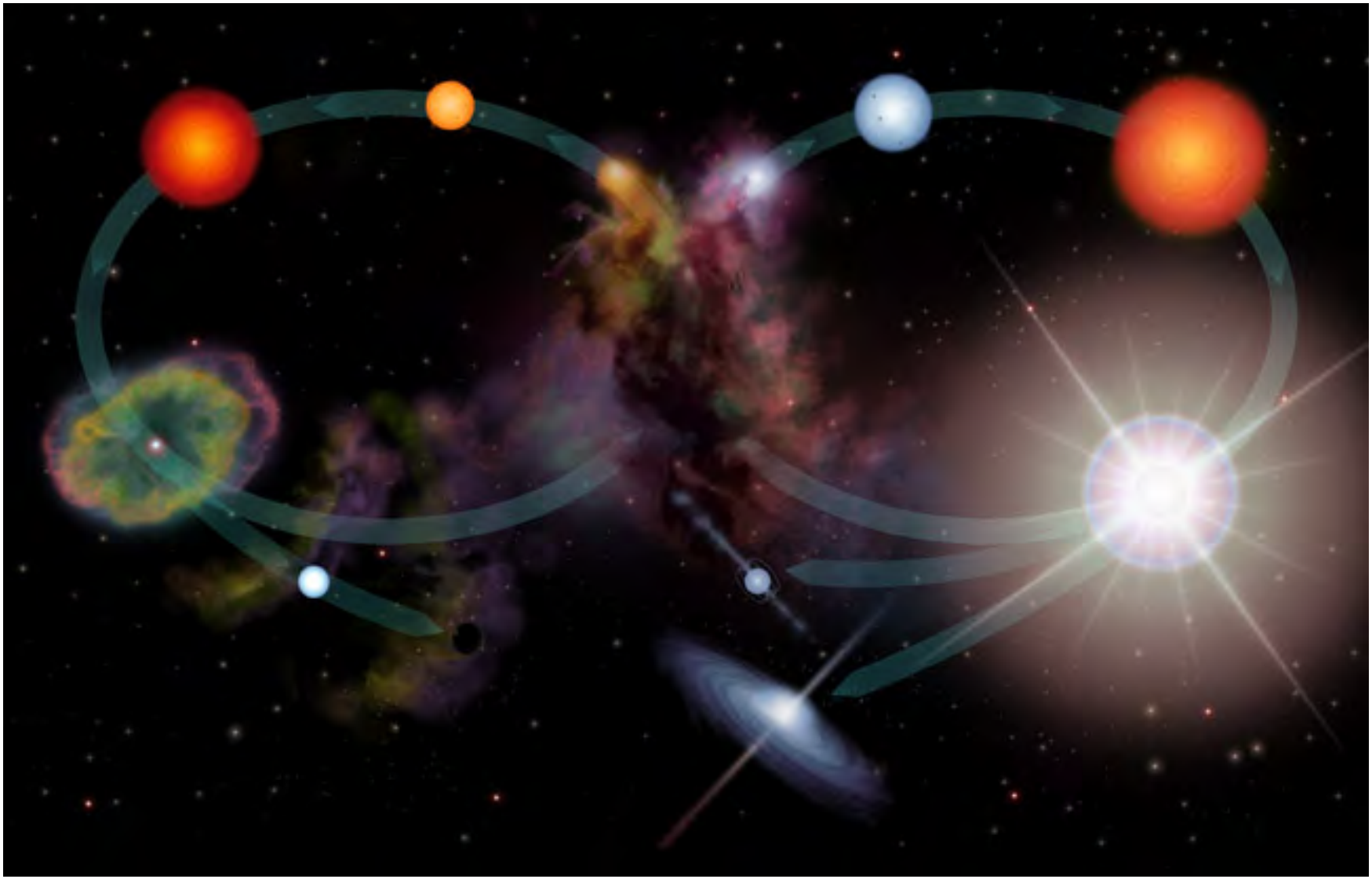
The *HERschel* Inventory of The Agents of Galaxy Evolution (HERITAGE) in the Magellanic Clouds

Margaret Meixner
(STScI, JHU)
Collaborators: HERITAGE Teams

http://sage.stsci.edu/

Tracing the Lifecycle of Baryonic Matter:

