (2005) of the young, oxygen rich, supernova remnant 1E 0102.2-7219 in the Small Magellanic Cloud placed an upper limit on the dust produced in the supernova of 8 x 10^-4 Solar masses, far less than the amount predicted by models. We present 5-35 micron IRS spectral mapping observations of SNR E0102 obtained as part of the S^4MC project. The spectral information allows us to quantify the contribution of the [Fe II] and [O IV] emission lines at 25.8 microns to the 24 micron MIPS flux--a major source of uncertainty for Stanimirovic et al.--to be ~10 % of the total 24 micron flux. From fits to the spectral continuum we find on the order of 10^-4 Solar masses of ~ 100 K dust in the remnant. We compare the spatial distribution of the hot dust continuum relative to the line emission and infer the physical conditions in the remnant. We also discuss the composition of the hot dust as revealed by the infrared spectrum. Finally, we briefly mention initial results on other supernova remnants present in our data.

Sawada, Tsuyoshi
Nobeyama Radio Observatory

NRO/CSO/ASTE Galactic Plane CO Survey

How the gas dynamics around the spiral arms (compression, shock, expansion) affects the internal structure of molecular clouds and physical conditions of the gas? Our CO survey of the Galactic plane is designed to address this issue, and we present the results from the survey. We have observed two 0.8 deg x 0.8 deg fields toward l=38 and 42 deg so far, in the 12CO/13CO J=1-0, 2-1, and 3-2 lines. The observations were made using the Nobeyama Radio Observatory (NRO) 45-m, Caltech Submillimeter Observatory (CSO) 10-m, and Atacama Submillimeter Telescope Experiment (ASTE) 10-m telescopes. The line of sights sample the Sagittarius arm and interarm regions at different

radial velocities. Wide-field, high-resolution mapping observations allow us to relate (sub)pc-sized molecular cloud structures and their physical conditions to the Milky Way dynamics (spiral arms), avoiding local effects such as star formation. We found that the arm gas consists of many bright clumps and filaments. On the other hand, the interarm gas is widespread in the field of view (90 pc x 90 pc) and have no bright peaks. The physical conditions of the gas are estimated using intensity ratios among the transitions. The J=3-2/J=1-0 ratio in the interarm is much lower than that in the Sgr arm, indicating the significant difference of temperature between the arm gas and the interarm gas.

Schnee, Scott
Caltech
ISM and Star Formation in the Perseus Molecular Cloud
We have used MIPS 70 and 160 micron mosaics from the c2d legacy project and IRAS 60 and 100 micron data to map the dust temperature and column density of the Perseus molecular cloud with very high resolution (40") for a large (several square degrees) map. We study the regional variations in the dust emissivity and the emission from transiently heated very small grains (VSG's). Using IRAC and CARMA 3mm continuum data of subregions within the Perseus molecular cloud, we show that there is not a perfect correspondence between the location of the MIR location of a protostar and the location of the millimeter core. In fact, in some cases protostars detected in the millimeter have no IRAC counterpart.

Schultheis, Mathias
Observatoire de Besancon
Interstellar extinction in the Galactic center region and its impact on the study of AGB stars
M. Schultheis, S. Ramirez, K. Sellgren, S. Stolovy, S. Ganesh

The study of the Galactic center region is still hampered by its high interstellar extinction. We use the Spitzer/IRAC point source catalog of the Galactic Center region (Ramirez et al. 2008, ApJS in press) to obtain a high resolution extinction map using the RGB/AGB star population together with new isochrones including the mass-loss of AGB stars. We will compare this map to known extinction maps derived from near-IR data (2MASS/DENIS). Our new map is much more sensitive compared to the near-IR extincion maps, especially in highly extincted regions (Av > 30 mag) where the near-IR maps are incomplete.

Using this extinction map we discuss the stellar populations in this region, in particular the properties of Long Period Variables (LPVS). We will discuss the fundamental parameters of AGB variables such as pulsation, amplitude and mass-loss and their behaviour in the IRAC bands.

