Spitzer Space Telescope - Guaranteed Time Observer Proposal #96

The mid-IR SED of nearby AGN

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Vassilis Charmandaris, Cornell University

Science Category: AGN/quasars/radio galaxies
Observing Modes: IracMap IrsStare
Hours Approved: 2.8

Abstract:
We wish to examine the variations in form of the mid-IR spectral energy distribution in a few nearby active galactic nuclei. Of particular interest is the detection of high ionization lines as well as the the presence of the 5-8 hot continuum emission. Our small sample consists of galaxies with different Seyfert type and/or presence of a maser activity which could lead to further absorption of the nuclear spectrum.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #108

Search for Obscured Supernovae in Ultraluminous Galaxies

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Nick Gautier, JPL

Science Category: AGN/quasars/radio galaxies
Observing Modes: IracMap
Hours Approved: 5.5

Abstract:
Four ultraluminous galaxies will be monitored for supernova activity with oderately deep IRAC imaging at 4.5 and 8.0 microns. Arp 220, NGC 3690, NGC 7469 and NGC 1614 will be imaged with the 4.5 and 8.0 um IRAC arrays to a sensitivity of about 5 uJy, 1 sigma, approximately every 3 months for 2.5 years. A single 5.1 x 5.1 arcminute IRAC field will be used for each observation, no mapping will be done.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #101

Infrared Imaging and Spectroscopy of Cen A and its Central Disk

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Jocelyn Keene, JPL

Science Category: AGN/quasars/radio galaxies
Observing Modes: IracMap IrsMap IrsStare MipsScan
Hours Approved: 6.7

Abstract:
This project attempts to create a comprehensive infrared picture of Cen A, the closest active galaxy. It will produce large-scale images of the galaxy in all the IRAC and MIPS bands. Particular attention will be paid to the dust lane and embedded disk. Here we will use MIPS 70 micron super-resolution and SED modes for high-resolution and spectral imaging. IRS will be used in high-resolution mode to obtain a few spectra of the disk and in low-resolution mode to make a complete spectral image of it.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #61

Intrinsic Spectra of Hyperluminous Infrared Galaxies

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Dean Hines, Space Science Institute

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare
Hours Approved: 8.2

Abstract:
We will use the low and high spectral resolution capabilities of the IRS aboard SIRTF to obtain high signal-to-noise mid-infrared spectra of a small sample of the most luminous Active Galactic Nuclei, which are characterized by their "warm" far-infrared spectral energy distributions as obtained by IRAS (the so called Hyperluminous Infrared Galaxies or HIGs). The sample consists of both Type 2 and Type 1 AGNs. The Type 1 objects present a relatively unobscured view of the central engine, and also have a polarized (scattered) component that is completely unobscured. The Type 2 objects have Type 1 polarized spectra, but this scattered light is highly extinguished indicating some obscuration even along the line of sight to the scattering region. The sample will allow us to compare the properties of the Type 1s and Type 2s, thus providing a check on the orientation and providing strong constraints on the geometry and internal structure of all four objects.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #86

Imaging and Spectroscopy of X-ray Selected Seyfert Galaxies

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Varoujan Gorjian, JPL

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare MipsPhot
Hours Approved: 23.5

Abstract:
In present unified schemes, dust plays a major role in determining Seyfert types, with Seyfert 1's being less obscured and Seyfert 2's being more obscured, but both with the same underlying energy generation mechanism, an accretion disk around a supermassive black hole. We have chosen to study a group of Seyferts at two wavelengths that are least affected by dust obscuration: x-rays and infrared. Our sample is a mix of Seyfert 1's and Seyfert 2's which have been observed in the x-rays, for which we will obtain IR spectra with all IRS modules, and photometry at 25 and 70 microns with MIPS. By comparing the characteristics of these two penetrating data sets we will be able to constrain better the role of dust in the nuclei of these active galaxies, especially the large column densities (>10^25 Hydrogen atoms per cm^2) derived from x-ray observations.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #14

IRS Standard Spectra for AGN, Starbursts and QSOs

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Daniel Weedman, National Science Foundation

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare
Hours Approved: 23.6

Abstract:
A selection of AGN, Starburst Galaxies and QSOs will be observed with single pointings to determine high S/N spectra with all modules of the IRS. These spectra will be used to study the typical spectral signatures of these objects as well as the variations within each class. They will also be used as comparisons for other sources in the IRS program.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #49

The Nature of Infrared-Selected QSOs

Principal Investigator: Frank Low
Institution: University of Arizona

Technical Contact: Paul Smith, University of Arizona

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare MipsPhot
Hours Approved: 40.2

Abstract:
Near-infrared surveys are currently uncovering a large population of previously unidentified radio-quiet active galactic nuclei (AGN). The large IR-to-optical flux ratios of many of these objects suggest that their optical emission is largely obscured from our view. Optical spectropolarimetry of some of the most luminous examples of IR-selected AGN indicates that the optical radiation is not emitted isotropically, and that these objects would be indistinguishable from UV/optically-selected AGN if the nuclei were viewed from a different vantage point. The existence of a population of obscured AGN may increase the space density of AGN by a factor of two or more, and this has major implications for theories of the origin and evolution of these accretion-powered objects. The space density of AGN also has important implications for our understanding of the history of star formation in the early universe. This program will obtain MIPS observations of a large sample of confirmed AGN discovered by the Two-Micron All Sky Survey. These measurements will place infrared-selected AGN in context with traditional UV/optical and radio AGN samples.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #74

Powerful Radio Sources

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Charles Lawrence, JPL

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare MipsPhot
Hours Approved: 43.6

Abstract:
We will determine the mid- and far-infrared spectral energy distributions of powerful radio sources selected from the 3CRR sample in the redshift range 0.5 to 1.0. The total time for this program is 42.8 hours, of which 24.4 get accounted under Charles Lawrence General GTO time and 18.4 get accounted under the IRS GTO time.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #59

Starburst Activity in Nearby Galaxies

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Chad Engelbracht, The University of Arizona

Science Category: AGN/quasars/radio galaxies
Observing Modes: IracMap IrsMap IrsStare MipsPhot MipsScan
Hours Approved: 45.3

Abstract:
This program combines MIPS and IRAC imaging and MIPS and IRS spectroscopy (where available) of a sample of nearby starburst galaxies, over a range of metallicity and luminosity that includes the lowest metallicity galaxies known. These galaxies are near enough that groundbased support data already exist for many of them and they are bright enough that observing them does not take much time (except for the lowest metallicity galaxies). These data will be combined with new groundbased data and data from the literature to constrain a suite of starburst models. The models will provide the age and intensity of the burst that is consistent with the observations over a broad range of wavelengths and could be used to predict the subsequent evolution of the galaxy properties. Furthermore, this extremely detailed study of a small sample of starburst galaxies would provide the insight required to interpret observations of more distant galaxies (such as in the cosmological surveys) where we may only have a few photometric data points.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #82

The Far-IR Spectral Energy Distributions of Luminous Active Galactic Nuclei

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Dean Hines, Space Science Institute

Science Category: AGN/quasars/radio galaxies
Observing Modes: IracMap IrsStare MipsPhot MipsSed
Hours Approved: 88.2

Abstract:
The Far-IR Spectral Energy Distributions of Luminous Active Galactic NucleiHines, G.Rieke, Neugebauer, LowBy obtaining accurate photometry in the three MIPS bands, we will address the relationship between different forms of luminous AGNs, the evolution of AGN properties with redshift, and which physical processes regulate the energy outputs. In particular, unification schemes posit that various types of AGN (e.g., QSO vs. Hyperluminous Infrared Galaxy) are fundamentally similar in nature, but appear to have diverse properties because they are viewed at different angles. These aspect angles accentuate or de-emphasize emission at various wavelengths and from various regions near the central engine. We concentrate on sub-sets of the most luminous 10-20 objects each drawn from complete catalogs with z <= 0.3 and selected on different bases e.g., x-ray brightness, high frequency radio brightness, etc.. Use of previously well defined samples and the z <= 0.3 redshift limit aids completeness and ensures access to large existing databases and high resolution imaging. We supplement the core sample with two small samples of AGNs at z ? 2 and z >= 4.5 to probe evolutionary trends. This comparison will be particularly important for evaluating the effectiveness of our low-z SEDs as templates for identifying very high redshift AGNs.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #15

Seeking Redshifts for Optically Unidentifiable Infrared Sources

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Daniel Weedman, National Science Foundation

Science Category: AGN/quasars/radio galaxies
Observing Modes: IrsStare
Hours Approved: 129.4

Abstract:
Optically faint or unidentifiable sources from ISOCAM 15 micron, ISO FIRBACK, and SCUBA surveys are selected for MIPS and IRS lo res observations with the objective of determining spectroscopic redshifts. IRS observations will be obtained only for sources found to have MIPS 24 micron fluxes above about 0.7 mJy. Eventual IRS targets will also be chosen from the First Look Survey.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #12

MIPS Survey and IRS Spectroscopy of Sources in the KPNO Bootes Field

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Tom Soifer, Spitzer Science Center

Science Category: Cosmic infrared background
Observing Modes: IrsStare MipsScan
Hours Approved: 78.0

Abstract:
Surveys of high galactic latitude sky will be undertaken to learn the source of the cosmic infrared background. This project covers the shallow survey which has a dual purpose. It provides the modest-depth, large area survey descirbed below and provides an area from which to select targets for IRS spectroscopy by combining the MIPS data with groundbased optical imaging. First we will use MIPS primarily at 24um to survey the 14h+34d field of the NOAO Deep Wide-Field survey, identify targets from these observations that are bright enough to obtain spectra with IRS and meet selection criteria defined by the combined team, and obtain low resolution IRS spectra of these sources from 5.3-40um. A prime selection criterion for obtaining IRS spectra will be that they must be brighter than 1 mJy at 24um. Generally the main science goal of the IRS observation will be to determine redshifts from IR spectral features. The targets chosen for IRS observation will generally be faint enough so that optically determined redshifts will not be feasible even with 10m telescopes.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #64

Combined Program on Cosmic IR Background/Evolution of SFR/Lyman Break and SCUBA SED's

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Michael Pahre, Smithsonian Astrophysical Observatory

Science Category: Cosmic infrared background
Observing Modes: IracMap IrsStare MipsPhot MipsScan
Hours Approved: 88.9

Abstract:
This program combines three scientific programs: Detection of the Cosmic IR Background, evolution of the Cosmic star formation rate, and SED's of Lyman Break and SCUBA sources. Only the latter is described in detail here at this time. Over the past few years Steidel et al. have used the Lyman Break technique with great success to identify UV-bright star-forming galaxies at redshifts of 3 and 4. The expected corrections for extinction to the star formation rates are large, suggesting much of the luminosity will be reradiated in the mid and far infrared. Also in thelast few years, several high redshift galaxies have been detected at submm wavelengths, which again has been interpreted as due to high star formation rates reradiated by dust. The submm emission is generally on the (modified) Rayleigh-Jeans tail of the blackbody emission from the dust, and hence does not in itself significantly constrain basic properties such as dust temperature and bolometric luminosity. Lacking these constraints, estimates of star formation rates in these objects are wildly uncertain. We will use SIRTF observations to address these issues. IRAC measurements of redshifted near IR light provide a good estimate of the total stellar mass present. IRS measurements of the very strong 7.7um PAH feature are diagnostic of whether an AGN or starburst dominates the bolometric luminosity. And MIPS far IR photometry directly measures the dust temperature and luminosity. Adding these pieces to the puzzle will tell us the true total star formation rate in these objects.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #79

Proto-Clusters Around High-Redshift Radio Galaxies

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Peter Eisenhardt, JPL

Science Category: cosmology
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 14.0

Abstract:
High-redshift radio galaxies (HzRGs) provide our most robust examples of massive galaxies at early cosmic epoch. In biased galaxy formation models, we therefore expect associated galaxy overdensities around HzRGs. In this program we undertake deep IRAC, MIPS, and IRS observations of two distant radio galaxies, each of which once held the record for most distant galaxy known. These fields have also been subjected to deep optical (ground-based and Hubble) and sub-mm observations. We will attempt to identify possible galaxy proto-clusters surrounding these high-redshift AGN.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #76

IR Study of Gamma-Ray Bursts

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Bill Forrest, University of Rochester

Science Category: GRBs
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 6.7

Abstract:
Gamma Ray Bursts are interesting and enigmatic phenomena. With the accurate positioning given by Beppo-Sax and the rapid followup in the visible and radio, several bursts have been found to be associated with distant galaxies at z~1 and greater. Recent studies have provided evidence for collimated outflows and shocks associated with GRB's strenghtening the connection between them and supernovae. If GRB's are associated with young star-forming regions, then there is likely to be strong infrared emission from the heated dust. Furthermore, there is likely to be considerable extinction at shorter wavelengths, rendering visible and near IR observations less than definitive. We use the infrared cameras to measure the 4.5 to 24 um energy distribution and morphology of the putative emitting regions. For regions sufficiently bright, the spectrometer will provide diagnostics of the emission mechanisms and the redshift. The redshift is especially crucial in the cases where no host galaxy has been detected (or the host galaxy is too faint for ground-based redshift determination).

Spitzer Space Telescope - Directors Discretionary Time Proposal #196

Great Observatories Origins Deep Survey (GOODS) Validation Observations

Principal Investigator: Mark Dickinson
Institution: NOAO

Technical Contact: Peter Eisenhardt, JPL

Co-Investigators:
The GOODS Team ,

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsPhot
Hours Approved: 10.0

Abstract:
Validation observations of the Great Observatories Origins Deep Survey (GOODS).