Intermediate mass stars High mass stars

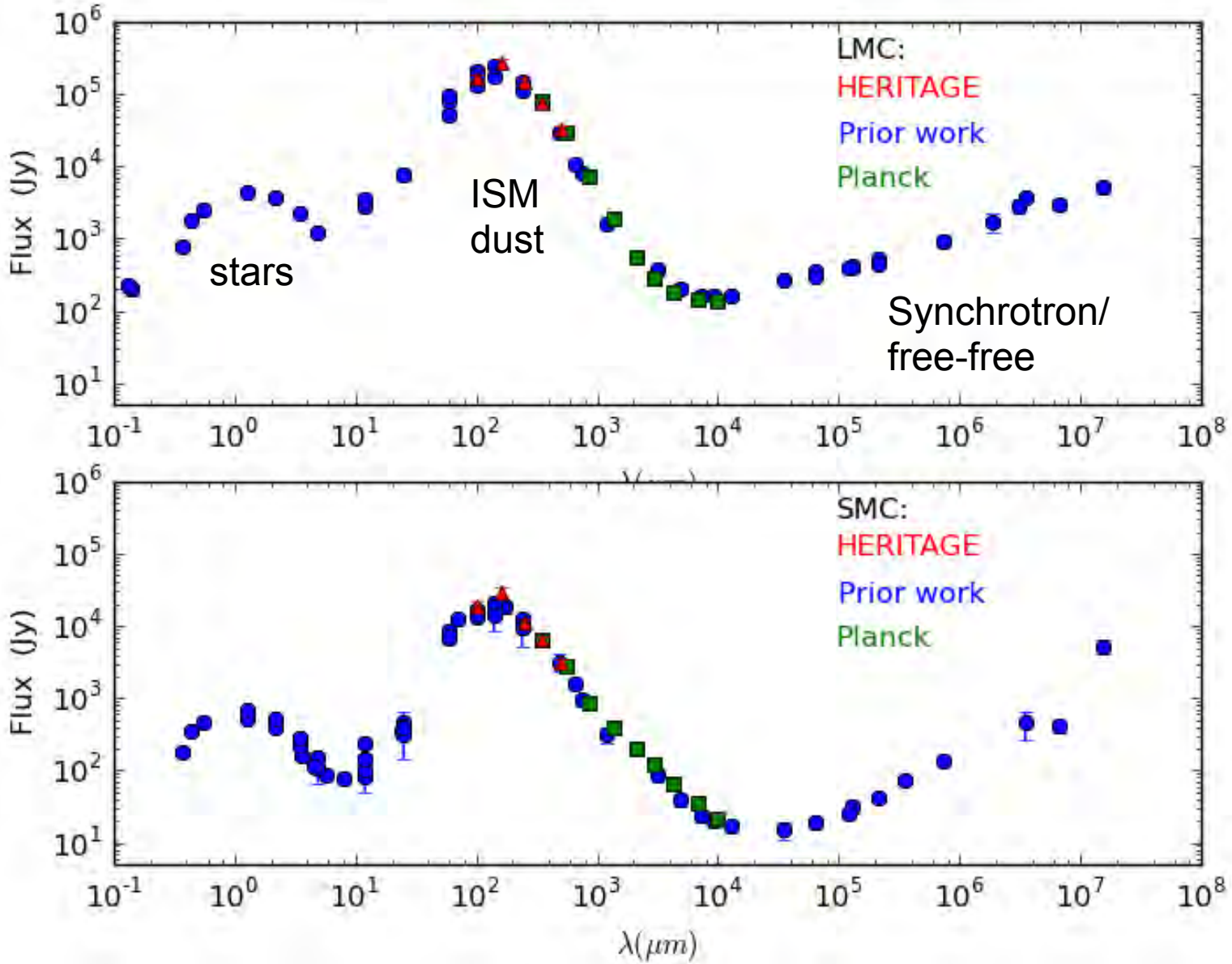


credit: http://hea-www.cfa.harvard.edu/CHAMP/EDUCATION/PUBLIC/ICONS/

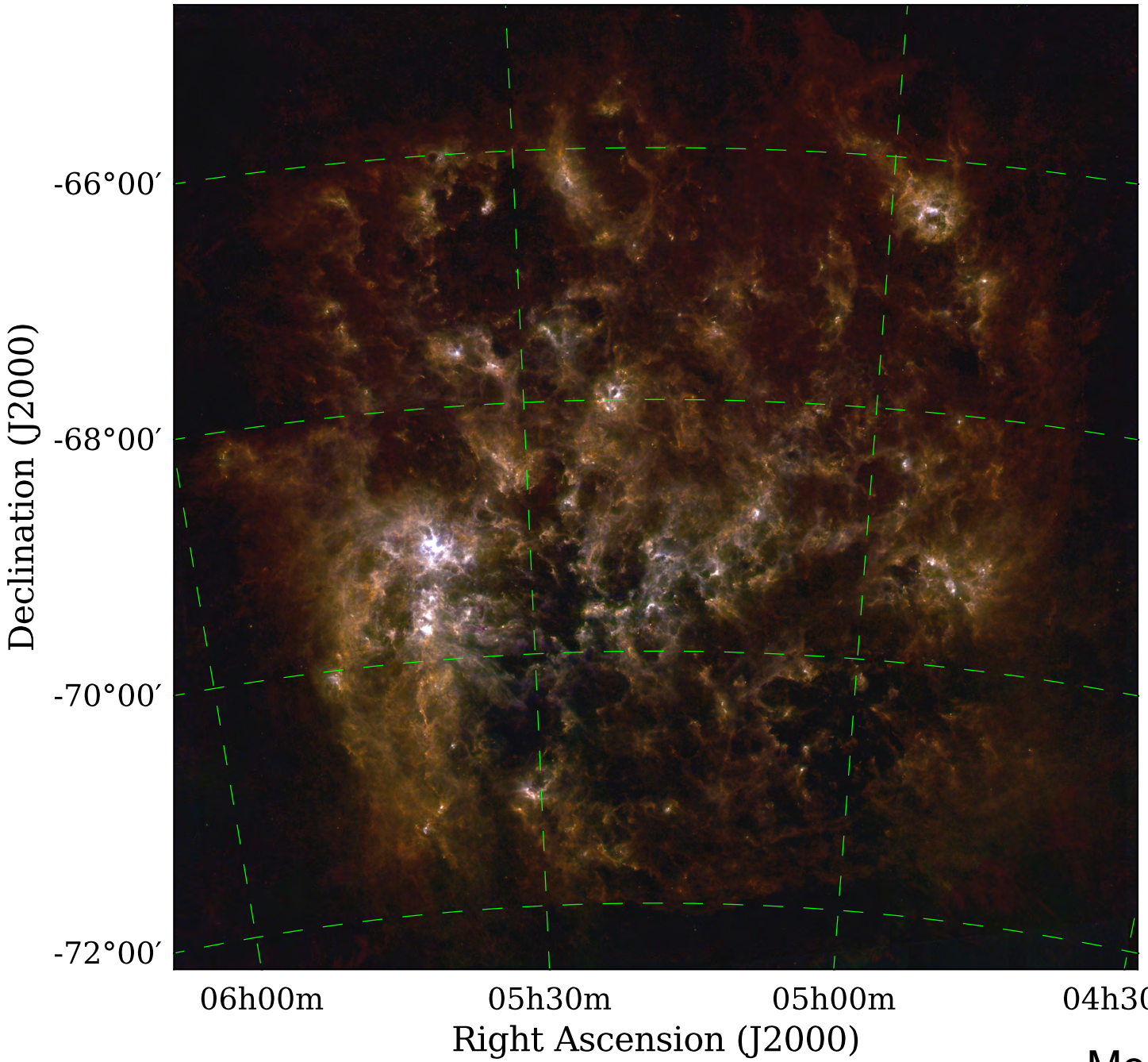
Why the Magellanic Clouds?