Schulz, Norbert S.
MIT/MKI
X-ray Absorption Studies of Interstellar Matter
The advent of high resolution grating spectrometers onboard Chandra and XMM-Newton established a new window in the X-ray band to study physical properties of the ISM in the Milky Way and beyond. This new generation of spectrometers enables us to resolve the

spectral morphology of the photoelectric absorption edges and
to diagnose absorber properties of cool, warm, and hot ISM phases.
Similar to traditional spectral studies in the UV band which allowed to
determine the structure of the local ISM, distant and bright back-illuminating
X-ray sources can now be used to map out densities and ionization
structure of the ISM throughout the entire Milky Way. Narrow line absorption from
$K\alpha$ lines of neutral and lowly ionized matter allows us to detemine
abundances and ionization fractions, resolved edges more precise neutral
column densities. Measurements of line absorption from highly ionized
atoms specifically allows the diagnostics of the many times elusive very
hot component of the ISM. I will review recent progress as well
as emphasize the benefits of a multiwavelength approach in future studies.
Finally I discuss the results in the context of star formation and enrichment history
of the Milky Way.

Simon, Joshua
Caltech
Young Stars in the SMC
We use Spitzer Space Telescope observations from the Spitzer Survey of
the Small Magellanic Cloud (S^3MC) to study the early stages of
star formation in the SMC in unprecedented detail. Although only one
embedded YSO was reported in the literature prior to the S^3MC,
Spitzer's impressive sensitivity allows us to use SED fits to identify
more than 100 YSOs in the HII region N66 alone. We discuss the
properties of these objects and show that they appear similar to Milky
Way YSOs despite the much lower metallicity and dust content of the
SMC. These protostars range up to masses of 17 Msun and exhibit
primordial mass segregation in the HII region, with the most massive
YSOs being preferentially closer to the center than lower mass
objects. We have also discovered a population of stars that have the
optical colors and luminosities of main-sequence B stars, but show
large 24um excesses. After considering the possible scenarios for the
nature of these objects, we suggest that they may represent debris
disks around massive, young stars, potentially providing an unforeseen
method for constraining planet formation beyond the Milky Way.

Simpson, Janet
SETI Institute/NASA Ames Research Center
IRS Observations of PAHs and CO2 Ice in the Galactic Center
During Cycle 1 we used Spitzer to take high-res IRS spectra
(10 - 38 micron) of 38 positions in the Galactic Center (GC),
all at the same Galactic longitude of and including the Arches Cluster.
Our positions include the Arched Filaments, regions near the
Quintuplet Cluster, the 'Bubble' south of the Quintuplet Cluster,
and the diffuse interstellar gas along the line of sight at higher
Galactic latitudes. From the line fluxes measured from our GC spectra
we determined that the Arched Filaments appear to be H II regions

excited by the Arches Cluster and that the Bubble contains significant amounts of shocked gas, probably as a result of the winds from the massive stars of the Quintuplet Cluster (Simpson et al., ApJ, in press). Here we present our analysis of the continuum features seen in these spectra. Just as the lines show that there are substantial differences in the local environment with position in the GC (e.g., density, excitation, radiation field, amount of shocked gas), the polycyclic aromatic hydrocarbon features (PAHs) show widely varying ratios with respect to the continuum emission, being strongest for sight lines through the diffuse ISM at ~0.3 degrees distance from the Galactic plane but having small equivalent widths in the high-continuum Arched Filaments. In our Short-High spectra these features occur at 11.0, 11.2, 12.0, 12.6, 13.5, 14.2, and 16.3 - 17.5 microns. Finally, a few positions in the Arched Filaments and the G0.099-0.166 radio and infrared source (probably an ultra-compact H II region) exhibit the 15.2 micron CO2 ice feature. We will discuss the correlations of these features with each other and with their local environments as previously determined from the line measurements.

Sloan, Gregory C.
Cornell Univ.

Dust production in metal-poor Local Group galaxies

The sensitivity of the Spitzer Space Telescope has made it possible for the first time to probe individual objects enriching the interstellar medium (ISM) in several metal-poor Local Group galaxies using infrared spectroscopy. The majority of these objects are stars on the asymptotic giant branch (AGB), which dominate dust production in the Galaxy. The Spitzer spectrocopic surveys cover metallicities from solar to about 1/25th solar. The surveys reveal little, if any dependence on metallicity of the mass-loss rate of carbon-rich AGB stars. For oxygen-rich AGB stars, the fraction of naked stars increases at lower metallicity, and the naked stars show weaker absorption from the molecules from which silicate grains form, raising the question of what physical process drives the mass loss in these objects. These results imply that the dust in metal-poor galaxies should be richer in carbon, yet ultraviolet extinction studies show evidence of less interstellar carbon dust, not more. Addressing these issues is fundamentally important if we are to understand the enrichment of the ISM in metal-poor galaxies, whether in the Local Group or in more distant clusters.