Spitzer Space Telescope - Directors Discretionary Time Proposal #26

First Look Survey -- Extragalactic Component

Principal Investigator: Tom Soifer
Institution: Spitzer Science Center

Technical Contact: Lisa Storrie-Lombardi, Caltech

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsScan
Hours Approved: 62.5

Abstract:
The SIRTF First Look Survey extragalactic component is designed to: 1. detect enough extragalactic sources at unexplored sensitivity levels to generate a representative sample and reduce the uncertainties in the source counts, 2. characterize the dominant source populations with both MIPS and IRAC data from SIRTF plus ancillary surveys at optical, near-infrared, and radio wavelengths, and, 3. explore the cirrus foreground at moderately high abs(b), and its effect on point-source detectability. This component is comprised of MIPS and IRAC surveys of four square degrees in the SIRTF northern continuous viewing zone (CVZ) and 1 square degree in the Elais N1 field. A verification survey covering a small region of the CVZ and Elais fields is also included.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #211

IRAC Imaging of a Cluster of Galaxies at $z=2.39$ and Extremely Red Objects

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Jiasheng Huang, CfA

Co-Investigators:
Myungshin Im, SSC
Mark Lacy, SSC

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap
Hours Approved: 2.0

Abstract:
IRAC Imaging of a Cluster of Galaxies at $z=2.39$ and Extremely Red Objects Myungshin Im (SSC) Mark Lacy (SSC) Abstract: This program is a deep IRAC imaging of a field near a known z=2.4 radio galaxy, 53W002. This field is also known to contain a proto-cluster of galaxies at z=2.4 (Windhorst et al. 1998, ApJ), and has been observed deeply in B,V,I,J, and H by HST, and in J and K by Subaru. Recent studies have revealed a number of z=2.4 galaxy candidates, and Extremely Red Objects (EROs) in this field. Two of the EROs are J-band dropouts, which could be either dusty/old galaxies at $z \\simeq 2.4$ or Lyman break galaxies at $z \\simeq 12.5$. With our IRAC imaging data, we will study: (1) The nature of J-band dropouts: deep IRAC ch1 and ch2 images will provide a strong indiciation whether the J-band dropouts are at z ~ 2 or at z ~ 12.5. If they are at z ~ 12.5, they will have a flux of about 1.5 microJy in ch1 and ch2. If they are at z ~ 2, they will have a flux of about 3 microJy or more; (2) The nature of EROs: we will study the spectral energy distribution of EROs, to estimate their redshifts and to study their stellar population; (3) Photometric redshift of galaxies in the field; we will use photometric redshift techniques to estimate redshifts of galaxies in the field. If this field indeed covers a z=2.4 cluster of galaxies as claimed, we expect to discover a large number of galaxies which show a SED peak at 5.5 micron (= redshifted 1.6 micron stellar emission peak). (4) Stellar population of galaxies: We will study stellar population of the spectroscopically confirmed z=2.4 galaxies. The IRAC bands corresponds to redshfited NIR wavelengths for such galaxies, thus will be useful for setting a stronger constraint on their stellar mass and star formation history.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #13

IRS Spectra + IRAC/MIPS imaging of EROs

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Tom Soifer, Spitzer Science Center

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 2.5

Abstract:
Extremely Red Objects (EROs) are believed to be either dusty starbursts or passively evolving elliptical galaxies. In either case they are believed to be at a redshift of z=1-2. If these are starbursts, they would produce a major fraction of the star formation in the z=1-2 range. If they are passively evolving ellipticals they would force the epoch of galaxy formation back substantially beyond z=5. This program involves IRS spectra of 2 specific EROs, HR10 and CADIS 16hr ERO1, as well as IRAC and MIPS imaging and followup spectroscopy of 4 targets from the CADIS 9 hr field.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #11

Dust at High Redshift

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Tom Soifer, Spitzer Science Center

Science Category: high-z galaxies (z>0.5)
Observing Modes: IrsStare
Hours Approved: 3.5

Abstract:
The goal is to probe the properties of dust at high redshifts by obtaining the spectra of sources where the infrared emission is believed to be thermal dust emission. The presence/absence of PAH/Silicate emission/absorption in these systems will address the evolution of the dust content in systems at significant lookback times. The targets chosen are all z>0.9 in which a strong dust continuum has been detected.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #136

Follow-up of Extragalactic SWIRE Sources

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Harding Smith, IPAC

Science Category: high-z galaxies (z>0.5
Observing Modes: IrsStare
Hours Approved: 3.8

Abstract:
We propose to make IRS long-low spectrometer observations of 6 galaxies in the SWIRE Lockman Deep Field (RA = 10h45m; Dec=+59d), selected to be high redshift, extremely luminous IR galaxies (from photo-z) or other unique candidates from optical/IRAC/MIPS/radio color-color relations. For S_24 = 1.0 mJy (10 sigma SWIRE detection) a complete 14-40 micron spectrum may be obtained in 1 hr integration with S/N ~ 5 in the continuum from 13--30 microns, with modest re-binning. From our survey model we expect several hundred IR-bright galaxies to this flux density limit, tens of them with z>2.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #16

IRS observations of X-ray Background Sources

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Daniel Weedman, National Science Foundation

Science Category: high-z galaxies (z>0.5)
Observing Modes: IrsStare
Hours Approved: 9.6

Abstract:
Optically faint or unidentifiable sources from Chandra deep surveys in SSA13, AXAF-South, Lockman Hole, Groth NE, and from XMM-Deep will be selected for IRS lo res observations with the objective of determining spectroscopic redshifts for optically obscured X-ray sources. IRS observations will be obtained only for sources found to have MIPS 24 micron fluxes above about 0.7 mJy.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #117

IRS Exploration program

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: James R. Houck, Cornell University

Science Category: high-z galaxies (z>0.5)
Observing Modes: IrsMap IrsStare
Hours Approved: 10.8

Abstract:
This short program includes a variety of objects which will be observed in a combination of lo-res and hi-res IRS modes. This project has multiple scientific goals. The proposed experiments are considered fairly challenging for the IRS capabilities, but have potential for new unexpected discoveries.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #198

Tidal Dwarf Galaxies

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Sarah Higdon, Cornell University

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap IrsStare
Hours Approved: 10.9

Abstract:
Tidal Dwarf Galaxies (TDG's) are formed from material stripped from the disks of spiral galaxies, which are undergoing tidal interactions with a nearby companion. These galaxies provide important clues to our understanding of galaxy formation, evolution and cosmic recycling. Using the IRS we will measure the star formation activity in 6 TDG candidates. We will measure the ionization state ([NeII] 12.8 um, [NeIII] 15.6 um and [NeV] 14.3um and [OIV] 25.9 um), the density in the ionized gas ([SIII] 18.7um/33.5um), the PAH fractions at 5.5-9um and 11-12.2um and possibly (optimistic here!) molecular hydrogen emission form PDRs at H2 (S0) 28um and H2 (S1) at 17um. In addition to the IRS observations we will map both the Guitar and Stephan's Quintet with IRAC. This will enable us to compare the PAH fraction in the dwarf galaxy to that of its parent. Similarly we will compare our observation of the proposed TDG at the southern tip of NGC 4038 with the GT observations of the central region of the Antennae. This program compliments two existing GT programmes: 1) the high-Z program - these observations enable us to observe in fine detail the nearby/present day analogs of galaxy formation in the early universe. 2) Blue Compact Dwarf programme - On first inpsection BCD's and TDG's appear the same: BCDs are similar in size to TDG's, but TDG's may not have a large dark matter halo component (affecting the long term stability of an object) and BCD's typically have a much lower metallicity. We will be able to compare the star formation activity in terms of the ionization state and PAH fraction in the two galaxy types.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #214

IRAC and MIPS imaging of the HDF_S

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Jiasheng Huang, CfA

Co-Investigators:
Pauline Barmby, SAO
Myungshin Im, SSC
Steve Willner, SAO
Mike Pahre, SAO
Zhong Wang, SAO
Marijn Franx, Leiden Obs.
Huub Rottgering, Leiden Obs.
Paul van der Werf, Leiden Obs.

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsPhot
Hours Approved: 14.0

Abstract:
We will image the WFPC2 field of the Hubble Deep Field South with IRAC, in four bands (3.5-8 micron). Combined with the ultra-deep VLT near-infrared imaging, we will determine the spectral energy distributions of the high redshift galaxies to the restframe K band. These SED's will be modeled using stellar population synthesis models.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #65

SED's of Galaxies with a Range of UV to Submm Properties

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Peter Eisenhardt, JPL

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 17.3

Abstract:
The Lyman Break population is bright at rest UV wavelengths. The SCUBA population is bright at far IR wavelengths. In this program I investigate the SED's of galaxies with a wide range of UV and submm fluxes. Besides very blue objects such as cB58 and very red objects such as HR10, the sample includes galaxies like LBDS 53W091 which are faint in both the UV (red) and the far IR and appear to have only an old stellar population even though they are at substantial redshift.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #8

The IRAC Deep Survey

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Jiasheng Huang, CfA

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsScan
Hours Approved: 232.1

Abstract:
The IRAC Deep survey is the major IRAC GTO science program. The primary objective of this program is to study the formation and evolution of normal galaxies to redshifts z>3. Identifying the initial epoch of galaxy formation and understanding the evolution of the galactic star formation rate as a function of redshift are two of the most important goals of observational astronomy. We select the Groth strip as our survey field which is also a survey field for the DEEP project, an ultra deep redshift survey project using Keck telescopes. The depth of the survey will be 6 uJy for 10sigma at the 8um band. This survey will cover 10'X2 deg area. This coverage will allow us to construct a luminosity function for L_* galaxies at z=3.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #81

The Deep Infrared Sky

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Marcia Rieke, The University of Arizona

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MIPS MipsScan MipsTp
Hours Approved: 235.9

Abstract:
The Deep Infrared SkyM. Rieke, MouldTo determine the source of the cosmic infrared background requires imaging at sufficiently deep levels to detect the individual sources producing the background. The highest redshift, most luminous sources will be powered by powerful starbursts or by non-thermal process driven by massive black holes in the object's nucleus. SIRTF photometric data alone will not be able to distinguish these two power sources based on experience from the Ultra-Luminous Infrared Galaxies discovered by IRAS. The simplest method of distinguishing between starbursts and AGN is to examine x-ray fluxes. Three layers of surveying will be used to detect adequate numbers of galaxies at both moderate and faint fluxes. Because only IRAS data are available between 1- and 175μm, some surveying to moderate depth is required to get adequate numbers of galaxies for tying IRAS data to the deepest counts. Deeper surveys will be conducted in selected areas, all with deep x-ray observations. A few SIRTF fields of view will be observed to hard confusion limits.

Spitzer Space Telescope - Legacy General Observer Proposal #169

Great Observatories Origins Deep Survey (GOODS)

Principal Investigator: Mark Dickinson
Institution: NOAO

Technical Contact: Peter Eisenhardt, JPL

Co-Investigators:
Jacqueline Bergeron, ESO
Stefano Casertano, STScI
Catherine Cesarsky, ESO
Ranga-Ram Chary, UC Santa Cruz
Stefano Cristiani, ESO
Peter Eisenhardt, JPL/Caltech
David Elbaz, CEA Saclay/UC Santa Cruz
Michael Fall, STScI
Henry Ferguson, STScI
Robert Fosbury, ST-ECF
Riccardo Giacconi, JHU/AUI
Mauro Giavalisco, STScI
Norman Grogin, STScI
Robert Hanisch, STScI
Michael Hauser, STScI
Richard Hook, ST-ECF
Inger Jorgensen, Gemini Obs
Anton Koekemoer, STScI
Michael Ledlow, Gemini Obs
Mario Livio, STScI
Bahram Mobasher, STScI
Paolo Padovani, STScI
Casey Papovich, STScI/JHU
William Reach, SSC/Caltech
Alvio Renzini, ESO
Marcia Rieke, U. Arizona
Piero Rosati, ESO
Katherine Roth, Gemini Obs
Jean-Rene Roy, U. Laval
Ethan Schreier, STScI
Daniel Stern, JPL/Caltech
Massimo Stiavelli, STScI
Marianne Takamiya, Gemini Obs
Eric Tollestrup, Boston U.
Megan Urry, STScI
Robert Williams, STScI
Claudia Winge, Gemini Obs
Edward Wright, UCLA

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsPhot
Hours Approved: 647.0

Abstract:
We propose a SIRTF Legacy Project, the Great Observatories Origins Deep Survey, to study galaxy formation and evolution over a wide range of redshift and cosmic lookback time. The survey will determine the galaxies' mass assembly history, stellar populations, and energetic output from star formation (SF) and AGN. By observing at lambda >3um, SIRTF measures the rest-frame near- and mid-IR light from objects at 1<z<6, but very deep observations are needed, to detect "ordinary" objects at these high redshifts. We propose to survey approximately 300 arcmin^2 at 3.6-8um with IRAC and at 24um with MIPS, reaching far deeper flux limits than observations planned by the GTO programs. The survey builds on the deepest observations of NASA's other Great Observatories, HST and Chandra, and on a partnership with astronomers at Gemini and ESO, with a commitment of extensive VLT support. The IRAC observations will be capable of detecting rest-frame near-IR light from progenitors of galaxies like the Milky Way out to z=4, and will enable us to study the galaxy stellar mass distribution versus

cosmic history. The MIPS observations will provide the best opportunity to detect emission from dust-obscured SF in ordinary, Lyman break galaxies out to z=2.5, and, in concert with the Chandra data, will enable a census of supermassive central black holes in obscured and unobscured AGN. An Ultradeep IRAC field will probe the faintest sources and provide the best lower limits to the extragalactic background light at 3.6-8um. By combining space- and ground-based observations, we will create a public data archive extending from X-ray through centimeter radio wavelengths, with a large sample of objects out to the highest known redshifts. This survey will give a uniquely comprehensive history of galaxies, from early epochs to the relatively recent past, and will serve as a bridge to future exploration in these wavelength and redshift regimes with NGST.

Spitzer Space Telescope - Legacy General Observer Proposal #142

The SIRTF Wide-area InfraRed Extragalactic Survey

Principal Investigator: Carol Lonsdale
Institution: Caltech

Technical Contact: David Shupe, Spitzer Science Center

Co-Investigators:
Tim Conrow, IPAC/Caltech
Fan Fang, IPAC/Caltech
Alberto Franceschini, Univ. of Padova
Nick Gautier, IPAC/Caltech
Matthew Griffin, Queen Mary & Westfield College, London
Frank Masci, IPAC/Caltech
Glenn Morrison, IPAC/Caltech
JoAnn O'Linger, IPAC/Caltech
Sebastian Oliver, Univ. of Sussex
Deborah Padgett, IPAC/Caltech
Ismael Perez-Fournon, Inst. Astrofisica Canarias
Marguerite Pierre, CEA, Saclay
Richard Puetter, Univ. of Calif., San Diego
Michael Rowan-Robinson, Imperial College, London
David Shupe, IPAC/Caltech
Harding Smith, Univ. of Calif., San Diego
Gordon Stacey, Cornell Univ.
Jason Surace, IPAC/Caltech
Cong Xu, IPAC/Caltech

Science Category: high-z galaxies (z>0.5)
Observing Modes: IracMap MipsScan
Hours Approved: 851.0

Abstract:
We propose a wide-area, high latitude, imaging survey to trace the evolution of dusty, star-forming galaxies, evolved stellar populations, and AGN, as a function of environment from z~2.5 to the current epoch. Building on ISO's heritage, SWIRE complements smaller, deeper GTO (Guaranteed Time Observer) surveys, and paves the way for FIRST. With MIPS 5 sigma sensitivities of 0.45/2.75/17.5 mJy at 24/70/160 microns over 100 square degrees (424 hrs), and 7.3/9.7/27.5/32.5 microJy at 3.6/4.5/5.8/8.0 microns for 55 square degrees (IRAC: 427 hrs), we will deliver highly uniform source catalogs and high-resolution, calibrated images, providing an unprecedented view of the evolution of galaxies, structure, and AGN on co-moving scales up to several hundred Mpc. SWIRE will, for the first time, directly address the clustering of evolved stellar systems (IRAC) vs active star-forming systems and AGN (MIPS) in the same volume. Extensive modeling suggests that the Legacy Extragalactic Catalog may contain in excess of 2 million IR-selected galaxies dominated by (1) luminous infrared galaxies, Lfir>10^11 L_sun, up to 40,000 with z > 2; (2) ~10^6 early-type galaxies (~4x10^5 with z>2); (3)~30,000 classical AGN and as many as 250,000 dust-obscured QSO/AGN. Pixon image reconstruction will optimize spatial resolution, reduce confusion noise and improve sensitivity, and will be delivered to the SSC. These fields will have extensive data at other wavebands, particularly in the optical, near-IR and X-ray; further ground-based imaging will be undertaken at NOAO and other observatories. SWIRE Legacy data will be will be combined with a wide range of X- ray, optical, infrared, submm and radio data, largely available through IPAC's Infrared Science Archive (IRSA), as part of this legacy.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #31

Evolution of Intermediate Redshift Clusters

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Terry Herter, Cornell University

Science Category: intermediate-z galaxies 0.05<z<0.5
Observing Modes: IracMap IrsStare MipsScan
Hours Approved: 16.4

Abstract:
Science Objectives - The goal of this project is to understand the increased fraction of low luminosity radio galaxies (LLRGs) with increasing cluster redshift. It will address the following questions (1) Are the LLRGs starburst galaxies (2) Does the L(FIR) - L(20-cm) relationship hold for these galaxies. That is, is this relationship valid for evolved galaxies or potentially a different population of galaxies (3) A side project will be to examine the FIR luminosity function of cluster galaxies for these clusters.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #83