- Proximity:
  - ~50 kpc (Large Magellanic Cloud - LMC; Ngeow & Kanbur 2008)
  - ~60 kpc (Small Magellanic Cloud - SMC; Szewczyk et al. 2009)
- Mean metallicity: (Russel & Dopita 1992; Asplund et al. 2004)
  - LMC: $Z \sim 0.5 \times Z_{\odot}$
  - SMC: $Z \sim 0.2 \times Z_{\odot}$
  - ISM during Universe's peak star formation epoch (z~1.5 Pei et al 1999)
- Known tidal interactions between LMC and SMC, possibly the Milky Way.
- Long History of Studies of the MCs provide a rich context:
  - Ideal Case study for a galaxy evolution (Bekki & Chiba 2005)

Global SEDs



Meixner et al. 2013



LMC:
Herschel
HERITAGE

SPIRE 250 μm

PACS 160 μm

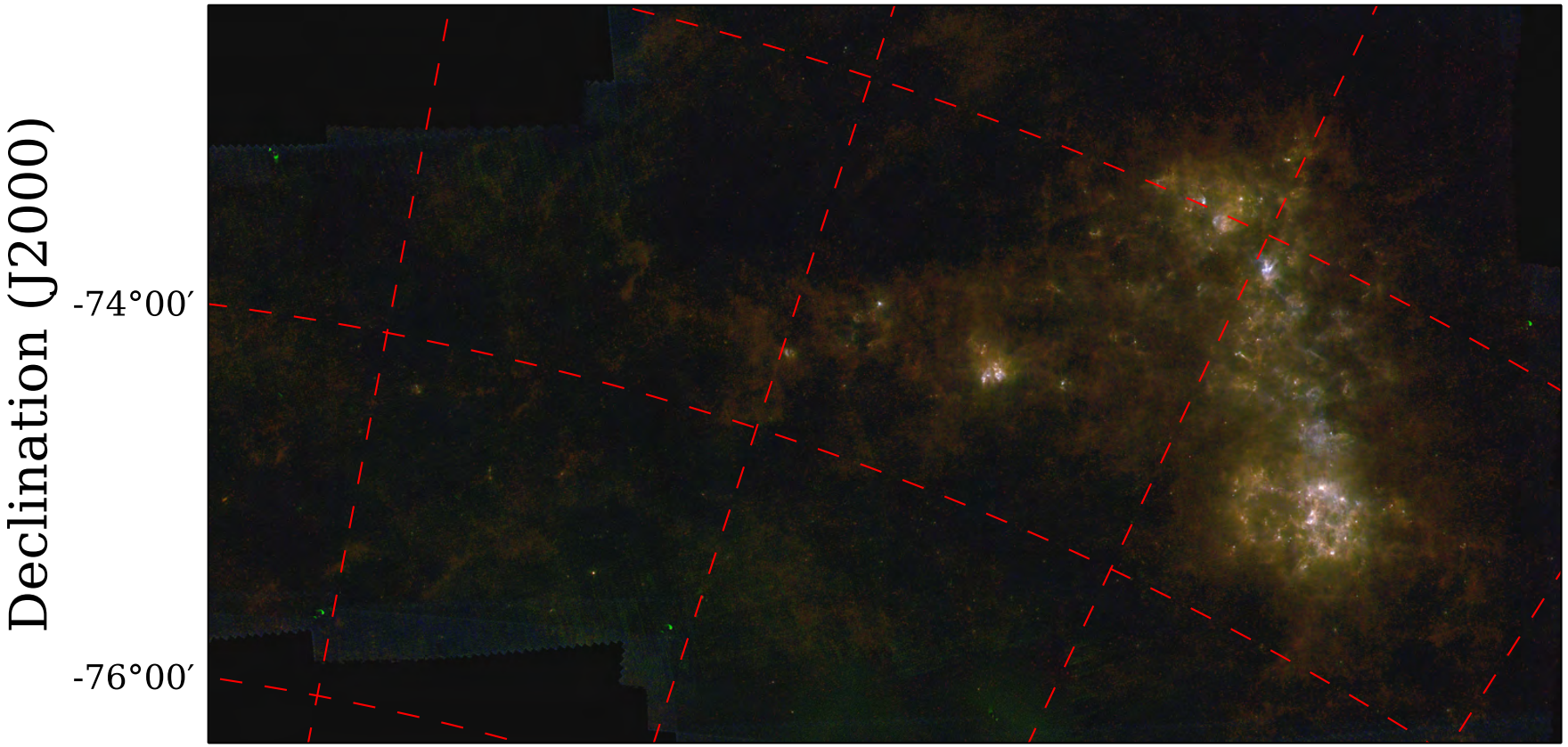