Stacey, Gordon
Cornell University

Pure Rotational Line Emission from the Disk of NGC 891

Roughly half the interstellar medium in late type spiral galaxies is in molecular hydrogen. Stars form within molecular clouds, and the pure rotational lines of H2 are important coolants enabling cloud collapse. However, until the advent of the ISO and Spitzer spectrometers these lines were relatively unexplored due to both telluric absorption, and the weakness of the H2 quadrupole transitions. Using the ISO SWS, Valentijn and van der Werf (1999) reported surprisingly strong S(0) and S(1) line emission from the Milky Way analogue, NGC891. The strong emission indicated a surprisingly large mass of warm molecular gas, and a second even more massive cold cloud component. They suggest the cold component may contain 10 times the mass of the atomic ISM in NGC 891 – so large that it solves the missing matter problem within the optical disk. As part of the IRS core program, we have obtained a large scale (33 point) map along the plane of NGC 891 with the short high, and long high spectrometers in the S(0), S(1) and S(2) lines. Our S(0) and S(1) observations are roughly consistent with those of Valentijn and van der Werf over much of the disk, but the additional observations of the S(2) line enable constraints on the ortho to para (o/p) ratio which greatly affects models of the physical conditions of the emitting gas. Our latest models suggest a low o/p ratio, and substantially less molecular gas mass than those of Valentijn and van der Werf, and motivated new Spitzer observations of the S(3) line and deeper integrations in the outer regions of the galaxy in the other 3 lines. We

will present the results of our modeling of the S(0), S(1) and S(2) lines, and (if the new observations have occurred) the modifications to this modeling required by the new S(3) and deeper S(0), S(1) and S(2) observations.

Stanghellini, Letizia
NOAO
Spitzer Spectroscopy of Magellanic Cloud planetary nebulae: the role of dust in their evolution
Our Cycle 2 Spitzer IIRS observations of ~40 planetary nebulae (PNe) in the Magellanic Clouds were analyzed to disclose their dust properties, and their relation to other PN and central stars physical characteristics. We classify
the IRS spectra based on the dust features, or lack thereof. We found that
about half of the spectra are dominated by nebular emission lines,
and the other half show solid state features, mostly compatible with carbon-rich dust (SiC, PAHs, etc.) with few oxygen-rich dust exceptions. We also found that
the dust chemistry is strongly related to the gas chemistry (i.e., the nebular abundances) and to the nebular morpohlogy, with important implication on the formation of PN morphology and the evolution of PN and their central stars in
low-metallicity environments.

Stankovic, Marija
Department of Astronomy, University of Toronto
A new view of the Galactic Center region: Methanol emission in the Sgr A* environment
By virtue of its proximity, the central region of our Galaxy is of special interest to the study of galactic nuclei since it contains evidence for nuclear and star forming activity (e.g. the nucleus itself, Sgr A* and central cluster, the circumnuclear disk, and the supernova remnant Sgr A East), with evidence for shocks, X-ray and photon-dominated regions involving molecular clouds existing within a radius of several arcminutes. Although existing energetic processes affect the chemistry on the grain mantles, promoting the formation of aldehydes and their reduced alcohols, little is known to date about their distribution with the central 30pc.

We present here the first results of our survey of methanol (CH3OH) emission in this region at 96GHz, 242GHz and 338GHz conducted with the IRAM 30-m and the JCMT telescopes. Methanol possess a rich mm and sub-mm spectrum allowing the reliable determination of both density and kinetic temperature from radiative transfer models. It is formed on dust grains, evaporated by UV and shocks, and destroyed by gas phase chemical reactions. We compare the methanol emission with the nonthermal emission at 6cm, thermal dust emission mapped with SCUBA, as well as with silicon monoxide (SiO) and ammonia (NH3) which have the common origin as methanol. Rather surprising difference in their distribution in the inner 2pc yields insights into the comparative time scales for depletion of different molecular species in this region. In addition, we present results of radiative transfer analysis using LVG code specifically tailored to methanol.

