First Results from the Very Nearby Galaxies Survey

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On behalf of the SPIRE consortium
(the SPIRE Nearby Galaxies Astronomy Group)
SPIRE Nearby Galaxies Astronomy Group

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Outline of talk

• Overview of goals and structure of the survey
• Spectroscopy
  • CO ladder and spatially extended line emission in M82
  • Thermal water in emission and absorption in Arp 220
• Photometry
  • M81 radial gradients in SPIRE colours
  • Tidal debris or Galactic cirrus?
Physical processes in the interstellar medium of nearby galaxies: Science Goals

• Physical properties of dust grains
  • Size, composition, temperature, fraction of mass in different components
  • Variation with type of galaxy
• Very cold dust: where is it found?
• Heating and cooling in ISM
  • Dependence of gas heating on $G_0/n$, heating source for cold dust
• Gas and dust in unusual environments
  • Above the plane, near AGN, mergers/starbursts
GALEX images of the VNGS target objects

M51  M81  N891  N2403
M83  M82  N4038/9  CenA
N1068  N4151  N205  N4125  Arp220

Very Nearby Galaxies Survey  Chris Wilson
Physical processes in the interstellar medium of nearby galaxies: observing modes

• SPIRE photometric mapping to 1.5 $D_{25}$
• PACS photometric mapping to 1.5 $D_{25}$
• SPIRE spectroscopy (FTS) in nucleus and surrounding regions (one pointing)
  • CO ladder, $^{13}$CO, [CI], [NII], H2O, etc.
• PACS spectroscopy in region observed with FTS and along a radial strip
  • [CII] at 158 microns
  • [OI] at 63 and 145 microns
  • [OIII] at 88 microns
  • [NII] at 122 and 205 microns
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M82 Spectroscopy with SPIRE FTS

Messier 82 © ESA and the SPIRE consortium
A Complete Spectrum from 200 to 600 microns

Intensity

Frequency (GHz)
Radiative Transfer Modeling of M82

- Lines used: $^{12}$CO ladder from J=4 to J=12
- Fixed beam sizes used for SLW (25") and SSW (19.6")
- Central pixel only
- Single component model
- Preferred $P/k = nT \sim 2.5 \times 10^5$ K cm$^{-3}$
- $P/k$ is order of magnitude larger under assumption of larger filling factor from emitting regions
- Presence of warm gas indicated in M82
Imaging M82 with the SPIRE FTS

Background image:
SPIRE
250 microns

PACS ~FOV (spectrometer)

~50”
Extended $\text{[NII]}$ in M82

Approx. Beam FWHM 50"

Very Nearby Galaxies Survey

Chris Wilson
Arp 220: Thermal Water Emission

NASA, ESA, Hubble Heritage team

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Arp 220: a rich molecular spectrum
Results for water in Arp 220

- Detect 7 of 8 water lines between 600 and 1210 GHz
  - only line not detected is the weakest (SPLATALOGUE)
- Mean redshift of H$_2$O lines 0.01790 or 5370 km/s
  - Blueshift suggests emission coming from the western nucleus, which is also brighter in continuum

SMA image
Sakamoto et al. 2008
Results for water in Arp 220

- Ground-state line is in absorption and appears broadened
- Remaining lines are in emission
  - Interesting contrast to ISO data, where H$_2$O in this galaxy always seen in absorption
- Combination with ISO and PACS data will pinpoint temperature

Gonzalez-Alfonso et al. 2004
M81 from 250 to 500 microns with SPIRE
M81 near the dust emission peak

MIPS 160 microns
(Gordon et al. 2004)

PACS 160 microns
M81 far-infrared colour maps

(PACS 160) / (SPIRE 250)  (SPIRE 250) / (SPIRE 350)
Radial temperature gradient in M81
Good correlation with dust and star formation
250 microns
GALEX NUV with
250 micron contours
M81: the big picture
M81: the big picture

SPIRE
250 microns
Galactic Cirrus or Tidal Debris near M81?

SPIRE contours on GALEX FUV

SPIRE contours on HI

SPIRE 250:500 micron colours
Summary

- Strong and spatially extended molecular and atomic emission lines seen in M82
- Arp 220: First detection of thermal water in emission in an external galaxy
- M81: radial far-infrared colour gradients and possible tidal debris

We anticipate additional exciting new results from these and future Herschel observations of very nearby galaxies!