PACS 100 μm

Panuzzo,
Engelbracht,
Montiel
Roman-Duval
& HERITAGE

Meixner et al. 2013

SMC: Herschel HERITAGE

SPIRE 250 μm PACS 160 μm PACS 100 μm

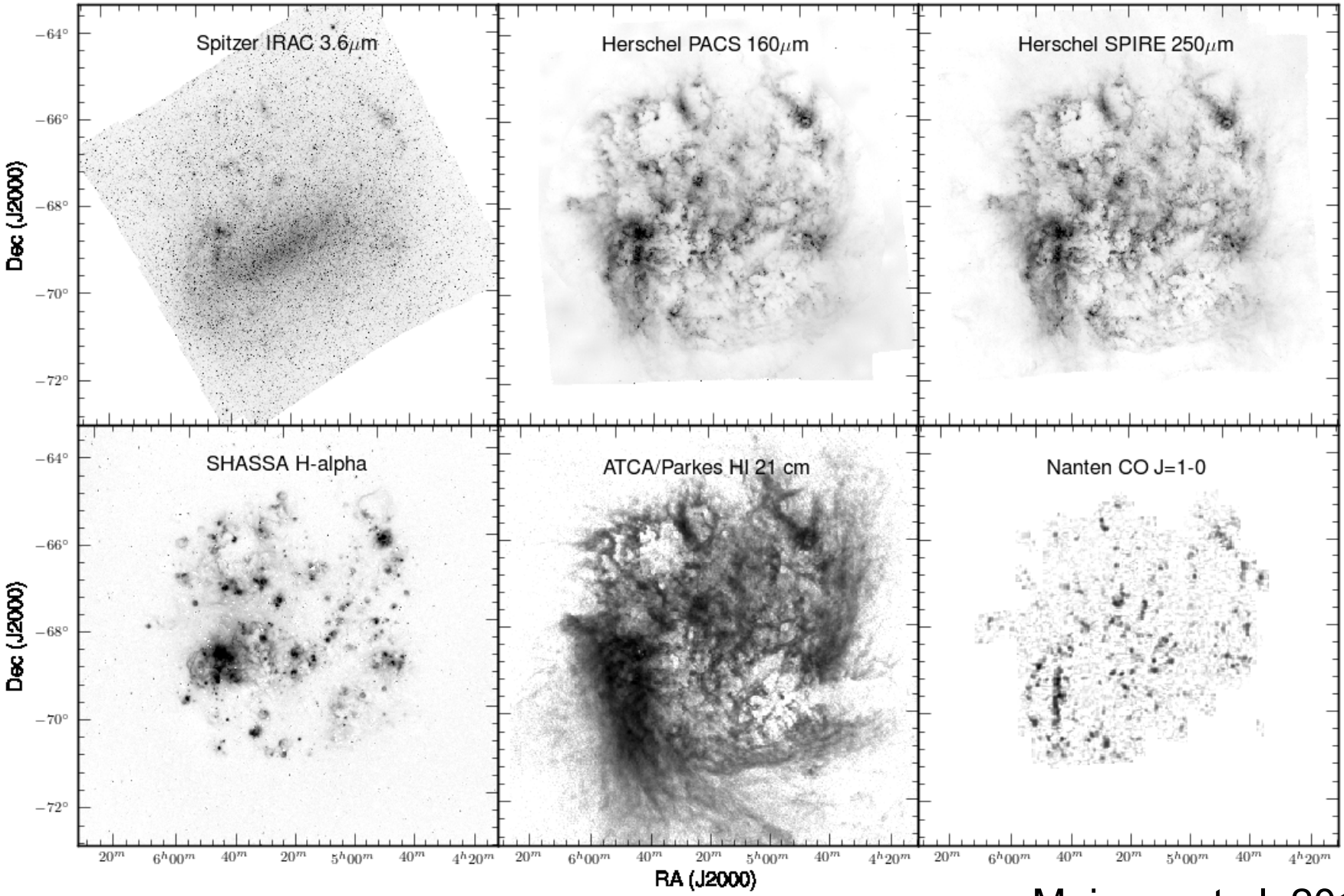


HERITAGE Team:
Meixner et al 2013

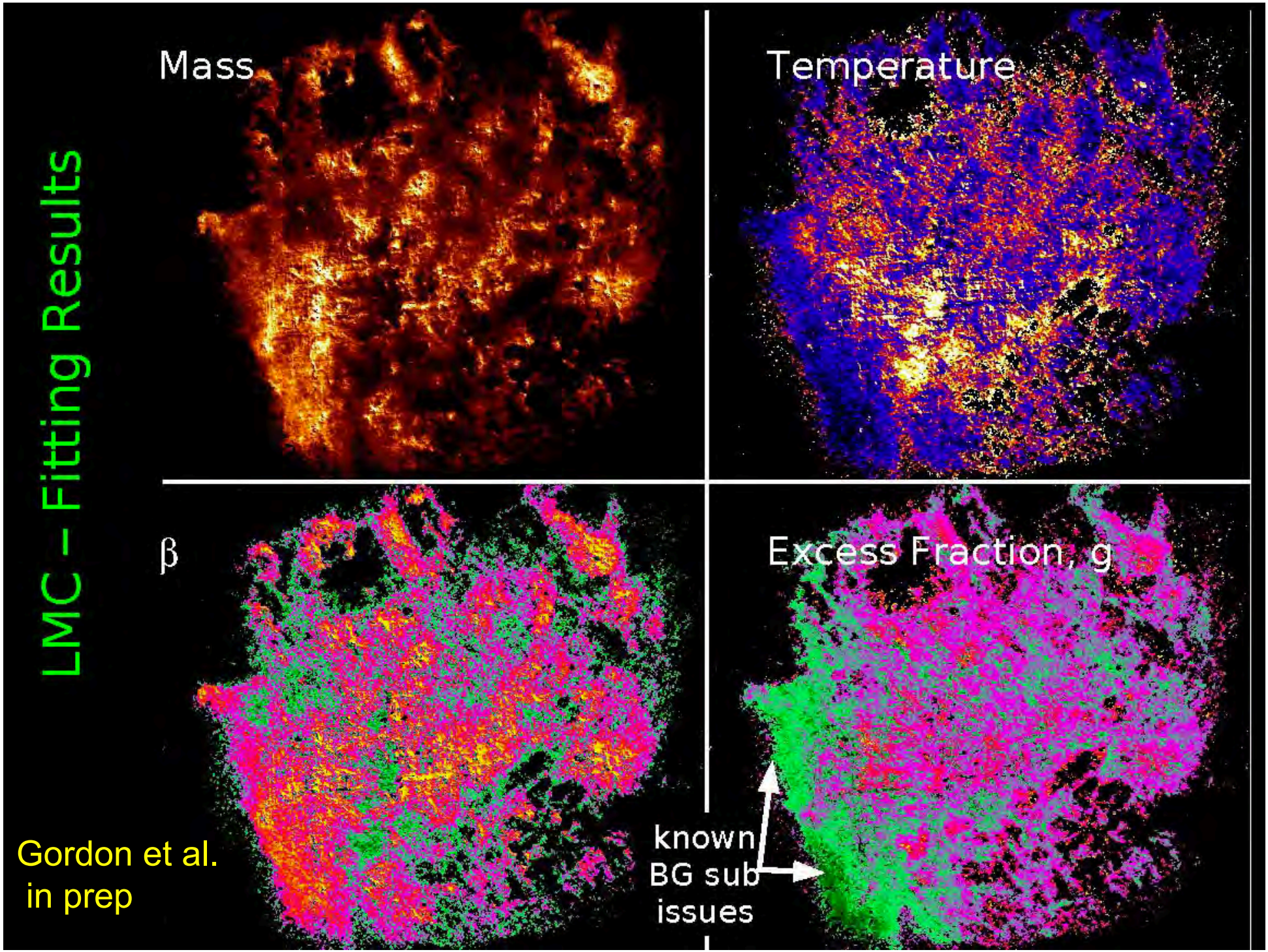
Life Cycle key questions:

- ISM: What are the properties, abundance and composition of dust in different parts of the ISM in the Magellanic Clouds (MCs: LMC & SMC)?
- Star Formation: What is the galaxy-wide star formation rate of the LMC and SMC and how do the details vary on a scale of a few pc?
- Evolved Stars: What is the mass budget of material injected into the ISM by evolved stars?