Stecklum, Bringfried
Thuringian State Observatory
Candidate outflows from massive YSOs
The sensitivity, wavelength range, and spatial resolution of IRAC permits the detection of emission from shocked gas caused by outflows from deeply embedded massive protostars. We established a sample of candidate flows which were traced by their excess emission in continuum-subtracted 4.5 micron GLIMPSE I & II images. The majority of the targets are both luminous and very young as indicated by their frequent coincidence with MIPS 24 micron sources and 6.7 GHz methanol masers. We will characterize the sample as a whole, and contrast the Spitzer data with available NIR imaging as well as molecular line maps for selected sources. Follow-up narrow-band imagery with NTT-SOFI will prove whether the excess emission indeed arises from shocked molecular hydrogen or not, and provide more detailed information on the morphology. The verification of the presence of bipolar outflows will substantially increase the number of massive YSOs for which unanimous evidence of disk accretion exists.

Stolovy, Susan
Caltech/SSC
Massive Star Formation in the Galactic Center
It is well known that massive star formation has occurred in the Galactic Center, despite the presence of strong tidal forces and locally strong magnetic fields.
We investigate massive star formation in the central 300 pc of the Galaxy via a study of compact HII region candidates identified in a Spitzer/IRAC survey with 2" spatial resolution. These objects are resolved with IRAC but are typically compact (< 20") and signify an early stage of massive star formation. They exhibit a variety of nebular morphologies and are typically confined to within 0.1 degrees of latitude from the Galactic Plane. In many cases, the central stellar sources remain undetected in the IRAC wavelengths, ranging from 3.6 to 8.0 microns. A multiwavelength analysis is used to better understand the properties of these objects and to put them in the context of the star formation history of the Galactic Center.

Stutz, Amelia
Steward Observatory, Univ. of Arizona
Probing Dense, Compact Dark Globules
Compact and dense dark globules have the potential to collapse into stars. However, we know of very few examples that appear to be collapsing yet do not already have young stars at their cores. Is this gap in our knowledge because of observational selection effects, or is the process very rapid, making it difficult to catch a globule doing it? The former possibility arises because methods such as near infrared extinction maps lose sensitivity at very high extinctions in compact regions, due to inadequate statistics of suitable background stars. We will demonstrate that these limitations can be overcome by using shadows cast by globules in Spitzer observations at 24 and even 70 microns. There are a number of globules with prominent mid or far infrared shadows that appear to supply the missing population. We discuss a detailed analysis of CB 190, one of these cases. In the regions of overlap with near infrared extinction measurements, the shadow of this globule gives similar results. However, because of the intrinsically low extinction levels in the mid and far infrared, the shadow can trace the extinction as it rises into the core to 30 magnitudes at V. The density and gas motions were also observed in CO with the Heinrich Hertz Submm Telescope. Our analysis shows that the dense core of CB 190 cannot be supported by thermal or turbulent pressure. Magnetic pressure might supply the deficit, but if so it is likely to be temporary because the magnetic field should diffuse out of the globule in 1 - 10 Myr. Thus, it appears that this globule is either collapsing or in a pre-collapse state. We will compare the properties of CB 190 with similar measurements of the archetypical star-forming globule, Barnard 335.

Suzuki, Toyoaki
ISAS/JAXA
Spatial distribtuions of cold and warm intersteellar dust in M101 resolved with AKARI/Far-Infrared Surveyor (FIS)
The face-on spiral galaxy M101 has been observed with the Far-Infrared Surveyor (FIS) onboard AKARI. We have investigated star-formation activity in various regions and obtained possible physical insight into star-formation processes.

The far-infrared four-band images (65, 90, 140, and 160 micron) reveal spatial structures of M101, which include global spiral patterns, giant HII regions embedded in outer spiral arms, and a bar-like feature crossing the center. The spectral energy distribution of the whole galaxy shows the presence of the cold dust component (18 K) in addition to the warm dust component (55 K). The distribution of the

cold dust exhibits smoothly distributed over the entire extent of the galaxy, whereas the distribution of the warm dust indicates some correlation with the spiral arms, and has spotty structures such as four distinctive bright spots in the outer disk in addition to a bar-like feature near the center as has been revealed in the CO observation. The star formation activity in the giant HII regions that spatially correspond to the former bright spots is found to be significantly higher than that of the rest of the galaxy. Unlike our Galaxy, M101 is a peculiar normal galaxy with extraordinary active star-forming regions. By examining the relation between gas and stellar surface densities for such active star-forming regions, we suggest that star formation in giant HII regions is induced by the Parker instability due to high-velocity gas infall, whereas star formation in the inner arms is driven by the cloud-cloud collision due to a spiral density wave.