Use of Massive Clusters as Cosmological Lenses/Evolution of Galaxies and Lensing in Clusters

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: George Rieke, The University of Arizona

Science Category: intermediate-z galaxies 0.05<z<0.5
Observing Modes: IracMap IrsStare MipsPhot MipsScan
Hours Approved: 144.2

Abstract:
Use of Massive Clusters as Cosmological LensesG. RiekeMassive galaxy clusters lens the part of the universe behind them D roughly speaking, the lensing action is strongest at twice the distance of the cluster. The effectiveness of the lensing is greatest for the most massive clusters. Although MIPS can observe to confusion limits at 24, 70, and 160mm, the advantage provided by lensing is that galaxies that normally would be below the confusion limit are amplified and can be detected individually. Hence, Massive clusters can be identified by their strong xray emission. This program concentrates on x-ray luminous clusters in the range 0.2 < z < 0.4, also selected to be in regions of very low infrared cirrus.Evolution of Galaxies and Lensing in ClustersKelly & G. RiekeWe have a number of goals for this survey. At low redshifts, we will scan map the clusters, measuring the brightnesses and colors of individual galaxies and checking to see if there is detectable emission from the intracluster medium. In addition, we will look at the properties of the cluster as a whole by determining the luminosity function and the total far-infrared flux, both globally and as a function of location in the cluster. At modest redshifts of 0.2-0.4 we will measure brightness distributions, fluxes for the brightest individual galaxies, and the brightnesses of the clusters as a whole. In this range, we will also use the data as a lensing cluster survey. Because of the very non-linear relation between redshift, z, and distance, the result is that clusters at z ~ 0.3 are effective at lensing from 1 < z < 2, approximately. Use of lensing can extend the MIPS deep surveys in depth by the lensing amplification factor, which typically is 3 to 5. At redshifts greater than 0.75, we will be studying the early history of the clusters. At all of these redshift ranges, we have used x-ray luminosity as a means to select massive clusters and hence we have a homogeneous sample ranging from nearby to z > 1.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #105

Spectroscopic Study of Distant ULIRGs II

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Lee Armus, Spitzer Science Center

Science Category: ULIRGS/LIRGS/HLIRGS
Observing Modes: IracMap IrsStare
Hours Approved: 85.3

Abstract:
Ultraluminous Infrared Galaxies (ULIRGs) have bolometric luminosities of quasars but they outnumber the QSOs with same optical luminosities. Even though several of the nearby ULIRGs have been studied extensively many questions regarding their dust content and energetics remain, and little is known about the more distant ones. We propose to extend our knowledge of these objects and explore the potential evolution in their properties with redshift by obtaining full low-res spectra of a sample of ULIRGs with redshifts up to 0.5.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #17

Distant X-ray Galaxy Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Peter Eisenhardt, JPL

Science Category: galaxy clusters and groups
Observing Modes: IracMap
Hours Approved: 31.4

Abstract:
We will measure the rest-frame 1.6um luminosity function of galaxies in x-ray selected clusters with z > 0.6. We expect to reach a depth of L*+4 at z=1. The sample consists of about 40 clusters with redshifts of up to 2.2, primarily selected from the Rosat Deep Cluster Survey, augmented by other clusters with z > 0.6 and known to have x-ray emission, and a few z > 1 clusters around radio galaxies for which the velocity dispersion or Faraday rotation implies a massive cluster is present. Locally, rest 1.6um emission correlates linearly with a galaxy's dynamical mass. X-ray emission arises from the intracluster medium, which dominates the baryonic mass in local galaxy clusters. Hence the 1.6um luminosity function in x-ray selected clusters as a function of redshift can be usefully compared to models for the growth of structure.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #30

IRAC Shallow Survey

Principal Investigator: Peter Eisenhardt
Institution: JPL

Technical Contact: Peter Eisenhardt, JPL

Science Category: galaxy clusters and groups
Observing Modes: IracMap
Hours Approved: 61.8

Abstract:
The NOAO deep survey is presently surveying a 9 - 10 square degree region in Bootes to K=19.5 and R=26. Data in Bw, I, J and H is also being obtained. The MIPS and IRS GTO teams are planning to survey this region with MIPS. The primary objectives for the IRAC survey of this region are to identify galaxy clusters with redshifts greater than one, and to find field brown dwarfs. If the luminosity evolution observed in clusters to redshift one continues to hold, we expect to detect L*+1 (evolving) cluster galaxies to z=2.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #32

Probing a Sample of Interacting and Ultraluminous Galaxies

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Zhong Wang, Smithsonian Astrophysical Observatory

Science Category: interacting/merging galaxies
Observing Modes: IracMap MipsPhot MipsScan
Hours Approved: 23.1

Abstract:
Galaxies closely interacting (or merging) with each other may trigger a wide range of activities, including star formation. These could profoundly alter the course of ordinary galactic evolution. Some of these objects are spectacular nearby examples of galaxy-galaxy interactions. Others, known as ULIGs (ultraluminous infrared galaxies), are among the most luminous objects in the local universe. High sensitivity, high resolution infrared data are essential in studying these galaxies, because a majority of them are found to be rich in gas and dust, making extinction a significant limiting factor at shorter wavelengths. We propose to image a limited sample of interacting and ultraluminous galaxies with IRAC and MIPS. Our main goal is to accurately measure the amount and extent of star forming activities and to explore their relationship to the dynamics of gravitational interaction.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #21

Spectroscopic Study of Star Formation in Interacting Galaxies

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Bernhard Brandl, Sterrewacht Leiden

Science Category: interacting/merging galaxies
Observing Modes: IracMap IrsMap IrsStare MipsPhot
Hours Approved: 36.0

Abstract:
The objective of our program is to study the properties of starbursts triggered by closely interacting galaxies in different states of their merging process. The properties of the starbursts may vary with location, dynamics, age, metallicity, distribution of gas and dust in the overlap region, and the presence of AGN. We will use the 4 IRS modules to measure the excitation of the gas and solid-state features in the mid-infrared spectra of a sample of 11 relatively nearby, spatially resolved interacting systems. In addition we will use IRAC and MIPS on a subset of our sample for complementary imaging.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #103

IRS Study of Planetary Nebulae in the SMC/LMC

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Jeronimo Bernard-Salas, Cornell University

Science Category: local group galaxies
Observing Modes: IrsStare
Hours Approved: 11.3

Abstract:
We propose to observe a number of planetary nebulae in LMC and SMC. The subsolar metallicities in the Magellanic clouds may result in strong ionization fields and thus unique high-exitation lines in the PNEs, unlike those of their Galactic analogues. Several of the sources will be used as early release observations and for bootstrapping the wavelength calibration of IRS.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #200

Circumstellar Dust in the Magellanic Clouds

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Greg Sloan, Cornell University

Science Category: local group galaxies
Observing Modes: IrsStare
Hours Approved: 14.8

Abstract:
This program will obtain low-resolution spectra of approximately 50 evolved stars in the Large and Small Magellanic Clouds known or suspected to exhibit a dust component on their infrared spectra. The goal is to obtain a representative sample of dust emission from evolved stars born in a metal-poor environment to (1) produce templates of dusty sources for use in interpreting the spectra of star-burst and blue compact dwarf galaxies obtained in the SBGAL_DEVOST and JRH_BCD program and (2) compare to similar samples of galactic sources obtained by ISO. Both objectives require a sample of as wide a variety of sources as possible, from both the LMC and SMC, including Miras (both short-period and long-period), irregular variables, MS stars, full S stars, carbon stars associated with both optically thin and thick shells, OH/IR stars, and supergiants. More evolved sources observed in other programs will supplement this list.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #99

Giant Extragalactic H II Regions in M31

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Karl Gordon, The University of Arizona

Science Category: local group galaxies
Observing Modes: MipsScan
Hours Approved: 17.1

Abstract:
This program is aimed at investigating the H II regions in M31. These regions will be used as analoges of starbursts and to probe the evolution of dust grain properties as a function of star formation activity. This program will acquire 24, 70, & 160 micron photometric spectral energy distributions on a large number of H II regions in M31. When combined with existing ultraviolet, optical, and near-IR images of M31, the data will be used to the star formation process and the properties of dust associated with H II regions.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #3

Brown Dwarf Galaxy Haloes

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Matthew Ashby, Harvard-SAO

Science Category: local group galaxies
Observing Modes: IracMap
Hours Approved: 32.4

Abstract:
The form of matter in galaxy haloes inferred from dynamical studies (i.e., rotation curves) remains unknown. We propose to image four bright local edge-on spiral galaxies with IRAC to detect these haloes and (if possible) characterize the distribution of halo mass. IRAC observations will be at least an order of magnitude more sensitive than previous attempts to measure flux from galaxy haloes. Combining images from all four IRAC bands also provides a potential means of discriminating among possible constituents of the dark matter.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #215

IRAC Imaging of NGC4013

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Jiasheng Huang, CfA

Co-Investigators:
Matt Ashby, SAO
Judy Pipher, Univ. of Rochester

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap
Hours Approved: 0.8

Abstract:
The proposed IRAC observations will characterize the disk properties of NGC 4013 in the infrared with unprecedented detail -- disk scale lengths and scale heights in all four IRAC bands, the location and strength of star formation within the disk, and the putative warp. The IRAC data will be particularly sensitive to the expected strong PAH emission. The resulting mosaiced image will make a striking contrast with existing visible wavelength images (e.g., HST NICMOS and WFPC2) that show a strong band of dust attenuation along the center of the disk; IRAC will reveal the underlying stellar emission.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #97

Molecular hydrogen content in nearby spirals

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Vassilis Charmandaris, Cornell University

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IrsStare
Hours Approved: 2.0

Abstract:
It is believed that the ratio of molecular to atomic hydrogen remains constant as a function of radius in late type spirals. The reason why the former is not detected is that current methods of estimating the molecular gas mass are based on indirect CO measurements which are metallicity depended. If the H2 to HI ratio is constant then molecular gas could potentially constitute a considerable fraction of the dark matter of a galaxy. We wish to examine this hypothesis by directly mapping the molecular hydrogen profile, using the mid-IR H2 lines, in one edge-on and one face-on spiral galaxy.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #197

Mid-IR Imaging & Spectroscopy of Starburst Rings

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: James Higdon, Cornell University

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 10.2

Abstract:
Ring galaxies are spectacular examples of galaxy transformation through gravitational interactions. They are created by the passage of a companion galaxy through the disk of a spiral along the rotation axis. This interaction reorganizes the spiral's disk, concentrating >90% of ISM into an expanding orbit-crowded ring. The enhanced gas density promotes the growth of very massive cloud complexes during the ring's ~400 Myr lifetime, which results in a coherent propagating starburst. Some rings, most notably the Cartwheel & AM0644-741, are host to "Super Starburst Clusters", which may be analogs of young globular clusters. At the same time, star formation interior to the rings is extinguished. These systems are ideal for studies as diverse as the global regulation/triggering of massive star formation and starburst populations. My collaborators and I are concentrating on the Cartwheel & AM0644-741, combining optical imaging & spectroscopy, HI and radio continuum interferometry, and (for AM0644-741) CO single dish mapping. They are physically the largest, the most gas rich, and with the highest SFRs (~20 M0/yr). The Cartwheel's metallicity is similar to the SMC, while AM0644-741's is close to solar. Both show strong & systematic changes in local SFR/area around the rings, arising from variations in orbit crowding. We wish to use SIRTF to obtain deep Mid/Far-IR images and Mid-IR spectra of starburst clusters in both of these dramatic systems: IRS Long/Short-High Spectroscopy: We will obtain high resolution Mid-IR spectra of two starburst clusters in each ring. IRAC 4.5 & 8um mapping: Deep 8um images will show emission from the strong PAH feature at 7.7um, after subtracting a similar map at 4.5um. MIPS 70um imaging: Both galaxies are unresolved by IRAS. MIPS 70um maps will have sufficient resolution (20") for us to distinguish FIR emission from the nucleus, disk, and rings.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #62

Dust in Low Surface Brightness Galaxies

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: George Rieke, The University of Arizona

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsStare MipsPhot MipsSed
Hours Approved: 15.3

Abstract:
Low surface brightness galaxies may represent a significant componentof the baryonic matter in the Universe. However, these galaxies appearto have followed a very different star formation history fromhigh surface brightness galaxies. IRAS was able to detect a coupleof these galaxies as was ISO, but enough data to characterizethe dust temperature and spatial distribution were not acquired.This project uses MIPS photometry mode to detect the dust ina sample of LSB galaxies chosen to have low cirrus and sufficientlylarge angular diameters for resolution by MIPS.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #60

Dust in Giant Extragalactic H II Regions in M101

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Karl Gordon, The University of Arizona

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsMap MipsScan MipsSed
Hours Approved: 16.3

Abstract:
This program is aimed at investigating the evolution of dust grain properties as a function of star formation activity. This program is aimed at acquiring 4-200 micron photometric spectral energy distributions on a large number (~500) of H II regions in M101. All of M101 (35' x 35') will be imaged with MIPS and IRAC resulting in images of the galaxy at 7 wavelengths from 4 to 160 microns. In addition, a smaller sample (~10) of the brighter H II regions will be observed with MIPS SED mode and IRS in both low and high resolution modes. This sample was defined to include H II regions in M101 which span a range of metallicities (7.9-9.1), luminosities, and dust contents. The low resolution spectroscopy will be used to determine the PAH emission spectrum and continuum level. The high resolution IRS spectroscopy will give various emission lines which act as diagnostics of the gas and stars present. When combined with existing ultraviolet images of M101, the resulting data will be used to probe the properties of dust associated with H II regions. This will be done using their ultraviolet attenuations and PAH emission spectra.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #25

Luminosity Function in Local Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Peter Eisenhardt, JPL

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap MipsScan
Hours Approved: 19.2

Abstract:
We will obtain spectral energy distributions of large numbers of galaxies across the SIRTF wavelength range by mapping four local galaxy clusters with IRAC and MIPS. The four clusters: Coma, Hercules, A1367, and A2199, span a wide range of X-ray luminosity, cooling flow rates, and late vs. early type galaxy morphologies. Coma and A2199 will be mapped by MIPS under a MIPS GTO program. The maps will cover 30 by 30 arcmin, roughly one Mpc at these cluster distances, and one square degree in the case of Coma. The IRAC 3.6um map will reach to about L*+5, probing well into the dwarf galaxy regime. Dust emitting at 7.7um and in the far IR will also be revealed. Finally, a map reaching several magnitudes deeper will be obtained with IRAC over 10 x 10 arcmin regions centered on the peak of the cluster x-ray emission, to determine whether the cooling flows in these clusters are producing low mass stars or brown dwarfs.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #85

Dust and Gas in BCDs

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: James R. Houck, Cornell University

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IrsPeakupImage IrsStare
Hours Approved: 42.6

Abstract:
The objective is to learn about the formation of stars under conditions which are similar the those under which the first generation of stars formed. The regions of study are blue compact dwarf galaxies. These are low mass regions which are undergoing their first, or more likely second, episode of star formation. Typical metallicities range from 1/5 to 1/50 solar. The latter value is typical of the metallicity following the first round of star formation. The scientific questions which will be addressed include: What is the iozionation state of the gas as assessed primarially by the NeII, NeIII and NeV, and the SIII and SIV lines. Why are the PAH feature often absent in the ISO spectra of BCDs. Are the star formation regions matter bound, as suggested by the presence of NeIII, but not NeII. Why is NeIII sometimes seen to be very extended. What is the MIR SED of BCDs, as measured by low resolution spectra. What are the implications for determining the redshift of medium redshift of ULIRGs using the PAH features if the PAH feature disappear at high z,and therefore low Z. What are the implications for the infrared background radiation. What is the extinction curve for dust formed under thse low metallicity conditions. The data to answer these, and other related questions, will require both high and low resolution spectra. Most objects will be imaged by the peak-up prior to taking the spectra. Objects with known MIR fluxes will be observed directly without the preceeding images. If the "success rate" with imaging is very high we will consider eliminating the reimages.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #5

M33 Mapping and Spectroscopy

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Steven Willner, Center for Astrophysics

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsMap IrsStare MipsScan
Hours Approved: 54.9

Abstract:
SIRTF maps of M33 will provide a global perspective on both star formation and stellar evolution in a spiral galaxy. Combined with ground-based observations, MIPS and IRAC maps will provide a unified set of maps that relates the locations of chemical enrichment, gas available to form stars, star formation, and existing stars. Repetition of the maps during the SIRTF mission will detect many types of variable stars, including the luminous, massive stars that inject processed material into the interstellar medium. The project includes followup IRS spectroscopy of sources found in the maps.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #69

A Mid-IR Hubble Atlas of Galaxies

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Michael Pahre, Smithsonian Astrophysical Observatory

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsMap MipsPhot
Hours Approved: 76.2

Abstract:
The unprecendented spatial resolution and sensitivity of SIRTF at mid- and far-IR wavelengths will allow detailed images of the distribution of and relative importance of non-thermal nuclear emission, stars, gas, dust, and star formation activity for nearby, bright galaxies. This observing program targets a representative sample of 101 galaxies in the local universe for IRAC and MIPS photometry from 3.6 to 160 um, and IRS step-and-stare spectroscopy to cover the 7.7 um PAH feature. The goals of the project are: to resolve spatially various components of the mid- and far-IR galaxy emission as a function of galaxy type and luminosity; to calibrate UV, Halpha, and far-IR estimators of the unobscured star formation rate; to determine the stellar masses using the shortest wavelength data; to create a nearby galaxy sample suitable for comparison with higher redshifts; and to construct a mid-IR "Hubble Atlas."