LMC survey comparison

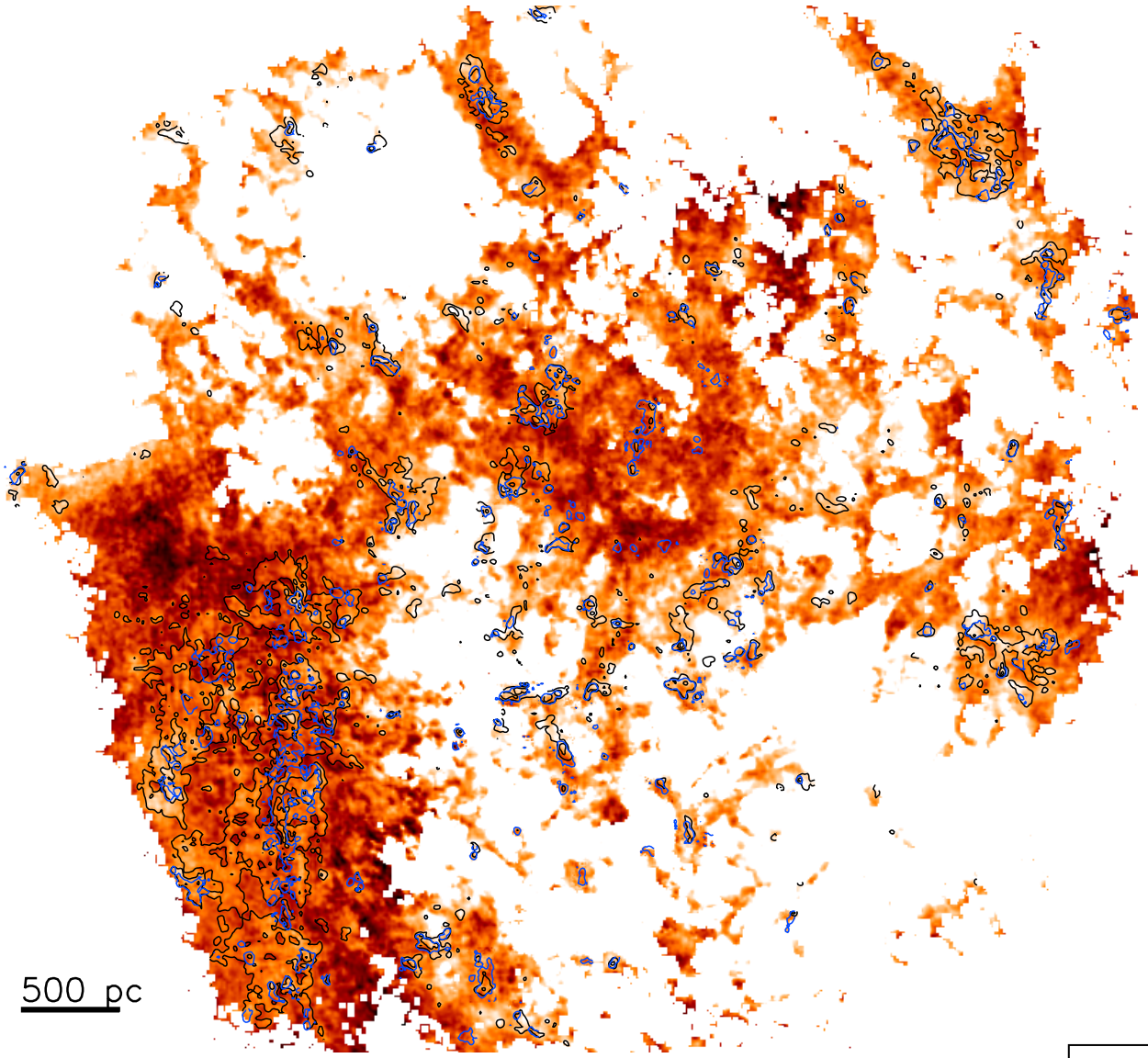


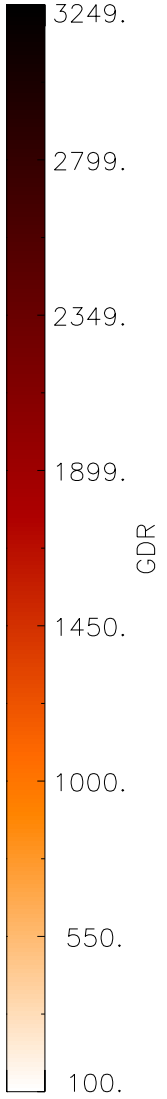
Meixner et al. 2013


LMC – Fitting Results
Mass
Temperature
β
Excess Fraction, g
known
BG sub
issues
Gordon et al.
in prep

