Spitzer Survey of the Large Magellanic Cloud: Surveying the Agents of a Galaxy’s Evolution (SAGE)

Margaret Meixner (STScI)
Collaborators: SAGE Team

http://sage.stsci.edu/
SAGE: Tracing the Lifecycle of Baryonic Matter:
Intermediate mass stars
High mass stars

credit: http://hea-www.cfa.harvard.edu/CHAMP/EDUCATION/PUBLIC/ICONS/
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Poster: Meixner & SAGE team

Gordon & SAGE team (Meixner et al. 2006)

IRAC 3.6 µm
IRAC 8.0 µm
MIPS 24 µm
SAGE-LMC sensitivity limits and discovery space

SAGE Deep Catalog, Source Counts:
- ~6.3 million point sources
- >650,000 red giant stars
- >45,000 dusty evolved stars
- >1200 Young Stellar Objects

Diffuse ISM limit
- > $1.2 \times 10^{21}$ H/cm$^2$  
  ($A_V = 0.2$ mag)

Indebetouw & SAGE Team
Meixner et al. (2006)
SAGE Point
Source Populations:

AGB stars: Blum et al. (2006)
YSO candidates: Whitney et al. (2008)
PNe: Hora et al. (2008)
Empty field = background galaxies:
  Whitney, Sewilo et al.

Sewilo &
SAGE Team (2006)
SAGE-LMC the Mass budget:

– How much mass is currently in the ISM?
– What is the galaxy-wide star formation rate of the LMC?
– What is the mass budget of material injected into the ISM by evolved stellar winds?
160 um and the HI contours

Dust Optical Depth at 160 um, HI gas

SAGE/MIPS
160 um
Dust Temp. Map

\[ \tau_{160} = \frac{I_{\nu}^{160}}{B_{\nu}^{160}(T_d)} \]

Bernard, Reach, Paradis et al.

May 27, 2009
Fazio Conference Meixner
LMC FIR excess map & ISM mass

Color: $N_H^x$

Units: $10^{22}$ H/cm$^2$

Contours $H_I$

Total mass of excess component = HI mass
$= 5.6 \times 10^8$ Msun

Total mass of ISM (MIPS 160 um):
$\sim 10^9$ Msun

Bernard, Reach, Paradis et al.
point sources ~ candidate YSOs/protoclusters

> 1000 new candidate YSOs

R: CO Fukui et al
G: HI Kim et al 1998
B: 4.8GHz Dickel et al 2005

YSO population properties

Star Formation Rate: $>0.1 \, M_{\text{sol}} / \text{yr}$

• Identification of Infrared Stellar Populations

• Asymptotic Giant Branch (AGB) stars: O-rich become C-stars during dredge up

• Lower Z, easier to get C/O > 1

• Extreme AGB stars identified in 3.6, 8.0 IRAC bands

Blum et al. (2006)
Mass Loss Rate vs. 8 um excess

Srinivasan et al. 2009
AJ, 137, 4810
AGB star dust mass loss return:

![Graph showing cumulative dust mass loss rate versus luminosity.](image)

Contributions:
- \(10^{-5} \text{ M}_\odot \text{ yr}^{-1}\)
- 0.14 (O-rich)
- 0.24 (C-rich)
- 2.36 (Extreme)
- 2.74 (All)

Srinivasan et al. 2009
AJ, 137, 4810
Identification of Massive stars in SAGE


May 27, 2009  Fazio Conference Meixner
## SAGE-LMC inventory in context

<table>
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<tr>
<th>Item</th>
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<tbody>
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<td>Stellar Mass</td>
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Variable Stars ~2000

Vijh et al. 2009
AJ, 137, 3139
Comparing SAGE & MACHO data: Period-luminosity relations for AGB stars

May 27, 2009
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Riebel et al. in prep
The Mega-SAGE Team:

http://sage.stsci.edu/

For more Info and delivered source lists and images
HERschel Inventory of The Agents of Galaxy Evolution (HERITAGE) in the Magellanic Clouds:

SPIRE coverage on Spitzer Legacy SAGE-LMC image. Both the LMC and SMC will be mapped with PACS and SPIRE on Herschel.

HERITAGE will be sensitive to the long wavelength dust emission from the ISM and detect circumstellar dust from massive stars.

PI: Meixner, HERITAGE team

May 27, 2009

Fazio Conference Meixner
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