Spitzer Space Telescope - Legacy General Observer Proposal #159

SINGS: The Spitzer Infrared Nearby Galaxies Survey -- Physics of the Star-Forming ISM and Galaxy Evolution

Principal Investigator: Robert Kennicutt
Institution: University of Arizona

Technical Contact: Chad Engelbracht, The University of Arizona

Co-Investigators:
Lee Armus, Spitzer Science Center
Daniela Calzetti, STScI
Daniel Dale, Caltech
Bruce Draine, Princeton University
Chad Engelbracht, University of Arizona
Karl Gordon, University of Arizona
George Helou, Caltech
David Hollenbach, NASA/Ames Research Center
Claus Leitherer, STScI
Sangeeta Malhotra, Johns Hopkins University
Michael Regan, STScI
George Rieke, University of Arizona
Marcia Rieke, University of Arizona
Michele Thornley, Bucknell University

Science Category: nearby galaxies (z<0.05, v_sys<15,000 km/s)
Observing Modes: IracMap IrsMap MipsScan MipsSed
Hours Approved: 512.0

Abstract:
We propose a comprehensive Legacy survey to characterize the infrared emission across the entire range of galaxy properties and star formation environments, including regions that until now have been inaccessible at infrared wavelengths. SINGS will provide: 1) New insights into the physical processes connecting star formation to the ISM properties of galaxies; 2) A vital foundation of data, diagnostic tools, and astrophysical inputs for understanding SIRTF observations of the distant universe and ultraluminous and active galaxies; and 3) An archive that integrates visible/UV and IR/submillimeter studies into a coherent self-consistent whole, and enables many follow-up investigations of star formation and the ISM. SINGS will characterize the large-scale infrared properties of galaxies and their principal infrared-emitting components through SIRTF imaging and low-resolution spectroscopy of 75 nearby galaxies ($d < 30$ Mpc), and targeted high- resolution spectroscopy of their centers and a representative set of extranuclear IR-emitting regions in the galaxies. These data will be combined with an extensive library of ground- and space-based data at other wavelengths.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #73

IRS and MIPS observations of Starburst galaxies

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Daniel Devost, Cornell University

Science Category: starburst galaxies
Observing Modes: IrsMap
Hours Approved: 12.2

Abstract:
The observational properties of starburst galaxies are dominated by the light emitted by their young stellar population. Many starburst galaxies have high FIR fluxes which are the direct product of heating by the hot stars and re-emission in the 60-100 microns part of the spectrum. Starburst galaxies thus form an ideal laboratory to study star formation and its relationship to the physical properties of a galaxy and it's ISM. A sample of 7 starburst galaxies for which physical properties have been derived from optical spectroscopy will be observed with IRS and MIPS. First, observations at 24 microns with MIPS imaging are planned to estimate fluxes and source position for IRS spectroscopy. Then, low resolution IRS observations will allow studies of the dust, PAH and PDR properties while high resolution spectroscopy will be performed on two bright unresolved sources to study high excitation lines. MIPS imaging at 160 microns is also planned to allow the deepest probing possible of the dust. The properties derived with these observations will be compared with the physical properties derived from the optical observations.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #24

Studies of the broad 22-micron feature

Principal Investigator: Thomas Roellig
Institution: NASA Ames Research Center

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: starburst galaxies
Observing Modes: IrsMap IrsStare
Hours Approved: 28.4

Abstract:
Recently a broad 22 um feature has been observed in H II regions and starburst galaxies. We are planing further studies of this feature and its relationship with starburst galaxies. Supernovae are very likely the major production source of this broad 22 um dust feature and the strength of the feature can be used to trace the supernova rate in a galaxy. We plan to use the IRS to observe a sample of galaxies with different degree of starburst activities, with the goal of studying the strength of the 22 um feature strength and its relationship to starburst activity. In addition, we also plan to map the Carina Nebula where the 22 um feature was previously observed, with the goal of studying the excitation mechanism of this feature and the identification of its carrier. Finally, we will also observe the 22 micron feature in two supernova remnants.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #217

Mass Loss in Globular Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Pauline Barmby, SAO

Co-Investigators:
Brian Patten, SAO

Science Category: evolved stars/pn/sne
Observing Modes: IracMap
Hours Approved: 1.2

Abstract:
The goal of this project is to use warm circumstellar dust around globular cluster red giants as an indicator of mass loss. We will identify the giants from ground-based near-IR photometry, and identify the presence of dust with near-IR-to-IRAC colors. This will allow us to determine the mass-loss duty cycle and overall mass-loss rate. Combining the data with the results of a previous ISO study, we will calibrate the dependence of mass-loss on cluster properties such as metallicity, horizontal branch type, and structure. Mass loss is an important input to stellar population modeling, and this project will provide a much better observational calibration than has been used in the past.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #130

IRAC and MIPS Maps of the Crab Nebula

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: evolved stars/pn/sne
Observing Modes: IracMap MipsPhot
Hours Approved: 2.4

Abstract:
IR images of the Crab will be made to elucidate the composition and extent of the ejecta of the supernova and to reveal the fossil winds remnants of the progenitor.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #122

Observations of Recent Bright Novae in Outburst

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: evolved stars/pn/sne
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 2.7

Abstract:
We will obtain imaging and spectroscopic measurements of these novae to assess the chemical abundances of the ejecta and to image the fossil remnants of the ejecta emited during earlier phases of the evolution of the binary star system.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #9

Dust Around First Ascent Red Giants

Principal Investigator: Michael Jura
Institution: University of California - Los Angeles

Technical Contact: Michael Jura, University of California - Los Angeles

Science Category: evolved stars/pn/sne
Observing Modes: IrsStare MipsPhot
Hours Approved: 4.3

Abstract:
We propose to use MIPS to measure the dust around first ascent red giants which show infrared excesses in the IRAS data base. Our goal is to infer the mass, spatial distribution and temperature of the particles with the hope of inferring their origin. We chose stars that lie within 150 pc of the Sun that display an excess at 60 microns of at least 0.5 Jy and lie at absolute Galactic latitude greater than 10.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #68

Studying Stellar Ejecta on the Large Scale using SIRTF-IRAC

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Joseph Hora, Harvard/Smithsonian Center for Astrophysics

Science Category: evolved stars/pn/sne
Observing Modes: IracMap IrsStare
Hours Approved: 11.3

Abstract:
We will use IRAC mapping (along with MIPS images and IRS spectra) to study the stellar ejecta primarily in planetary nebulae. IRAC will map the distribution of emission from PAHs, thermal emission from dust, along with numerous atomic and molecular features from photon-dominated and shock-heated gas. These images will show the structure of the nebular shells and cool halos which will provide insight on the formation and evolution of the planetary nebulae and the ejected matter as well as information on the mass loss of the central stars.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #93

Survey of PAH Emission, 10-19.5 um

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Kris Sellgren, Ohio State University

Science Category: evolved stars/pn/sne
Observing Modes: IrsStare
Hours Approved: 15.2

Abstract:
A survey of the emission bands in the region 10-19.5 um, in planetary nebulae, proto-planetary objects, YSOs/HII regions, and related sources. The study will focus on the emission band at 16.4 um, attributed to PAHs, and will include the plateau of emission that extends from 15 um to the long wavelength limit of the Short-High IRS module.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #77

Stellar Ejecta: Macro-Molecule and Dust Formation and Evolution

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Kate Su, The University of Arizona

Science Category: evolved stars/pn/sne
Observing Modes: IrsStare MipsPhot MipsScan MipsSed
Hours Approved: 31.9

Abstract:
Mass ejected into the interstellar medium during the early and late stages of stellar evolution -- protostellar jets, asymptotic giant branch (AGB) stellar mass loss, novae, and supernovae -- is the primary source of chemically enriched material to the interstellar medium (e.g. Jura 1987, in ISP). Dust and large "macro" molecules (polycyclic aromatic hydrocarbons or PAHs) are a major constituent of the interstellar medium, and strongly influence the physics and chemistry of the ISM. The origin and evolution of these key components are not well known. With IRAC we will determine the detailed structure in various tracers, such as the warm dust component and PAHs, molecular hydrogen (v=0-0), and various ionized species. The IRAC bands are well placed to be able to detect large scale emission in the IR PAH bands. Some confusion with other species will be present, but IRS spectroscopy will quickly resolve any issues. Its large field of view allows rapid study of some of the most well known, but poorly observed objects. MIPS will give us access to extended shells and ISM interactions, the cold and very cold components, interaction interfaces, with efficient wide field mapping and fast/accurate photometry with a wide FOV. MIPS SED mode will provide information on the temperature and composition of the cold and very cold components and the dust. IRS will be used for detailed composition and temperature studies of the dust, PAHs, and numerous atomic and molecular species available in the IRS wavelength ranges of the high and low resolution modules.

Spitzer Space Telescope - Directors Discretionary Time Proposal #195

The SIRTF Galactic Plane Survey (GLIMPSE) Validation Observations

Principal Investigator: Ed Churchwell
Institution: University of Wisconsin

Technical Contact: Christer Watson, Manchester College

Co-Investigators:
The GLIMPSE Team ,

Science Category: galactic structure
Observing Modes: IracMap
Hours Approved: 10.0

Abstract:
Validation observations of the Galactic Plane Survey (GLIMPSE).

Spitzer Space Telescope - Directors Discretionary Time Proposal #104

First Look Survey - Galactic Component

Principal Investigator: Tom Soifer
Institution: Spitzer Science Center

Technical Contact: Deborah Padgett, California Institute of Technology

Science Category: galactic structure
Observing Modes: IracMap MipsScan
Hours Approved: 35.7

Abstract:
The galactic component of the SIRTF First Look Survey is intended to characterize diffuse emission and point source confusion at a variety of galactic latitudes and in a typical molecular cloud. The strategy involves sparse mapping in 15 arcmin x 1 degree strips with MIPS and IRAC along galactic longitudes 105.6 (galactic latitudes -1.3,0.35, 2.0,4.0,8.0,16.0, and 32.0 degrees) and 254.4 degrees (galactic latitudes 0.0,-2.0,-5.0,-9.0, and -14.0 degrees). In addition, four small IRAC maps at galactic longitude 97.5 (galactic latitudes 0,-4,+4, and +16) will be made to best sample the stellar density of the Galactic disk. The L1228 molecular cloud will be mapped with a 10 arcmin x 2 degree strip with MIPS and IRAC.

Spitzer Space Telescope - Legacy General Observer Proposal #146

The SIRTF Galactic Plane Survey

Principal Investigator: Ed Churchwell
Institution: University of Wisconsin

Technical Contact: Christer Watson, Manchester College

Co-Investigators:
Thomas Bania, Boston University
Robert Benjamin, University of Wisconsin
Joseph Cassinelli, University of Wisconsin
Daniel Clemens, Boston University
John Dickey, University of Minnesota
James Jackson, Boston University
Henry Kobulnicky, University of Wisconsin
Alexander Lazarian, University of Wisconsin
John Mathis, University of Wisconsin
Sara Seager, Princeton Institute for Advanced Study
Barbara Whitney, Space Science Institute
Mike Wolff, Space Science Institute
Mark Wolfire, University of Maryland

Science Category: galactic structure
Observing Modes: IracMap
Hours Approved: 400.0

Abstract:
We propose to image the inner galaxy from 10 to 70 degrees on either side of the Galactic center and one degree above and below the plane (240 square degrees) in all IRAC and MIPS bands. The survey will be fully sampled in all bands except at 160 μm. It will reach the three natural sensitivity limits: the saturation limit at wavelengths 70 μm and longer; the background limit at 24 μm; and, the confusion limit in the IRAC bands. This survey will be as good as can be obtained with SIRTF or any other telescope regardless of the integration time or observing strategy. It will require less than 20% of the time set aside for SIRTF Legacy programs. This SIRTF survey will: 1) produce a complete census of star formation in the inner galaxy; 2) measure the stellar disk scale length; 3) delineate the stellar structure of the molecular ring, inner spiral arms and bar as traced by the distributions of stars and star formation regions; 4) determine the luminosity and initial mass functions of all nearby star formation regions and clusters down to the stellar limit; 5) detect all young O and B stars still embedded in their natal clouds; 6) detect and identify young stellar objects (surrounded by circumstellar disks) in nearby star forming regions; 7) determine the interstellar extinction law in dense regions for the first time; 8) investigate the nature of Photo Dissociation Regions and the density structure within the interstellar medium; and, 9) detect a host of other types of stars and nebulae such as supernovae, planetary nebulae, hidden galaxies, OH/IR stars, etc. that will be of interest to a large fraction of the community. An additional value of a large, unbiased Galactic plane survey is its potential for new discoveries that might otherwise be missed by piecemeal imaging of selected regions.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #218

Trifid Nebula

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: William Reach, Caltech

Science Category: HII regions
Observing Modes: IracMap MipsPhot
Hours Approved: 2.9

Abstract:
The Trifid Nebula (M20) is a double-nebula, with a blue reflection nebula above a red ionized nebula, the latter being trisected by dark lanes. This observing program iamges the reflection and ionized nebulae and the dark lanes. The mid-infrared emission will trace the reflection nebula via aromatic hydrocarbon emissions and the dark lane via hot, small grains. Massive protostars have been detected in the dark lanes using submillimeter observations; the new mid-infrared observations will fully sample the lower-mass protostars. The Trifid is one of the youngest known HII regions, and the interaciton of its young, massive O-type star with its surrounding placental material is clearly affecting its ability to form new stars.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #18

H2 column densities and relative HD abundances toward a variety of warm regions in the Galaxy and the LMC/SMC

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Keven Uchida, Cornell University

Science Category: HII regions
Observing Modes: IrsMap IrsStare
Hours Approved: 3.5

Abstract:
The relative deuterium abundance in the galaxy, and ultimately, the cosmological deuterium abundance, can be determined only if reliable H2 reference column densities can be derived. A promising way to derive H2 column densities is via the mid-IR rotational lines of para-H2 (S(2) 12 micron and S(0) 28 micron) and ortho-H2 (S(1) 17 micron). We use the IRS to observe these lines toward a number of Galactic HII and SNR regions (M17SW, IC443 and NGC1096A) and regions in the LMC and SMC (N44, N81, N83B, N88, N113, N159A, N160A, LIRS36). Corresponding observations of the HD(1-0) line at 112 microns will be performed with SOFIA. One of us (R.Guesten) is PI of the 2.6 THz heterodyne instrument dedicated to observations of this transition aboard SOFIA.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #63

Comparative Study of Galactic and Extragalactic HII Regions

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Bernhard Brandl, Sterrewacht Leiden

Science Category: HII regions
Observing Modes: IracMap IrsMap IrsStare MipsPhot
Hours Approved: 35.0

Abstract:
The objective of our program is to study the interplay between massive stars and the ISM in HII regions. Our sample of Galactic and Extragalactic HII regions spans a wide range in metallicity, density, mass and age. We will use the IRS to determine the general properties of the regions using line ratios, the strength of the PAH features, and the H2 column density at numerous locations within the clusters. In addition we will use IRAC and MIPS for mapping of the PAH features (IRAC) over a larger field and the detection of massive, embedded stellar sources (MIPS).