Tappe, Achim
Harvard-Smithonian Center for Astrophysics
Discovery of extraordinarily high-J OH (v=0) in HH 211
We present a Spitzer 5-37 micron infrared spectrum toward the southeastern lobe of the young protostellar outflow HH 211 obtained with the low and high-res IRS modules. The high-res spectrum shows an exceptionally rich sequence of high-J OH (v=0) emission with a total number of about 30 detected lines covering J=13/2 to 69/2. The highest excited line has an upper state energy E/hc of almost 19,600 cm^-1 (E/k about 28,000 K) above the ground level, which is, to our knowledge, by far the highest rotational OH excitation observed in molecular shocks to date. In addition, we observe H2 0-0 S(0) to S(7), HD 0-0 R(3) to R(6), and atomic fine-structure lines from Fe+, Si+, and S. The large number of lines from rotationally excited molecules in combination with the fine-structure transitions allows us to analyze the shock excitation conditions in detail and to predict potentially interesting transitions involving highly excited states from other molecules, e.g. H2O.

Tasker, Elizabeth
University of Florida
Simulating the ISM in global disc galaxies
Until recently, simulations which modelled entire galaxies were restricted to an isothermal or fixed 2- or 3-phase interstellar gas. This left astronomers somewhat in the dark about the full role of the ISM in star formation. Simple observational relations such as the Kennicutt-Schmidt law suggested that star formation could be modelled through basic recipes of gas density and efficiency. Contrary to this, Spitzer images and small-scale simulations portrayed a turbulant and complex star-forming medium where many forces competed for dominance. I present here results from global disc galaxy simulations with fully multiphase ISMs and compare different models for the gas to uncover the importance of its role in the star formation of the disc. I go on to look at the formation of the largest giant molecular clouds and compare these results to observations.

Temi, Pasquale
NASA - Ames
Cold Interstellar Dust in Elliptical Galaxies: Evidence for Energetic Processes in Galactic Cores
Our recent Spitzer observations of extended far infrared dust emissionfrom normal elliptical galaxies show that many of these galaxies

have unexpected extended regions of cold dust with masses exceeding that of dust produced by a normally evolving local old stellar population. The dust lifetime is only ten million years in the hot interstellar gas. In one galaxy excess dust is observed in a highly asymmetric, plume-like extension out to five kiloparsecs from the center and coincident with warm gas that emits optical line emission. Since the excess dust is highly transient, it must be internally produced (not by mergers) on a frequent duty cycle of about ten million years. Evidently, the extended dust in these normal ellipticals originates in small dusty nuclear disks a few hundred parsecs in size which are commonly observed and which contain enough dust to explain the extended dust we observe. The dusty disks are disrupted and heated (and made buoyant) by intermittent accretion energy released near the central black holes. Dust grains can cool the buoyant gas to warm temperatures that are optically visible. The astronomical implications of this unexpected excess dust we observed with Spitzer are far-reaching and provide new information about energetic processes in galactic cores.

Terebey, Susan
Cal State Los Angeles

Far-infrared Observations of the Very Low-Luminosity Embedded Source L1521F-IRS in the Taurus Star-Forming Region

A very low-luminosity (~0.1 Lo) embedded infrared source was discovered by Spitzer in the L1521F dense cloud core, falling within the region surveyed by the Taurus Spitzer Survey. The low-luminosity suggests the object is substellar, and its similarity to class 0 sources suggests it is extremely young. We investigate the dust temperature and density structure in the L1521F cloud core through a comparison of Spitzer MIPS 160 um and IRAS 100 um data. We compare the effects of L1521F IRS on its environment to those of nearby class 0/I protostars. The results are discussed in the context of theoretical ideas for the very early phases of star formation.