Naïve gas-to-dust ratio maps: LMC

Roman-Duval et al. in prep



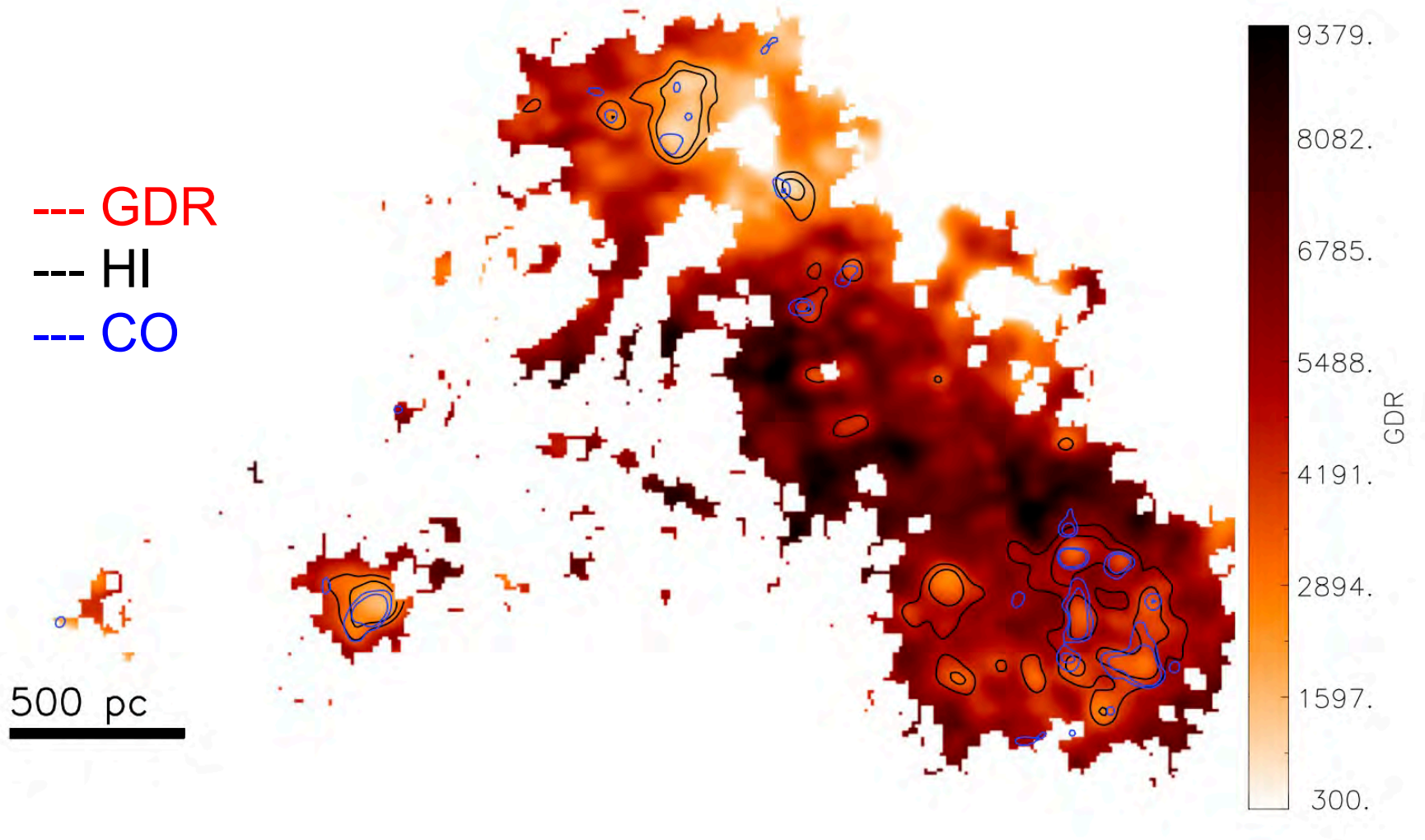


--- GDR
--- HI
--- CO

Median GDR = 520

Naïve gas-to-dust ratio maps: SMC

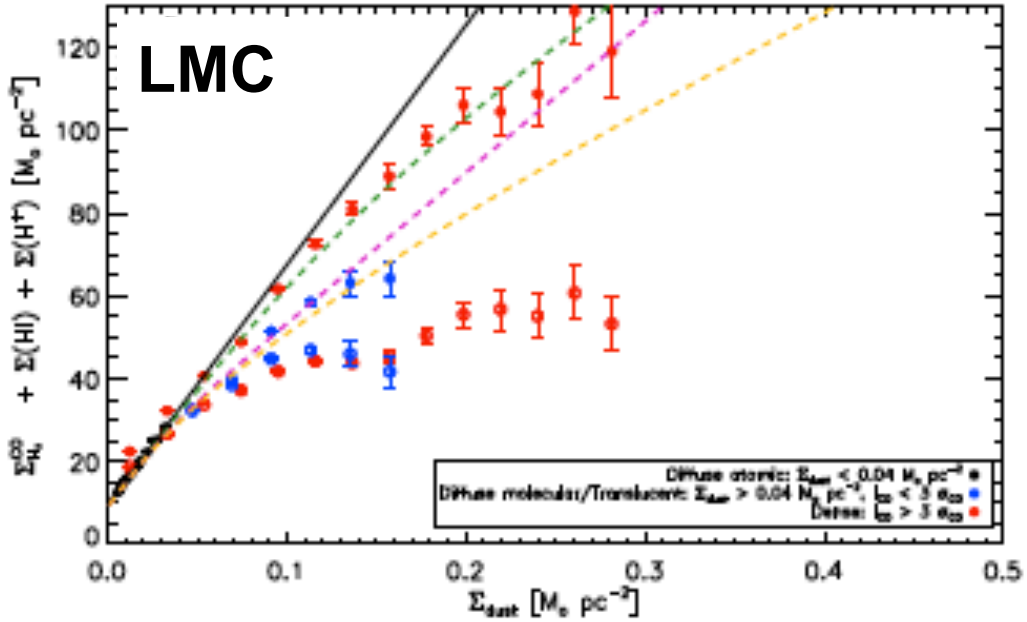
Roman-Duval et al. in prep



Median GDR = 3700

Explanation for GDR variations

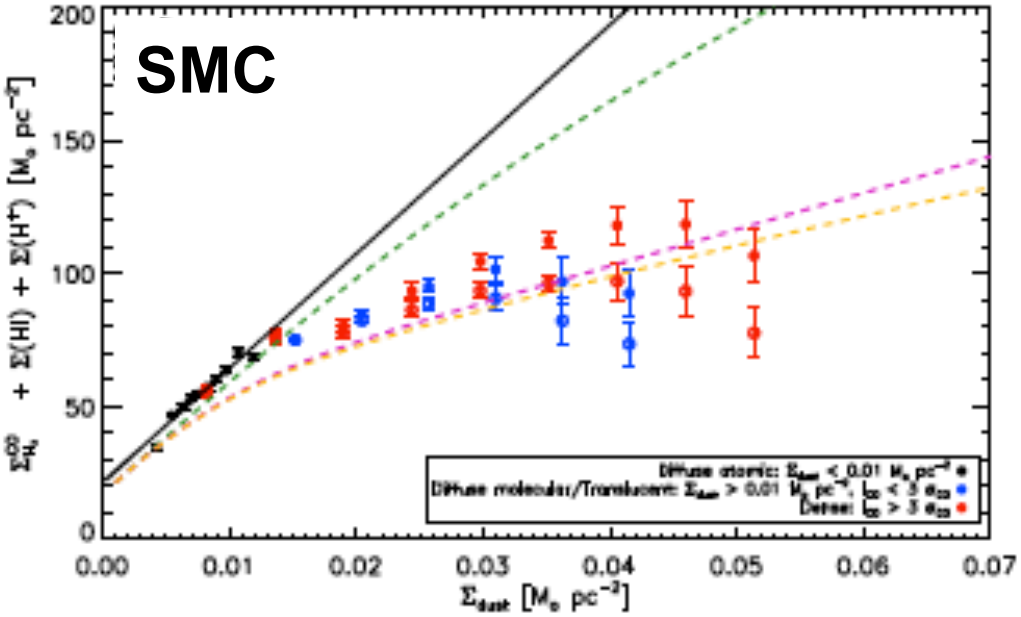
Roman-Duval et al. in prep



- **No CO detected, corrected for CO-dark H_2 and FIR emissivity changes**
- **CO detected, corrected for CO-dark H_2 and FIR emissivity changes**