Spitzer Space Telescope - Guaranteed Time Observer Proposal #120

Study of new 16.4 micron PAH feature

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Kris Sellgren, Ohio State University

Science Category: ISM
Observing Modes: IrsStare
Hours Approved: 1.7

Abstract:
These are four sources to be added to Cruikshank's existing program on the study of a new 16.4 micron PAH feature.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #27

CO2 Ice Absorption in the Interstellar Medium

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Edwin Bergin, University of Michigan

Science Category: ISM
Observing Modes: IrsStare
Hours Approved: 3.2

Abstract:
We will use the IRS to observe several lines of sight in the Taurus Molecular Cloud to search for the 15.2 micron absorption feature due to CO2 ice. The survey samples a variety of lines of sight towards embedded objects and field stars, probing gas with both high and low extinction. These observations will be used to examine the uncertain formation pathways of CO2 ice in the interstellar medium.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #4

Shedding light on Unusual Sources near the Galactic Center

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Keven Uchida, Cornell University

Science Category: ISM
Observing Modes: IrsStare MipsScan
Hours Approved: 3.3

Abstract:
The Galactic center contains a number of unusual structures that manifest the physical extremes of the interstellar medium there. We use SIRTF to elucidate the physical conditions in several of these structures. The first is AFGL 5376, a remarkably bright and extended 25-micron source which appears to be a well-defined, large-scale, vertical shock associated with a radio continuum structure, the Galactic Center Lobe. We will detail the MIR structure and the spatial variation of the mid-infrared dust and ionized gas features across this object. The observations are intended to provide insights into both the shock kinematics as well as the nature of the dust in the ISM near the Galactic center. We also use the IRS to observe high excitation mid-IR atomic lines toward two other high energy features that are also likely to have resulted from activity unique to the Galactic center: Sgr AE and the radio "Streamers". Finally, high resolution spectral line observations of the putative sites of origin of the nonthermal radio filaments will provide constraints on the illuminating mechanism of these spectacular linear magnetic field lines.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #28

Spectral Line Diagnostics of Shocks and Photon-Dominated Regions

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: David Neufeld, The Johns Hopkins University

Science Category: ISM
Observing Modes: IrsMap
Hours Approved: 6.7

Abstract:
We will use the step-and-stare mode of IRS to observe the sources S140, NGC 7023, and HH54, obtaining spectral line maps of regions of size ~ 55 x 55 arcsec (45 x 45 arcsec for HH54) using the Short-Lo, Short-Hi and Long-Hi modules. These observations will yield maps of the emission line intensities for several rotational transitions of H2 and H2O and many fine structure lines of atoms and atomic ions. The scientific goal is to study the spatial variation in gas temperature, density, H2 ortho-to-para ratio, water abundance and ionization conditions within the three sources studied, thereby enhancing our physical understanding of interstellar shock waves and photodissociation regions.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #19

SIRTF Observations of the Mid IR Features in Reflection Nebulae

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Michael Werner, JPL

Science Category: ISM
Observing Modes: IracMap IrsStare MipsScan MipsSed
Hours Approved: 21.5

Abstract:
Reflection nebulae (RN) are valuable tools for the study of the interstellar infrared emission features (IEFs) (at 3.3, 6.2, 7.7, 8.6, 11.3 and 12.7 microns). The localized heating of an interstellar cloud by a nearby, optically visible star allows us to study the IEFs over varying excitation conditions by observing reflection nebulae illuminated by stars of different effective temperature. We will use a combination of MIPS, IRAC and the IRS to observe the IEFs in seven reflection nebulae with two major scientific approaches: (1) use the unprecedented sensitivity of SIRTF to detect and characterize IEF emission toward RN (vdb 47, 101 and 135) with very low illuminating stellar temperatures (and thus low UV to total flux ratios), which tests the various carrier/excitation models of the IEFs, in particular the PAH models which require high energy UV photons for excitation; and (2) obtain both the highest quality images and most complete wavelength-coverage spectra of the IEFs to date, by observing a sample of relatively bright RN (vdb 17, 52, 133, and 139). For both approaches, MIPS (24, 70, 160 microns) will be used to map the mid-IR emission and characterize the far-IR color temperature around the nebulae. IRAC will be used to map the distribution of IEF emission in the nebulae and to pinpoint the brightest emission spots for observation by the IRS. The IRS will provide spectra spanning from 5 to 40 microns, with lower spectral resolution of 60 at lambda < 10 microns, and higher spectral resolution (600) at lambda > 10 microns.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #94

Search for Low-Luminosity YSOs and Measurement of Infrared Extinction in Dark Clouds and Bok Globules

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Jocelyn Keene, JPL

Science Category: ISM
Observing Modes: IracMap
Hours Approved: 23.4

Abstract:
This project is a survey of 50 Bok Globules and 2 dark clouds at IRAC wavelengths searching for embedded very low luminosity YSOs. With these data we will also derive extinction profiles of the globules. Comparisons to 2MASS observations will enable extension of the near-infrared extinction curve to 8 microns under a varity of density conditions. Comparisons with MIPS maps of the same sources, from a separate projects, will allow a derivation of the far-infrared dust emissivity.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #124

IRAC and MIPS Imaging and IRS Spectroscopy of Pre and Post Main Sequence Stellar Systems

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: ISM
Observing Modes: IracMap IrsMap IrsStare MipsPhot
Hours Approved: 29.6

Abstract:
We will obtain images of these systems to search for extended, faith ejecta and fossil remnants ejected in previous evilutionary phases. IRS follow-up will be used to determine the chemical composition and dynamics of the ejecta.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #45

Deuterium Enrichment in PAHs

Principal Investigator: Thomas Roellig
Institution: NASA Ames Research Center

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: ISM
Observing Modes: IrsStare
Hours Approved: 37.3

Abstract:
Laboratory studies have indicated that under interstellar radiation condition the hydrogen atoms in PAH molecules will be replaced in time by deuterium. This investigation will gather evidence for this process by examining the PAH spectral features in a number of regions with quite different ages, ranging from proto-planetary nebulae, through planetary nebulae of various ages, on out to older PAH material in molecular clouds. The presence of deuterium in the PAH molecules dramatically shifts the locations of the spectral features, so that they can be detected with the IRS instrument. Since these objects are generally extended and sensitivity to very weak features is needed, observations will be made both on the targets and on nearby background sky.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #129

IRS Observations of Selected LBVs

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: massive stars
Observing Modes: IrsStare
Hours Approved: 0.7

Abstract:
Mid-IR spectroscopy with IRS will be used to assess the chemical composition and dynamics of the winds of selected luminous blue variable stars.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #202

Star Formation in Bright Rimmed Clouds

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: massive stars
Observing Modes: IracMap MipsPhot
Hours Approved: 5.2

Abstract:
Bright-rimmed clouds (BRCs) contain dense molecular gas cores with at least one edge illuminated by a hot high-mass star, and as such they are good laboratories for the study of radiation-implosion driven star formation. The goal of this program is to obtain a complete census of protostars and young stars in a distance-limited sample of BRCs. The spatial distributions of the embedded protostars and young stars will be analyzed for signatures of sequential, or triggered, star formation. We plan to image a sample of 20 BRCs in the four IRAC bands and in the 24 micron band of MIPS. The sample is drawn from that of Sugitani et al. (1991, 1994) for BRCs within 1 kpc of the Sun. Since these sources are relatively compact, no mapping is required. The IRAC observations will consist of 5 dithered images centered on the source to encompass both the bright rim and the IRAS source contained within the core. The images will be obtained in the 12-sec HDR mode. MIPS photometry observations will be obtained at 24 microns, using an integration time at 24 microns of 10 seconds. The IRAC and MIPS observations each require about 9 minutes per source. The entire program will require a total time of approximately 6 hours.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #201

The Role of Photodissociation Regions in High Mass Star Formation

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: massive stars
Observing Modes: IracMap
Hours Approved: 5.9

Abstract:
The evolution of high mass star formation regions is affected by the creation and evolution of photodissociation regions (PDRs), which are not present in the case of low mass star formation since the latter do not emit the necessary UV. In star forming regions like NGC 7538 and S252, high mass YSOs representing a second generation of star formation are often found embedded in PDRs. We would like to understand how the chemistry, composition, and structure of PDRs fit in to the overall puzzle of high mass star formation. To this end, we propose a program of high sensitivity IRAC imaging of the infrared emission from these diffuse regions. IRAC's spectral coverage, high sensitivity to extended IR emission, and good spatial resolution over large fields will allow us to obtain critical data on the dust populations in PDRs. In particular, three of IRAC's four bands include wavelengths of emission from PAHs, which strongly contribute to the heating of PDRs via photoelectric heating due to PAHs' highly efficient ionization by far-IR photons. PAHs are excellent diagnostics for probing the conditions in PDRs through spectral and spatial variations.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #199

Dust Properties Along the Wolf-Rayet Evolutionary Sequence

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Pat Morris, Caltech

Science Category: massive stars
Observing Modes: IracMap IrsMap IrsStare MipsPhot
Hours Approved: 11.0

Abstract:
Massive stars ending in the Wolf-Rayet (WR) phase of advanced core-burning may drive star formation and dramatically influence the energy budget, kinematics, and chemistry of active star forming environments in galaxies, in the cores of some active galaxies, and our Galactic Center where the massive star content is high. The dust properties of these environments are affected by production of oxygen- and carbon-rich dust during the WN, WC, and related Luminous Blue Variable phases. However, the dust and gas in the compact carbonaceous dust shells around WC-type stars, and in the extended nebula around WN type stars (the precursors to WCs) are poorly studied. In particular, no thermal IR spectroscopy of O-rich dust in nebulae around WN stars is available, but there are indications from ISO observations of WR galaxies that they may be strong contributors of crystalline silicates, a possibility also supported by the dust content of less-evolved LBV nebulae. WC dust spectra are limited to only the 5 brightest WC9-type stars (ISO), and several additional late WC's at much reduced spectral coverage (SCORE, 8-13 micron). We are pursuing spectroscopy of previously unobserved dusty WR stars, including four compact dusty WC-type stars, with high resolution and SL spectroscopy to analyze the dust grain properties and composition along the early-type to late-type WC sequence. We can address the debate on the ISM vs. circumstellar nature of the 6.3um aromatic band. We will also do high resolution spectroscopy of the WN central stars, employng non-LTE model atmospheres to demonstrate how the mid-infrared spectrum can be quantatively analyzed to derive the fundamental stellar and wind parameters, and spectrally map the surrounding ring nebulae at low resolution for first results on WN dust. We can use H2 detections (reported only at 2.12 microns in one nebula thus far) to constrain the formation mechanism and abundances, allowing us to test the hypothesis the WR nebulae are the principal contributors of H2 in galaxies.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #132

IRAC and MIPS Images of Omega Cen

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: star clusters
Observing Modes: IracMap MipsPhot
Hours Approved: 3.7

Abstract:
We will obtain data to construct IR HR diagrams of a globular cluster including a long-wave search for dust.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #46

Deep IRAC Imaging of High Mass Protostars

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: Star Formation
Observing Modes: IracMap IrsMap
Hours Approved: 3.2

Abstract:
We will perform deep IRAC imaging of three high mass star forming regions: M17SW, NGC 6334 I, and NGC 281West. All three regions are known to contain deeply embedded high mass protostars in regions where the extinction is in excess of 50 AV. We will probe these high extinction regions for deeply embedded low mass stars. From this measurement, we can estimate the stellar densities in the immediate vicinities of forming high mass stars and test theories which explain the formation of high mass stars through collisions of lower mass stars.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #127

IRAC and MIPS Images of W3

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: Star Formation
Observing Modes: IracMap MipsScan
Hours Approved: 3.2

Abstract:
We will obtain IRAC and MIPS images of the region of star formation W3 to study the distribution and initial mass function of the embedded sources.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #113

Emission lines from shocks: water, molecular hydrogen, and low-excitation ions in the Cep A East and HH 7-11 outflows

Principal Investigator: Gary Melnick
Institution: Harvard-Smithsonian Center for Astrophysics

Technical Contact: Dan Watson, University of Rochester

Science Category: Star Formation
Observing Modes: IrsMap
Hours Approved: 11.4

Abstract:
Emission lines from shocks: water, molecular hydrogen, and low-excitation ions in the Cep A East and HH 7-11 outflows PI: Gary Melnick, Center for Astrophysics Co-Is: Ted Bergin, Center for Astrophysics David Neufeld, Johns Hopkins U. Dan Watson, U. Rochester SIRTF and the IRS offer access, at moderate spectral and spatial resolution, to some of the best molecular and atomic probes of the outflows and shocks associated with recent star formation. Here we intend to use IRS for emission-line imaging of Cepheus A East and HH 7-11, two well-known star-formation regions that were studied in detail by SWAS. The maps we obtain will include extended emission by molecular hydrogen (v = 0 S(0)-S(5)) and water (several pure rotational lines), as well as numerous transitions of low-excitation atomic and ionic species associated with jets and shocks. We will use these data, combined with SWAS observations of thermal water-line emission and shorter-wavelength H2 and [Fe II] images, in models of the excitation, energetics and chemistry of the shocked gas.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #128

IRAC and IRS Observations of Nearby Dwarf Irregular Galaxies

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: Star Formation
Observing Modes: IracMap IrsStare
Hours Approved: 15.7

Abstract:
We will conduct mid-IR imaging with IRAC at 4.5 and 8.0 microns to survey the stellar population for embedded stars what would not be identifiable in optical surveys. Mid-IR spectroscopy with IRS in low resolution covering the wavelength range from 5 to 40 microns will be used to obtain spatially resolved spectra of the mid-IR nebular emission lines and the PAH lines in a small sample of well-studied, nearby dwarf starburst galaxies. Mid-IR spectroscopy with IRS in high resolution covering the low wavelength range from 10 to 19.5 microns to search for the molecular hydrogen emission at 0-0 S(1) 17 microns and 0-0 S(2) 12.3 microns in low metallicity environments.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #22