Truch, Matthew
University of Pennsylvania

Maps and Fluxes from Targeted Sources Scanned by the Balloon-borne Large Aperture Submillimeter Telescope (BLAST)

The Balloon-borne Large Aperture Submillimeter Telescope (BLAST) operated successfully during a 100-hour flight from northern Sweden in June 2005 (BLAST05). As part of the calibration and pointing procedures, several compact sources were mapped, including solar system, Galactic, and extragalactic targets, specifically Pallas, CRL~2688, LDN~1014, IRAS~20126+4104, IRAS~21078+5211, IRAS~21307+5049, IRAS~22134+5834, IRAS~23011+6126, K3-50, W~75N, Mrk~231, NGC~4565, and Arp~220 (this last source being our primary calibrator). The BLAST observations of each compact source are described, flux densities and spectral energy distributions are reported, and these are compared with previous measurements at other wavelengths. BLAST was particularly useful for constraining the slope of the submillimeter continuum.

Velusamy, Thangasamy
Jet Propulsion Laboratory

Molecular and PAH emission in the shocks and UV dominated regions

Observations of embedded young star clusters, still contained within their parent molecular clouds are important to understand how the UV flux and shocks caused by young stars influence the evolution of the cloud, its dispersal and subsequent termination or triggering of star formation. NGC 2316 is a young embedded star cluster containing a central HII region powered by a B3 star. The UV flux and shocks caused by this young star affect the physical conditions and the chemical composition of the surrounding cloud. We present Spitzer IRS maps of the PAH features and H2 lines in the 9 -14 µm (SL1) and 15 -18µm (LL2) bands obtained using multiple slit positions. We show the distribution and the relative variations between the various PAH features at 11.2, 12.0, 12.7, 13.5, 16.4, and 17.4 µm with distance from UV source, and with respect to the shocks. We have also mapped the line intensities at three H2 transitions: S (1) Ortho 17.0 µm, S(2) Para 12.3µm, and S(3) Ortho 9.7µm. The H2 line emission is dominant over the outer shock regions while PAH features are prominent inside. The H2 line intensities are used as diagnostics of the temperature structure and the PAH features to trace the UV field and the chemical composition of the gas and dust. We interpret the observed differences between the distributions of the PAH features in terms of the excitation, destruction and molecular structure of PAHs.

This work was performed by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Vermaas, Liesbeth
Leiden Observatory
The nuclear starburst of M83 revealed with SINFONI
The nuclear star formation site of barred spiral M83 is one of the closest starbursting systems at a distance of 4.5 Mpc. Previous studies showed already that the star formation peak, clearly indicated by recombination lines (eg. Br-gamma) is offset from the optical nucleus by about 4.4" (~100pc). Our near infrared integral field VLT/SINFONI observations of the nuclear region (15"x15", 340x340parsec) provide a wealth of information for the study several of aspects of this starburst in detail. As mentioned recombination lines trace the newborn stars, whereas the continuum is built up by somewhat older stars, and exploded massive stars are indicated by [FeII] line emission from supernova remnants. The morphology of the line maps gives us a picture of the star formation history of this region. Also we obtain dynamical information about the nucleus from gas (excited H2) as well as from stars (from CO absorption bands). This solves the issue of the location of the dynamical nucleus, which was debated over the past few years.

Wang, Zhong
Smithsonian Astrophysical Observatory
A Detailed Comparison of Multi-wavelength Probes in Nearby Galaxies

With the increasing availability of high angular resolution data in infrared and UV wavelengths, it becomes feasible to study individual emission regions in nearby galaxies down to the scales of young stellar clusters or star-forming GMCs. We show some examples of such analysis with data ranging from radio to the ultraviolet, drawing upon the knowledge of similar objects within the Milky Way, while demonstrating physical conditions that are vastly different from those of our own Galaxy. A systematic census of such regions and their variations within the context of each individual galaxy's property and environment helps to track the evolutionary changes in both their stellar contents and the interstellar medium.