Observations of nine-micron IRTS sources

Principal Investigator: Thomas Roellig
Institution: NASA Ames Research Center

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: Star Formation
Observing Modes: IracMap IrsStare
Hours Approved: 24.3

Abstract:
During the course of its one month mission, the Infared Telescope in Space detected a number of unusal objects with strong nine-micron peaks. This investigation follows up these discoveries. The program consists of IRAC mapping followed up by IRS low-resolution spectroscopy of candidate objects detected in the IRAC survey.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #53

Pre-stellar and Proto-stellar Cores and Cold Dust

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Jocelyn Keene, JPL

Science Category: Star Formation
Observing Modes: MipsPhot MipsScan
Hours Approved: 34.5

Abstract:
This proposal is designed to address several different scientific topics, the unifying theme of which is the search for and observation of nearby, very cold, dusty sources. We plan an imaging survey of pre-stellar cores to search for lower luminosity and/or younger sources than have been found in the IRAS and ISO data. Recent comparisons of pre-stellar and proto-stellar cores have indicated that they have fundamentally different structures: pre-stellar cores have not yet developed steep density gradients near their centers. These results were inferred from sub-millimeter observations of flux gradients in pre- and proto-stellar cores. MIPS has the capability for not only measuring flux gradients, but also temperature gradients and thus measuring much more directly the density gradients of the young cores to see whether this conclusion holds up. We plan an SED survey of some proto-stellar and pre-stellar cores to measure temperature and density gradients. Finally, MIPS is ideally suited to mapping far-infrared color temperatures, which we propose to do in a small number of clouds that have been well studied in the near-infrared and at other wavelengths. These data can be used to study the grain properties in the clouds.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #219

Dark Clouds

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Sean Carey, SSC

Science Category: young stellar objects
Observing Modes: IracMap MipsPhot
Hours Approved: 1.1

Abstract:
This program will map three infrared dark-clouds (IRDCs) with IRAC and embedded massive protostars within the IRDCs with MIPS. IRDCs are large, cold, dense molecular cores with substantial mid-infrared extinction (> 1 mag from 8-25 microns). IRDCs have gas densities of 10^6 cm^-3 and temperatures of 8-15K. IRDCs contain bright submillimeter sources with molecular outflow and infall signatures. The available data suggests these sources are massive class 0 protostars. This program will measure the embedded protostellar/young stellar content of the IRDCs and measure the mid-infrared extinction curve towards these objects. A total of 73 minutes of observing time with IRAC and MIPS is required.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #114

Molecular and atomic emission-line images of DR 21 and GGD 37

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Dan Watson, University of Rochester

Science Category: young stellar objects
Observing Modes: IrsMap
Hours Approved: 6.5

Abstract:
Molecular and atomic emission-line images of DR 21 and GGD 37 PI: J.R. Houck Technical contact: Dan Watson DR 21 and GGD 37 (Cep A West) are two of the best-resolved examples of bipolar outflows and shocks from massive young stellar objects. In this program we will use the high-spectral-resolution modules of the IRS to obtained detailed images of emission by molecular hydrogen (three pure rotational lines), water (13 pure rotational lines) , and several low-excitation ions and atoms (e.g. [Si II], [Fe II], [S I] and [Ne II]). The structure of the shocks will be resolved in the images; in particular the dual cloud-shock/jet-shock structures will be cleanly separated in the many nearly-edge-on shock rims in these objects. This provides a unique opportunity -- not possible from suborbital platformas -- for study of the interaction of a YSO outflow and its surrounding cloud, using probes that trace the bulk of the material (H2) as well as the bulk of the radiated energy (H2O) in the shocked gas, and will provide strong constraints on models of the interaction and on the influence of outflows and shocks on ongoing star formation.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #116

Spectral Mapping of NGC 1333

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Nick Gautier, JPL

Science Category: young stellar objects
Observing Modes: IrsMap
Hours Approved: 12.9

Abstract:
We will carry out a spectral mapping of the central 17x25 arcmin of NGC 1333, a galactic molecular cloud rich in dense gas, very young stars, and outflows from low mass stars. Our primary goal is to map the spatial distribution of H2 rotational emission at 17 and 28 microns associated with the outflows. Additional goals are a study of the ice features associated with the embedded YSOs, and the identification of extended dust emission features. The results will be compared with existing millimeterwave CO maps and images of shocked gas from optical and near-IR wavelengths.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #43

An IRAC Survey of the L1630 and L1641 (Orion) Molecular Clouds

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: young stellar objects
Observing Modes: IracMap MipsScan
Hours Approved: 45.3

Abstract:
We will conduct a survey of the Orion A (L1641) and Orion B (l1630) Molecular Clouds in all four IRAC bands. From this survey we can achieve the following: 1.) probe the spatial distribution of young stars in the Orion clouds, comparing the number of clustered and isolated stars, 2.) study the evolution of circumstellar disks and envelopes during the first few millions years of pre--main sequence evolution, and 3.) measure the Orion cloud IMF down to 10-20 Mjupiter.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #6

Structure and Incidence of Young Embedded Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard-CfA

Science Category: young stellar objects
Observing Modes: IracMap MipsScan
Hours Approved: 49.8

Abstract:
We plan to use the IRAC and MIPS cameras on SIRTF to measure the spatial distribution of the youngest stars in ~ 24 groups and clusters within 1 kpc, and to measure the degree of clustering in 7 star-forming complexes within 350 pc. This program will allow us for the first time to determine systematically how stars in clusters are arranged at birth--their organization into groups, the number, spacing, and density of these groups, their range of stellar ages and their distribution of stellar masses. These observations should strongly constrain models of cluster formation and of the initial mass function.

Spitzer Space Telescope - Legacy General Observer Proposal #139

From Molecular Cores to Planets

Principal Investigator: Neal Evans
Institution: University of Texas

Technical Contact: Neal Evans, University of Texas

Co-Investigators:
Lori Allen, Smithsonian Astrophysical Observatory
Geoffrey Blake, California Institute of Technology
Paul Harvey, University of Texas at Austin
David Koerner, University of Pennsylvania
Lee Mundy, University of Maryland
Philip Myers, Smithsonian Astrophysical Observatory
Deborah Padgett, Spitzer Science Center
Anneila I. Sargent, California Institute of Technology
Karl Stapelfeldt, Jet Propulsion Laboratory
Ewine van Dishoeck, Leiden University

Science Category: young stellar objects
Observing Modes: IracMap MipsPhot
Hours Approved: 400.0

Abstract:
The formation of stars and planets from molecular cloud cores is a key area for research this decade. Crucial steps in this process can only be studied at mid-infrared to far-infrared wavelengths, where SIRTF provides an unprecedented improvement in sensitivity. We propose to use SIRTF (IRAC, MIPS, and IRS) to obtain data that span the evolutionary sequence from cores to planets, including a sampling of other variables, such as mass and environment, sufficient to separate these variables from evolution. In addition to observing known sources, we will scan large areas in molecular clouds for low luminosity sources and make a complete sample of nearby solar-type stars for debris disks. Spectroscopy of known objects spanning the full evolutionary range will be complemented by follow-up spectroscopy on new objects found in the surveys. The resulting data products will include catalogs of thousands of previously unknown sources, multiwavelength maps of very large regions, spectra of hundreds of sources, ancillary data, and new tools for analysis and modeling. These will provide many opportunities for follow-up studies with SIRTF, other space missions, including SIM, NGST, and TPF, and ground-based telescopes.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #44

IRS observations of nearby stars

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: brown dwarfs/very low mass stars
Observing Modes: IrsStare
Hours Approved: 1.0

Abstract:
SIRTF will conduct a survey of the nearest stars. Most of these objects are observed by the IRS in others programs devoted to M-star observations and nearby stars with known disk emission. The objects to be observed here are those that are not in this program nor are so bright that they would saturate the IRS instrument.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #50

IRAC Imaging of the Trapezium and NGC 2024 Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 2.1

Abstract:
We will obtain IRAC images of 15'x15' fields in the Trapezium and NGC 2024 to complement the IRAC Orion survey. This data will provide: 1.) deep imaging of the Trapezium cluster from which we will obtain IRAC photometry of brown dwarf candidates, 2.) accurate photometry in regions of high surface brightness.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #118

MACHO Search

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Hien Nguyen, Jet Propulsion Laboratory

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap MipsPhot
Hours Approved: 4.4

Abstract:
We will carry out deep imaging with IRAC (all bands) and MIPS (24um only) at the position of selected MACHO events in the LMC to search for cold objects which might be responsible for the magnification.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #33

A Search for Companions Around Stars Within Five Parsecs

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 8.2

Abstract:
Each star known within 5 parsecs of the Sun will be observed with IRAC to discover very low mass companions. Simply because of their proximity, these targets promise to provide one of the most sensitive experiments possible with IRAC --- the detection of super-Jupiters around the nearest stars. Depending on distance and separation from the stars, companions with masses as low as 5-20 Mjup can be detected. The sample of 60 stars in 44 systems within 5 parsecs requires 45 IRAC pointings (Proxima Cen requires its own pointing because it is two degrees from alpha Cen). The sample includes 4 white dwarfs, 1 A star (Sirius), 1 F star (Procyon), 2 G stars (alpha Cen A and tau Ceti), 6 K stars, and 46 M stars. These stars comprise 30 single systems, 10 doubles, and 3 triples, as well as the nearest star with a probable extrasolar planet, Gl 876.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #48

Brown Dwarfs Around Extrasolar Planetary Candidates

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 8.5

Abstract:
Forty-eight stars with extrasolar planet candidates will be observed to detect additional, wider companions with masses as low as 20 Mjup. The most important question that might be answered by observing these stars with IRAC is: "Are there brown dwarf companions in the systems at larger radii?" There are currently only two main sequence stars --- the Sun and upsilon Andromedae --- known to have more than one companion of planetary mass. If a brown dwarf were discovered in addition to a planetary companion around one of these stars, it would have serious implications for the formation of solar systems. In fact, the nature of brown dwarfs themselves might come into play, e.g. might brown dwarfs sometimes be considered planetary bodies?

Spitzer Space Telescope - Guaranteed Time Observer Proposal #29

IRS observations of the dwarf M-star sequence

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: brown dwarfs/very low mass stars
Observing Modes: IrsStare
Hours Approved: 9.3

Abstract:
M-dwarfs are the lowest-mass stars that still undergo a normal main-sequence phase. Studies of these objects are important for two reasons: (1) they are the stellar transition into the brown dwarf classes of objects, and (2) their low photospheric temperatures mean that the chemistry of their atmospheres changes radically as the M-star sequence is traversed. These observations use the IRS to observe a sample of M-dwarfs ranging from M0 to M9.5. The observations generally use the short-low and both high resolution modules.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #34

Substellar Mass Companions to Nearby Young Stars

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 13.0

Abstract:
Seventy-three nearby (d < ~30 pc), young dwarfs with types ranging from A0V to M4.5V will be observed with IRAC to detect companions with masses as low as 5 - 20 M_Jup. The advantage of observing targets which are young is that substellar mass companions will also be young and therefore much more luminous than their cooler counterparts found around older stars in the field. The targets in this program have been selected from the literature using multiple indicators of youth (age < 120 Myr) including high X-ray luminosity, high chromospheric activity levels, high Li abundance, rapid rotation, photometric colors consistent with youth (when combined with theoretical isochrones), and young disk kinematics. This volume-limited sample will allow us to search for companions on distance scales of 50 AU to 4000 AU from the primary.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #56

Photometry of L and T Dwarfs and Late-Type M Stars

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: John Stansberry, The University of Arizona

Science Category: brown dwarfs/very low mass stars
Observing Modes: MipsPhot
Hours Approved: 15.0

Abstract:
L Dwarfs span the transition between stars and brown dwarfs, while T Dwarfs are all brown dwarfs. The MIPS program on these objects has two goals. The first is to obtain measurements of the 24 micron brightness of ~30-40 'L' and ~8 'T' Dwarfs, and of a comparable number of M stars with spectral types later than M5. To the extent possible, the targets will be selected to overlap with the IRAC and IRS programs. The photometry will provide the longest wavelength point in the spectra of these objects, in a region of the spectrum which is relatively uncomplicated compared to the visible through 15mum region, having only very broad absorptions by molecular hydrogen. As such, our photometry will serve as an anchor for determinations of the relationship between radius and luminosity. The photometry of late-type M stars will also be the first ever at such long wavelengths, and the data will also complement IRAC and IRS measurements which will be obtained for the same objects. The second goal emphasizes observations at 24mm (overlap with IRAC and IRS is not required, but is generally desirable). Since the 24mm luminosity of an L dwarf is only weakly dependent on its temperature, mass, or atmospheric parameters, flux measurements can be converted to distances in a straightforward way.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #35

Multiplicty and Infrared Colors of Nearby MLT Dwarfs

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 16.1

Abstract:
Eighty nearby, low mass dwarfs of type M5.0V and later will be observed with IRAC to discover companions with masses as low as 10-20 Mjup. These targets are ideal for a companion search because they are nearby, yet relatively faint. This allows low mass companions to be revealed close to the target object because the psf of the primary isn't overwhelming. The mass limit of 10-20 Mjup (depending on target distance) for this survey is for 30 sec integrations in the 4.5 micron band. In addition to the companion search, this study will provide double duty because the targets themselves are the ideal calibrators for other IRAC brown dwarf search programs.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #42

IRAC Imaging of the Hyades

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 18.0

Abstract:
Imaging in all four IRAC bands will be obtained for members of the Hyades and Pleiades clusters ranging in mass from the top of the main sequence to the faintest known cluster members, using the "cluster" mode. One goal of the observations will be to define the single-star main sequence in the four IRAC bands at (a) solar metallicity and age ~ 100 Myr (i.e. members of the Pleiades) and (b) at [Fe/H] ~ +0.14 and age ~ 600 Myr (i.e. members of the Hyades). In the Pleiades,this will include obtaining IRAC photometry for most of the known or proposed sub-stellar members of the cluster. Comparison of the IRAC colors for the sub-stellar Pleiades members to older VLM stars (and to very young, sub-stellar objects identified in star-forming regions) will help to empirically establish the gravity sensitivity of the IRAC colors at very low masses. A second goal will be to search for previously unknown, very low mass members of the cluster, either as companions to the targeted members or as "free-floating" cluster members that happen to be located near the targeted members.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #38

IRAC Imaging of the Pleiades

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap
Hours Approved: 19.1

Abstract:
Imaging in all four IRAC bands will be obtained for members of both clusters ranging in mass from the top of the main sequence to the faintest known cluster members, using the "cluster" mode. One goal of the observations will be to define the single-star main sequencen the four IRAC bands at (a) solar metallicity and age ~ 100 Myr (i.e. members of the Pleiades) and (b) at [Fe/H] ~ +0.14 and age ~ 600 Myr (i.e. members of the Hyades). In the Pleiades, this will include obtaining IRAC photometry for most of the known or proposed sub-stellar members of the cluster. Comparison of the IRAC colors for the sub-stellar Pleiades members to older VLM stars (and to very young, sub-stellar objects identified in star-forming regions) will help to empirically establish the gravity sensitivity of the IRAC colors at very low masses. A second goal of the observations will be to search for previously unknown, very low mass members of the cluster, either as companions to the targeted members or as "free-floating" cluster members that happen to be located near the targeted members. The goal of the observations of the target objects is to obtain photometry with intrinsic S/N ~ 1% in all four IRAC bands (or 2% in the SiAs bands for the faintest targets) in order to define the IRAC CM and CC diagrams as precisely as possible. The goal for the search for new, even lower mass Pleiades members is to be able to detect substellar mass members of the Pleiades down to 10 M(Jup) at 4.5 microns.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #36

Deep IRAC Imaging of Brown Dwarfs in Star Forming Clusters

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: brown dwarfs/very low mass stars
Observing Modes: IracMap IrsStare
Hours Approved: 21.9

Abstract:
Deep IRAC imaging will be used to measure 1) the substellar IMF (>0.5-1 M_jup) and 2) the 1-8um SEDs of young brown dwarf/disk systems (>1-2 M_jup) within the three nearby star forming clusters (0.5-2 Myr) of IC 348 (300 pc), Rho Oph (150 pc), and Cha I (150 pc). The maps of these clusters will have dimensions of 15'x15', 10'x10', and 15'x15' and total exposure times per pointing of 3000, 3000, and 2000 s.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #51

IRS Observations of the Brown Dwarf L and T Sequence

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Thomas Roellig, NASA Ames Research Center

Science Category: brown dwarfs/very low mass stars
Observing Modes: IrsStare
Hours Approved: 76.3

Abstract:
We examine the spectra of brown dwarfs in a study complementary to the IRS GTO proposal "IRS observations of the dwarf M-star sequence." These objects do not have sustained fusion, only temporary deuterium burning early in their evolution. L and T dwarfs are distinguished observationally by the presence of methane in the T dwarfs, but not the L dwarfs, which are too hot for methane to be stable. These observations use the IRS to observe several examples of each spectral subtype L0-L8, and T dwarfs of a variety of effective temperatures. These spectroscopic studes are important for 1) observing dust the atmospheres of these objects, which tells us about the chemical composition, temperature, and degree of convection on the object 2) observing molecular species in the atmospheres analogous to those observed in the Jovian planets of our own Solar System. The observations generally use the short-high and both low resolution modules.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #100

MIPS Survey of eta Cha cluster

Principal Investigator: Charles Lawrence
Institution: JPL

Technical Contact: Nick Gautier, JPL

Science Category: circumstellar/debris disks
Observing Modes: MipsScan
Hours Approved: 2.6

Abstract:
The eta Cha cluster will be mapped to high sensitivity with MIPS scan map to search for circumstellar disks around the bright cluster stars and to search for cluster brown dwarfs. The mapped area is approximately 0.5 deg x 0.5 deg centered approximately on eta Cha itself

Spitzer Space Telescope - Guaranteed Time Observer Proposal #206

The Castor Moving Group

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Christine Chen, NOAO

Science Category: circumstellar/debris disks
Observing Modes: IrsStare MipsPhot
Hours Approved: 2.7

Abstract:
We plan to search for 24, 70, and 160 micron excesses, using MIPS, around 8 main sequence stars in the Castor Moving Group. This association is believed to have an age of approximately 200 Myr and contains the well studied debris disk objects Fomalhaut and eps Eridani.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #102

A Search for Terrestrial Planetary Debris Systems and Other Planetary Debris Disks

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Luisa Rebull, JPL

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 3.8

Abstract:
MIPS photometry will be obtained for a large sample of young, relatively nearby (generally within 100 pc) stars. The primary objectives of this program are: 1) identify systems possessing warm dust emission analogous to the zodiacal bands of the inner solar system, 2) find further examples of the pre-main-sequence planetary debris system (PDS) discovered for HD 98800B, and 3) identify Vega-type cooler dust excesses early in the evolution of their illuminating stars. This survey will constrain models of the origin and evolution of PDSs with the ultimate goal of determining how often, and in what circumstances terrestrial planets are formed. In addition, the survey will identify objects having mid-IR excesses that will be suitable targets for follow-up ground- and space-based observations at higher resolution. This program is a collaboration among four SIRTF GTOs (F. Low, M. Werner, M. Jura, and R. Gehrz). Each GTO will will submit his portion of the observational program separately.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #95

IRS observations of Spatially Extended Vega-type Dust Disks

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: circumstellar/debris disks
Observing Modes: IrsMap IrsStare
Hours Approved: 4.1

Abstract:
We collect high S/N spectra of 9 main-sequence stars with significant IR excesses at 25 um, which may have spatially resolvable dust disks, in order to study the temperature and compositional profiles of these disks. The same source list is being used by MIPS in their co-ordinated study. This study uses all IRS modules, and uses the Long Lo 1st order aperture in a step and stare study of spatial extent.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #123

Young PMS Stars

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 5.5

Abstract:
We will obtain MIPS observations of young PMS stars to determine the structure and composition of their circumstellar environment.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #135

2-MASS sources with 12um excesses

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Sergio Fajardo-Acosta, Spitzer Science Center

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 7.3

Abstract:
We will observe 14 main-sequence stars with 12 micron excesses, indicating the presence of warm (temperature of order 300 K) circumstellar dust debris disks. We discovered these systems using 2MASS J, H, Ks photometry, to estimate photospheric SEDs, and IRAS FSC or SSC 12 micron photometry. The dust is located at about 1--10 AU from the stars, in possible asteroidal clouds. We will obtain IRAC 3.6, 4.5, 5.8, and 8 micron very precise photometry (S/N > 100) to search for the hottest dust, and therefore the innermost edge, of the disks. Through IRS 5.3--21.8 micron spectroscopy (S/N > 20) we will search for PAH 6.2, 7.7, 8.6, and 11.3 micron features, and 10 and 20 micron silicate emission features. We will also search for colder dust, more distant from the stars, in Kuiper Belt-like regions, through MIPS 24 micron photometry (S/N > 20).

Spitzer Space Telescope - Guaranteed Time Observer Proposal #134

SWIRE Galactic Follow-up

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Deborah Padgett, California Institute of Technology

Science Category: circumstellar/debris disks
Observing Modes: IrsStare
Hours Approved: 8.2

Abstract:
We intend to perform SIRTF IRS short-low observations of interesting galactic sources discovered by the SWIRE photometric surveys. We expect our targets to fall into one of two categories. The first class is circumstellar debris disks, characterized by an excess of 24 and/or 70 micron emission over photospheric levels in a stellar source. The second is cool brown dwarfs, characterized by a deficit of 3.6 microns to 4.8 microns flux in a faint stellar source.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #47

A MIPS Survey of the Orion L1641 and L1630 Molecular Clouds

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: circumstellar/debris disks
Observing Modes: MipsScan
Hours Approved: 11.8

Abstract:
We plan MIPS observations of the Orion L1630 and L1641 clouds. In conjunction with IRAC imaging, we will obtain the spectral energy distribution of the entire Orion young star population from 3.6-70 um. These data will be used to study the evolution of circumstellar disks and envelopes during the first few million years of pre-main sequence evolution and survey the clouds for embedded protostars.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #57

Connecting Images and SEDs in Bright Debris Disks

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Karl Stapelfeldt, Jet Propulsion Laboratory

Science Category: circumstellar/debris disks
Observing Modes: IracMap MipsPhot MipsSed
Hours Approved: 12.9

Abstract:
To identify systems with disks resolvable by MIPS, a list of infrared excess stars with well-determined distances was compiled from the Backman & Paresce lists and published ISO results. Using each object's distance and luminosity, the angular size of the 40 K emission region (the temperature of a blackbody whose peak emission falls in the MIPS 70 mm band) was calculated. The list was ranked from the largest to smallest potential angular sizes, and cut off at a disk radius of 10" (corresponding to two pixels in the MIPS 70 mm super-resolution mode). This list consists of 16 sources, mostly A stars due to their greater luminosity. This program will obtain imaging data on the stars not already included in other programs. For each source, the intention is to obtain imaging photometry in the 24 mm and 160 mm MIPS bands, plus 70 mm super-resolution images and SED mode. An observing strategy in common with the MIPS volume limited survey program will be used. These sources are also being observed spectroscopically in a separate but coordinated program by the IRS team.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #80

A Search for terrestrial Planetary Debris Systems and Other Planetary Debris Disks

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Karl Stapelfeldt, Jet Propulsion Laboratory

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 15.0

Abstract:
MIPS photometry will be obtained for a large sample of young, relatively nearby (generally within 100 pc) stars. The primary objectives of this program are: 1) identify systems possessing warm dust emission analogous to the zodiacal bands of the inner solar system, 2) find further examples of the pre-main-sequence planetary debris system (PDS) discovered for HD 98800B, and 3) identify Vega-type cooler dust excesses early in the evolution of their illuminating stars. This survey will constrain models of the origin and evolution of PDSs with the ultimate goal of determining how often, and in what circumstances terrestrial planets are formed. In addition, the survey will identify objects having mid-IR excesses that will be suitable targets for follow-up ground- and space-based observations at higher resolution. This program is a collaboration among four SIRTF GTOs (F. Low, M. Werner, M. Jura, and R. Gehrz). Each GTO will will submit his portion of the observational program separately.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #54

Binary Star Debris Disk Survey

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: John Stansberry, The University of Arizona

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 21.8

Abstract:
The purpose of this project is to quantify the frequency with which debris disks occur in binary star systems, and to obtain an initial characterization of those disks which are discovered. We will obtain 24 and 70 micron MIPS photometry of about 40 nearby binary star systems in order to address these goals. While there are mainsequence binary systems with IR excesses, little is know about whether those excesses are attributable to disks, or the nature of the disks which may be involved. The question of whether and how binary star systems form and retain disks is intimately linked with the question of the occurrence of planets in binary star systems because of the genetic link between disks and planets. Our target list samples binary separations in the range 1-500 AU, with a preponderance of targets in the dynamically interesting range 10-100 AU. The signal to noise of the measurements will be about 20 relative to the photospheric emission of the primary star to give good sensitivity to disks and to maintain a photometric sensitivity which is consistent with that of the Volume Limited Sample project.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #10

Dust Around Main Sequence A-Type Stars

Principal Investigator: Michael Jura
Institution: University of California - Los Angeles

Technical Contact: Michael Jura, University of California - Los Angeles

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 24.0

Abstract:
We propose to use MIPS to search for dust around a well defined sample of nearby A-type main sequence stars. Our selection criteria are: (1) the have distances measured by Hipparcos data of less than 80 pc (2) 0.0 > (B-V) > 0.2 mag and (3) M(V) > 1.0 + 5.5 (B-V). These stars mostly have ages less than 100 million years and may still display circumstellar dust emission.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #52

Circumstellar Environments of the Nearest Stars

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Nick Gautier, JPL

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 27.4

Abstract:
The Sun's nearest neighbors are predominantly cool, low-mass dwarf stars. These objects are likely to harbor circumstellar disks or substellar companions that have gone undetected in previous searches. Only a dozen of the nearest M dwarfs were bright enough to allow IRAS detections of their photospheres, and only a single one was measured well enough to suggest an infrared excess. The nearest stars offer SIRTF its best opportunity to address two important science goals: (1) Measure the frequency and nature of infrared excess among M dwarfs, the most common stellar type in the galaxy; and (2) Conduct an imaging search for substellar companions as small as ten Jupiter masses at SIRTF's maximum linear resolution, with minimal required image contrast. The results of this program will provide important supporting information for future planet searches in the solar neighborhood. This program explicitly includes all stars within 5 pc of the Sun which are not targeted in other MIPS GTO programs, a total of 45 targets. All are M dwarfs, with the exceptions of alpha Cen, Sirius, and Altair. Similar programs are planned for these targets by the IRAC and IRS teams, and will be coordinated with this effort.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #84

A Search for Terrestrial Planetary Debris Systems and Other Planetary Debris Disks

Principal Investigator: Michael Jura
Institution: University of California - Los Angeles

Technical Contact: Michael Jura, University of California - Los Angeles

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsStare MipsPhot MipsSed
Hours Approved: 28.8

Abstract:
MIPS photometry will be obtained for a large sample of young, relatively nearby (generally within 100 pc) stars. The primary objectives of this program are: 1) identify systems possessing warm dust emission analogous to the zodiacal bands of the inner solar system, 2) find further examples of the pre-main-sequence planetary debris system (PDS) discovered for HD 98800B, and 3) identify Vega-type cooler dust excesses early in the evolution of their illuminating stars. This survey will constrain models of the origin and evolution of PDSs with the ultimate goal of determining how often, and in what circumstances terrestrial planets are formed. In addition, the survey will identify objects having mid-IR excesses that will be suitable targets for follow-up ground- and space-based observations at higher resolution. This program is a collaboration among four SIRTF GTOs (F. Low, M. Werner, M. Jura, and R. Gehrz). Each GTO will will submit his portion of the observational program separately.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #40

Debris Disk Evolution in A stars

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Kate Su, The University of Arizona

Science Category: circumstellar/debris disks
Observing Modes: MipsPhot
Hours Approved: 36.6

Abstract:
We defined this program by hypothesizing that debris disks would have completed any significant evolution by the time they had aged to a few hundred million years, and that we therefore needed to study a sample of stars out to about 1 Gyr. A stars provide a high luminosity probe where surrounding material is easily visible over this age range. We also set the requirement that MIPS should be able to detect the stellar photosphere at 70um, equivalent to requiring that the star be brighter than about 7.4 magnitude, or for main sequence A stars, that the star be closer than about 170pc. A separate sample was selected for which MIPS should be able to detect the photosphere at 160mm, requiring the star to be brighter than about magnitude 3.5. Ages have been estimated from cluster membership, association with moving groups, or Stromgren photometry combined with Hipparchos distances. The stars have been screened for relatively low columns of atomic hydrogen. We have coordinated with a similar program by Michael Jura to provide more intense sampling at young ages. Our total sample is about 140 objects, with a similarly sized sample in his program.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #90

The Fabulous Four Debris Disks

Principal Investigator: Michael Werner
Institution: JPL

Technical Contact: Karl Stapelfeldt, Jet Propulsion Laboratory

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsMap IrsStare MipsPhot MipsSed
Hours Approved: 46.9

Abstract:
This program is a comprehensive study of the four bright debris disks that were spatially resolved by IRAS: Beta Pictoris, Epsilon Eridani, Fomalhaut, and Vega. All SIRTF instruments and observing modes will be used. The program has three major objectives: (1) Study of the disk spatial structure from MIPS and IRAC imaging; (2) Study of the dust grain composition using the IRS and MIPS SED mode; and (3) companion searches using IRAC. The data from this program should lead to a detailed understanding of these four systems, and will provide a foundation for understanding all of the debris disks to be studied with SIRTF. Images and spectra will be compared with models for disk structure and dust properties. Dynamical features indicative of substellar companions' effects on the disks will be searched for. This program will require supporting observations of PSF stars, some of which have been included explicitly. In the majority of cases, the spectral observations require a preferred orientation to align the slits along the disk position angles. Detector saturation issues are still being worked for this program, and will lead to AOR modifications in subsequent submissions. The results from this program will be analyzed collaboratively by the IRAC, IRS, and MIPS teams and by general GTOs Jura and Werner.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #72

A Search for Terrestrial Planetary Debris Systems and Other Planetary Debris Disks

Principal Investigator: Frank Low
Institution: University of Arizona

Technical Contact: Paul Smith, University of Arizona

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsStare MipsPhot MipsSed
Hours Approved: 48.6

Abstract:
MIPS photometry will be obtained for a large sample of young, relatively nearby (generally within 100 pc) stars. The primary objectives of this program are: 1) identify systems possessing warm dust emission analogous to the zodiacal bands of the inner solar system, 2) find further examples of the pre-main-sequence planetary debris system (PDS) discovered for HD 98800B, and 3) identify Vega-type cooler dust excesses early in the evolution of their illuminating stars. This survey will constrain models of the origin and evolution of PDSs with the ultimate goal of determining how often, and in what circumstances terrestrial planets are formed. In addition, the survey will identify objects having mid-IR excesses that will be suitable targets for follow-up ground- and space-based observations at higher resolution. This program is a collaboration among four SIRTF GTOs (F. Low, M. Werner, M. Jura, and R. Gehrz). Each GTO will will submit his portion of the observational program separately.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #37