Weinbeck, Tony
Tufts University
Multi-spectral Imagery of the Multi-phase ISM in Messier 33
Tony D. Weinbeck and William H. Waller, Tufts University
Massimo Marengo, Harvard-Smithsonian Center for Astrophysics
Robert Gehrz, University of Minnesota, and the Spitzer/M33 Research Team

M33 is an ideal source for studying extragalactic star formation, due to both its large angular size and modest inclination. We combine IRAC, MIPS, and H-alpha imagery to create a multi-wavelength mosaic of the galaxy. Using these data, we then focus in on 8 prominent HII regions, studying the interplay of the PAHs, dust, and ionized gas in these regions. In particular, we measure the angular distribution of each component from the central core of each region. These distributions show the 24um-emitting dust to be the most compact component, and hence the best tracer of the clustered high-mass star formation. The HII regions NGC 604 and IC 133 show especially

strong evidence for dust-embedded star formation. We also investigate the relative abundance of each phase as a function of galactocentric radius. The 8um-emitting PAHs and 24um-emitting dust are seen to fall-off with radius faster than the H-alpha-emitting ionized gas. This behavior is likely due to an actual decrease in the abundance of PAHs and dust at large galactocentric radius.

Wong, O. Ivy
Yale University
Star formation in Virgo Cluster galaxies using H-alpha and 24 micron observations
We present the Spitzer MIPS observations of a sample of spiral and peculiar galaxies selected from the VIVA (VLA Imaging of Virgo galaxies in Atomic gas) survey. The effects of interactions (with and within the cluster environment) on the distribution of star formation is studied using the 24 micron observations. Combined with previous H-alpha observations, the complete spatial extent of the star-forming regions (including the regions once obscured by dust extinction) is revealed within each galaxy.

Wu, Ronin
CCPP (NYU)
A PAH deficit in extremely low luminosity galaxies
We present a study of 29 extremely low luminosity galaxies randomly selected from the footprint of the Sloan Digital Sky Survey (SDSS). The galaxies comprise a statistically complete sample of galaxies with Mr > -15 and recession velocity vr < 2000 km s-1 as measured in SDSS Data Release 2 (DR2). We also observe these sample galaxies in all four channels with the Spitzer Infrared Array Camera (IRAC). The photometry in SDSS shows that these galaxies appear to be visually blue (g-r < 0.6), and the IRAC color analysis shows that they are blue in IRAC infrared color [3.6]-[8]. The IRAC [3.6] magnitude measures the starlight, and the [8] measures PAH emissions. We find that these star-forming galaxies show very low PAH to star ratios. This result agrees with earlier observations on other dwarf galaxies including SBS0335-052 and small samples from ISO and the overlap of the SDSS with the Spitzer First Look Survey, but it is worth emphasizing that this sample has a lower mean luminosity than those samples. The PAH deficiency of these galaxies is discussed in the context of their metallicity and dust properties.

Wu, Yanling
Cornell University
A Spitzer Mid-Infrared Study of Blue Compact Dwarf Galaxies
Blue Compact Dwarf Galaxies (BCDs) are galaxies that are characterized by their blue optical colors, low luminosities and small sizes. BCDs are found to typically have have subsolar metallicities and have been proposed, by bottom up cosmological models, as local laboratory analogues of the building blocks of galaxies in the early universe.

The unprecendented sensitivity of the Spitzer Space Telescope has enabled us for the first time to observe a large sample of ~60 of these low luminosity systems in the infrared. We will summarize our findings based on a detailed study of the dust content and star formation properties of the sample performed using all three Spitzer instruments. We have examined the factors that suppress the abundance of complex organic molecules (PAHs) in BCDs as well as the correlations of their mid-IR and radio emission and contrasting those in normal late type and starburst galaxies. Finally using IRS high-resolution spectroscopy, we obtained for the first time the elemental abundances of neon and sulfur in BCDs using infrared lines, which are insensitive to uncertainties in extinction and temperature, and compare them with results from opticalstudies.

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Wyder, Ted

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Dust and Star Formation in Nearby Dwarf Galaxies

While much of the bolometric luminosity from star formation in massive spiral galaxies is absorbed by dust and re-emitted in the FIR, much less is known about the FIR emission from dust in low metallicity dwarf galaxies. Understanding the emission from dust at low metallicity is essential in extending measurements of the star formation rates of galaxies to low metallicity. The nearest dwarf galaxies provide an opportunity to explore these issues due to their low heavy element abundances and their proximity. We present FIR measurements of the dust emission from 13 dwarf galaxies that have distances less than 2 Mpc, span metallicities from 5-28% of the solar oxygen abundance, and with star formation rates ranging from 10^-5 to 10^-1 solar masses per year. We compare the "obscured" star formation traced by the FIR images with measurements of the "un-obscured" star formation traced by UV images from the Galaxy Evolution Explorer and ground-based H-alpha images. We find the FIR star formation rates are lower than those in the UV by a nearly constant factor, independent of the SFR. The H-alpha star formation rates are consistent with both the far-infrared and UV values for the galaxies with the highest star formation rates, but are systematically lower than both of these
values at the lowest star formation rates.