Disk Evolution in the Planet Formation Epoch

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: Tom Megeath, Harvard, CfA

Science Category: circumstellar/debris disks
Observing Modes: IracMap MipsPhot MipsScan
Hours Approved: 49.7

Abstract:
The goal of this program is to trace the evolution of circumstellar disks around young stars through the likely epoch of planet formation at around 5-10 Myr. Disk spectral energy distributions will be used to determine the times of disk clearing as a function of radius, age, and stellar mass. IRAC and MIPS will be used to study circumstellar dust emission, with special emphasis on objects in the age range 3-10 Myr which are vastly underrepresented in current samples. Studies of nearby regions in Taurus and Chamaeleon I are included for comparison, along with objects in the nearby eta Cha and TW Hya associations.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #58

Evolution and Lifetimes of Protoplanetary Disks

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Erick Young, The University of Arizona

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsStare MipsScan
Hours Approved: 81.0

Abstract:
The goal of our study is twofold. First, we intend to determine the frequency and duration of the protoplanetary disk phase of evolution and thus directly constrain the probabilities and timescales for the formation of the major planetary bodies. Second, we intend to investigate the timescale for and nature of the transition to the debris disk phase of disk evolution. To achieve these goals we intend to survey a sample of young stellar clusters of varying age, richness and stellar content. We will determine disk frequency by measuring the amount of infrared excess toward every resolved star in each of our clusters. The primary wavelength of the survey will be 24 microns. Since the observations will be done in MIPS scan map mode, concurrent observations at 70 and 160 mm will be made. Additionally, for many of the clusters, we will coordinate observations with the IRAC team to obtain photometry at 3.5, 4.5, 6.3, and 8 mm. Our sample consists of clusters ranging in age from 1-100 million years.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #41

A Volume Limited Sample of Nearby Stars

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: Charles Beichman, JPL

Science Category: circumstellar/debris disks
Observing Modes: IrsStare MipsPhot MipsSed
Hours Approved: 85.6

Abstract:
The primary goal of the Volume Limited Sample (VLS) is to look for emission in the wavelength range from 15-160 um from solid material orbiting stars at distances of a few to a few hundred AU. Because SIRTF cannot, in most cases, resolve spatially these disks, we will make a photometric and spectro-photometric survey looking for excesses over the emission expected from the photosphere. Our ability to identify small excesses will be limited by signal-to-noise, calibration effects and photospheric models. We will make photometric measurements down to a fraction of the expected photospheric level at 24 um (~1% from photon statistics but realistically to a few percent given calibration uncertainties) and 70 um (4%, 1 sigma). To detect very cold dust and/or the largest dust grains and to provide a linkage to ground-based submillimeter measurements, we will make measurements at 160 um down to the extra-galactic confusion limit. Spectro-photometry offers a powerful method of identifying weak excesses. The VLS program uses both IRS Long-Lo (to 4% of the photosphere at 40 um) and MIPS SED (to 4% on the photosphere at 70 um on the brightest members of the sample). The spectroscopy of detected disks will constrain the spatial distribution and composition of the dust.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #2

Spectroscopy of protostellar, protoplanetary and debris disks

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Dan Watson, University of Rochester

Science Category: circumstellar/debris disks
Observing Modes: IrsMap IrsStare MipsSed
Hours Approved: 167.0

Abstract:
SIRTF, and the IRS in particular, is sensitive to the crucial region for protostellar disk accretion, jet collimation and planetary formation, between a few hundredths and a few tens of AU from the central objects. We will exploit this feature of SIRTF-IRS in an exploration the evolution of circumstellar disks, from star birth, through the epoch of the clearing of the terrestrial-planet region and the formation of planets, and toward the end of stellar main-sequence lives. For this purpose we have selected a sample of some 600 objects, in nearby regions of current star formation, in open clusters of well-determined, intermediate age (3-100 Myr), and in lists of main-sequence stars with infrared excesses. Along with the range of ages we have taken care to cover variation in disk orientation, stellar multiplicity, and cluster richness, and have opted to cover relatively uniformly the stellar mass function down to (slightly past) the hydrogen-burning limit. We will observe each object in this sample over the whole IRS spectral range (5-40 microns). The low-resolution spectrographs will be used except for the brightest ~25% of the sample; for these latter objects the IRS high-resolution modules will be used instead of the Long Lo spectrograph. Among the spectral features we will see will be short-wavelength continuum "dropouts" due to inner-disk clearing; signatures of crystalline solids, developing in strength as dust grains are processed in the disk; and molecular, atomic and ionic lines from accretion shocks, jets, and outflow shocks.

Spitzer Space Telescope - Legacy General Observer Proposal #148

The Formation and Evolution of Planetary Systems: Placing Our Solar System in Context

Principal Investigator: Michael R. Meyer
Institution: The University of Arizona

Technical Contact: Michael R. Meyer, The University of Arizona

Co-Investigators:
Dana Backman, Franklin and Marschall College
Steven V.W. Beckwith, Space Telescope Science Institute
John M. Carpenter, California Institute of Technology
Martin Cohen, University of California-Berkeley
Thomas Henning, Astronomisches Institute, Jena
Lynne A. Hillenbrand, California Institute of Technology
Dean Hines, The University of Arizona
David J. Hollenbach, NASA-Ames Research Center
Jonathan Lunine, The University of Arizona
Renu Malhotra, The University of Arizona
Joan Najita, National Optical Astronomy Observatories
Deborah L. Padgett, California Institute of Technology
David R. Soderblom, Space Telescope Science Institute
John R. Stauffer, California Institute of Technology
Stephen E. Strom, National Optical Astronomy Observatories
Daniel M. Watson, University of Rochester
Stuart J. Weidenschilling, Planetary Science Institute
Erick Young, The University of Arizona

Science Category: circumstellar/debris disks
Observing Modes: IracMap IrsStare MipsPhot
Hours Approved: 350.0

Abstract:
We propose to trace the evolution of planetary systems at all ages ranging from: (1) 3-10 Myr when stellar accretion from the disk terminates; to (2) 10-100 Myr when planets achieve their final masses via coalescence of solids and accretion of remnant molecular gas; to (3) 100-1000 Myr when the final architecture of solar systems takes form and frequent collisions between remnant planetesimals produce copious quantities of dust; and finally to (4) mature sys tems of age comparable to the Sun in which planet-driven activity of planetesimals continues to generate detectable dust. Our strategy is to use carefully calibrated spectral energy distributions and high-resolution spectra to infer the radial distribution of dust and the molecular hydrogen content of disks surrounding a sample of 700 solar-like stars distributed uniformly in log-age over 3 Myr to 10 Gyr. The high precision and fine sampling of SIRTF spectral energy distributions can reveal both the existence of planets and their approximate masses and radial distributions through modeling of the dynamical effects of planets in sculpting planetesimal distributions and orchestrating their collision frequency. The size of our target list is designed to provide robust sampling of what we expect based on the dramatic exo-solar planet discoveries of the past half decade to be a wide diversity of planetary system architectures. We plan to deepen our appreciation of the range of possible outcomes of the planet formation process -- thus placing our own solar system in context. Our proposed Legacy program promises to provide: (1) new insight into problems of fundamental scientific and philosophical interest; (2) calibration with precision 2-3 times that of standard SIRTF data products, to the benefit of all SIRTF observers; (3) new numerical tools for simulating the dynamical history of forming solar systems; and (4) a rich database to stimulate follow-up observations with SIRTF, with existing and future ground-based facilities, and later with SI

Spitzer Space Telescope - Directors Discretionary Time Proposal #98

First Look Survey - Ecliptic Plane Component

Principal Investigator: Tom Soifer
Institution: Spitzer Science Center

Technical Contact: Victoria Meadows, Caltech

Science Category: asteroids
Observing Modes: IracMap MipsScan
Hours Approved: 14.3

Abstract:
This survey of two fields of 0.13 square degrees at ecliptic latitudes of 0 and 5 degrees characterizes the population of moving objects at 8 and 24um, and explores the smaller members of the asteroid population at diameters less than 1 km. These observations were designed to target asteroids in the main belt region between 2 and 4 AU, to determine number counts and ecliptic plane scale heights. This survey will also provide preliminary information on the zodiacal light as a function of distance from the ecliptic plane.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #91

Extinct Comets and Low-Albedo Asteroids-2

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: asteriods
Observing Modes: IrsMap IrsStare
Hours Approved: 6.1

Abstract:
Spectroscopic survey of asteroids that have dynamical characteristics indicating that they are extinct comets. the survey also includes main belt and Trojan asteroids of low albedo and classified as C, P, and D (and various subtypes).

Spitzer Space Telescope - Guaranteed Time Observer Proposal #88

Extinct Comets and Low-Albedo Asteroids

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: asteroids
Observing Modes: IrsMap IrsStare
Hours Approved: 15.4

Abstract:
Several objects classified as asteroids have orbits that are dynamically similar to those of comets. They are thought to be comets that have devolatilized by repeated passages through the inner solar system. Some of these objects are "near-Earth asteroids". This is a spectroscopic study of a sample of these objects. For spectroscopic comparison of the extinct comets, and for a parallel study of the compositions of low-albedo main belt and Trojan asteroids, a number of C, P, and D-type asteroids are included.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #119

SIRTF Obeserbations of Comet P/Encke

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: comets
Observing Modes: IracMap IrsMap MipsPhot
Hours Approved: 1.0

Abstract:
We will obtain far infrared images of coet P/Enck to determine the extent and composition of its coma.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #131

IRAc and MIPS Images of Comet P/Halley and MIPS Images of Comet P/Pons-Winnecke

Principal Investigator: Robert Gehrz
Institution: University of Minnesota

Technical Contact: Elisha Polomski, University of Minnesota

Science Category: comets
Observing Modes: IracMap IrsMap IrsStare MipsPhot
Hours Approved: 9.4

Abstract:
We will attempt to detect the emission from the bare nucleus of Comet P/Halley and emission from the cmoa of Comet P/Pons-Winnecke.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #210

Cometary Dust Trails

Principal Investigator: Giovanni Fazio
Institution: Harvard-Smithsonian Astrophysical Observatory

Technical Contact: William Reach, Caltech

Science Category: comets
Observing Modes: IracMap IrsMap MipsPhot
Hours Approved: 9.1

Abstract:
These observations search for large meteroids associated with short-period comets. We selected comets that have perihelion distance less than 3 AU and perihelion date 2002-2004. Images with MIPS or IRAC are made for a region at least 15 arcmin long along the comets' orbits. Spectra are taken, centered on the nucleus, to search for silicate features and measure dust temperature, which allows constrants to be placed on the size and composition of the recently-produced cometary particles as well as the albedo and diameter of the comet nucleus. For comet Encke, we make a spectrum or a region offset from the nucleus along the well-known debris trail. For the comet/asteroid transition object Phaethon, thought to be the parent of the Geminid meteor stream, we image a region along its orbit to see whether it is currently producing large meteoroids.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #67

IRS and MIPS SED observations of Centaurs and Kuiper Belt Objects

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: Kuiper belt objects
Observing Modes: IrsStare
Hours Approved: 11.6

Abstract:
We examine the spectra of Centaurs and Kuiper Belt Objects using the IRS and MIPS SED, using a target list which is a subset of the MIPS photometry list developed by Stansberry. The observations generally use the Long Lo module of the IRS, but other modules are used for the brightest Centaurs. When used in conjunction with the MIPS photometry observations, hIgh S/N observations of the brightest sources will provide compositional information, while low S/N observations of fainter sources will be used to constrain the albedo, size, and thermal properties of these objects.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #55

Far-IR Observations of Kuiper Belt and Centaur Objects

Principal Investigator: George Rieke
Institution: The University of Arizona

Technical Contact: John Stansberry, The University of Arizona

Science Category: Kuiper belt objects
Observing Modes: MipsPhot MipsScan MipsSed
Hours Approved: 45.9

Abstract:
We will obtain MIPS photometry for 44 KBOs and 12 Centaurs. For the KBOs we will focus on 70 microns, doing 24 micron and/or 160 micron observations for 10 to 20 objects, with S/N of 5 or better. These data will provide the first determinations of the albedos and diameters of KBOs, and the multi-wavelength data will constrain surface temperature distributions on some objects. For Centaurs we will focus on 24 microns, adding 70 micron measurements for all but 2, and 160 micron measurements for 3, and obtaining a minimum S/N of 5. While groundbased sizes/albedos already exist for 3 Centaurs, ours will be the first detections of these objects at longer wavelengths, and will provided constraints on the size, albedo, and temperature distribution for most known Centaur objects. In several cases 24 micron integration times were adjusted upward significantly from that required to obtain 5-sigma on the nuclear thermal flux in order to search for extended thermal emission. Such emission might result from the presence of comet-like dust trails in the neighborhood of the nucleus, although there is some possibility of detecting a dust coma directly."Shadow" observations are included for all targets in all bands. The shadow observations consist of a second observation of the target with the same integration time as the primary observation. The purpose of the shadow observation is two-fold. First is to obtain an additional measurement of the target flux, improving signal to noise and confirming any extended structure which may be detected. Second is to provide a resolved image of the background emission at the position the object occupied at the time of the primary observation (the primary observation then automatically provides an equivalent image for the shadow observation). The impact of confusing sources on photometry and searches for extended emission will be greatly reduced by subtraction of the background images.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #70

Observations of the Pluto/Charon system

Principal Investigator: Dale Cruikshank
Institution: NASA-Ames

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: planets
Observing Modes: IracMap IrsStare MipsPhot MipsSed
Hours Approved: 11.7

Abstract:
We examine the combined Pluto/Charon system using all SIRTF instruments. The IRS observations generally use the Long Lo module. When used in conjunction with IRAC and MIPS photometry observations, these observations will provide us with composition, albedo, and thermal properties information. Pluto is observed at 8 equally spaced observer sub-longitudes, and follow-up observations 1 and 2 yr after the initial lightcurve measurements are planned.

Spitzer Space Telescope - Guaranteed Time Observer Proposal #71

Observations of Outer Solar System Satellites and Planets

Principal Investigator: James R. Houck
Institution: Cornell University

Technical Contact: Jeffrey Van Cleve, Ball Aerospace

Science Category: satellites
Observing Modes: IracMap IrsMap IrsStare MipsPhot MipsSed
Hours Approved: 21.9

Abstract:
We examine the principal satellites of outer Solar System planets, as well as Uranus, Neptune, and Pluto, using all SIRTF instruments. IRAC photometry will establish the hitherto unknown albedo of these cold objects at wavelengths between 3.5 and 8 microns, IRS will do reflectance spectrosopy at wavelengths between 5.3 and 15 um, and thermal emission spectroscopy between 10 and 40 um. Combined with MIPS photometry and SED measurements, these data willl provide compositional information, albedo, and thermal properties of these objects. All synchronous satellites are observed at leading and trailing hemispheres, while in addition the sub-Neptune hemisphere of Triton, and a series of follow-on measurements of this particularly interesting moon, are performed. The observations of Uranus and Neptune will be used to monitor atmospheric trends seen by HST and ISO, for trace composition data, and for precise straylight subtraction for observations of their innermost principal satellites. Observations of Titan will be examined for different spectral signatures of the hemisphere containing the "continent" seen in near-IR Hubble images compared to the trailing hemisphere, and interpreted in terms of surface composition and temperature.