Young, Lisa
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Star Formation in an Unexpected Place: Early-type Galaxies

In recent years the UV data from the GALEX satellite have suggested that as many as 30% of the low-redshift early-type galaxies (ellipticals and lenticulars) may be actively forming stars. The molecular gas content of the nearby early-type galaxies appears to be consistent with this idea, with some 10^7 to 10^9 solar masses of molecular gas detected in at least 20% to 30% of nearby Es and S0s. But even when molecular gas is present, it is not obvious whether star formation should be taking place. Since the gravitational potentials of the early-type galaxies are deeper and steeper than those of late-type galaxies, a local gravitational instability analysis suggests that the early-types might not be expected to form stars. From the observational perspective, the most CO-rich early-type galaxies do follow the radio continuum-FIR correlation (albeit sometimes with unusually faint radio emission or unusually strong FIR emission), and this correlation suggests that their radio and FIR may trace star formation activity.
The Mid-IR and FIR emission from early-type galaxies can also come from AGN activity and circumstellar dust, however, so more detailed morphological work is necessary in order to find out how much of the FIR emission can be attributed to star formation in the molecular gas. The CO-rich early-type galaxies are found to have cold gas disks ranging in size from less than a kpc to 12 kpc. We compare radio continuum, CO, and MIPS imaging of the galaxies and we find that in at least some cases the bulk of the radio continuum and FIR emission must be coming from star formation activity. The relationships between the molecular gas and ionized gas are complex, however, so the FIR/radio continuum emission is probably a better indicator of star formation activity in early-types than the ionized gas. From the
FIR fluxes and gas contents, the efficiency of the star formation is roughly similar to that in spirals, which again was not necessarily to be expected. The comparisons of molecular gas, radio continuum, and FIR imaging thus pave the way for more detailed theoretical investigations of the star formation process in early-type galaxies.

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Dust evolution models with multiphase ISM

We aim in constructing a model of the dust evolution in the ISM,
which combines models of the chemical evolution of the galaxy, of interstellar gas and dust evolution model. The chemical evolution model of the galaxy determines the distribution of the total density of the matter, and its enrichment with heavy elements and dust from the stars. Taking account of the multiphase structure of the ISM is essential for dust modeling, since dust grains cycle between ISM phases, undergoing destruction by supernova shocks in the warm and growth in the cold medium. We incorporate into our model the three-phase ISM (McKee & Ostriker 1977) with the mass exchange processes between warm, hot and cold ISM phases. On the other hand, modern observations shed more light on the gas and dust abundances in different ISM phases of galaxies, allowing to constrain the model and to study the cycling of the dust grains in the ISM. We develop a new simple model for dust growth in the molecular clouds due to accretion of refractory material on the preexisting grains, which results in significant increase of dust mass after cloud dispersal.

We will discuss the application of our model for carbon, silicate, iron and SiC dust evolution in the Milky Way and other galaxies.

Zijlstra, Albert
University of Manchester
Mass loss from AGB stars in Local Group Galaxies

We have carried out a number of Spitzer surveys of AGB stars in the satellite galaxies to the Milky Way. The stars cover a metallicity range down to [Fe/H]=-1. The results show that at subsolar metallicity, AGB mass loss is strongly dominated by carbon stars. The mass loss from oxygen-rich stars is strongly suppressed at low metallicity. Carbon stars show little dependence of the mass loss rates on metallicity. This is attributed to the difference in dust formation efficiency. Spitzer spectroscopy of a halo PN are used to measure the C/Ne/O abundance of the intershell material which is dredged-up in carbon stars. The result is used to determine the C/O ratio in the low metalicity carbon stars, and to quantify the dependence of the mass loss rate on this ratio. The results impact on the expected enrichment of the ISM at low metallicity.