---Silicate ($MgSiO_3$) growth
---Carbon dust growth
---Combined

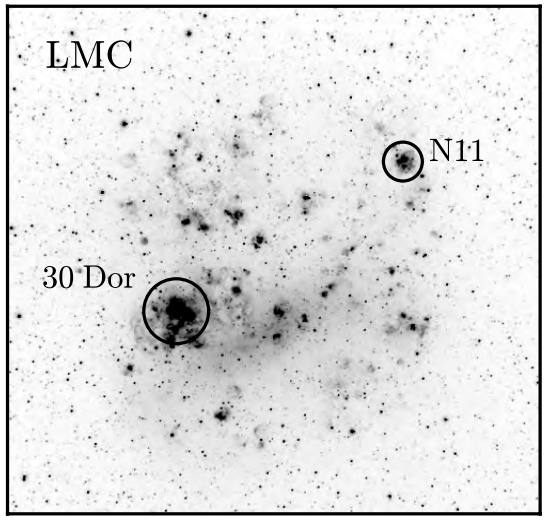
- The combination of CO-dark H_2, FIR emissivity variations, and dust growth in the dense ISM can explain the observed variations of the GDR
- FIR emissivity variations contribute a factor ~2-2.3 in LMC
- Dust growth contributes factor 2 in LMC, 5 in the SMC



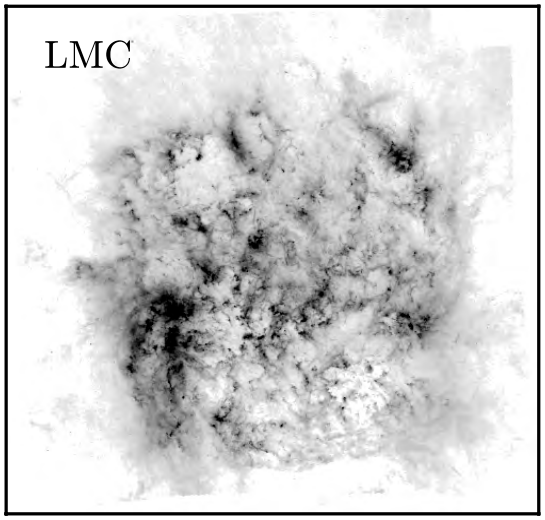
HERITAGE source extractions: spatial distribution

LMC~35000 SMC~7500

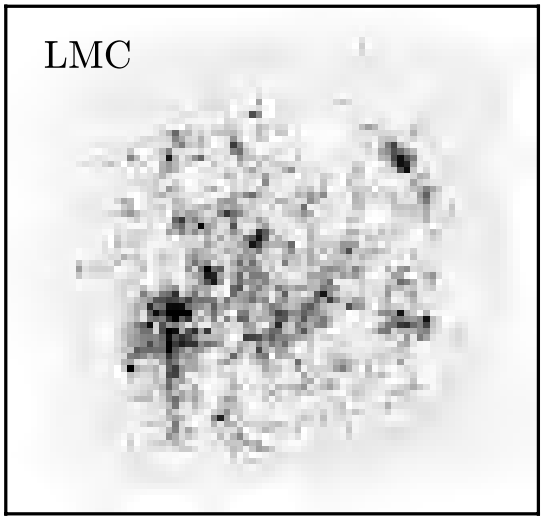
Hα



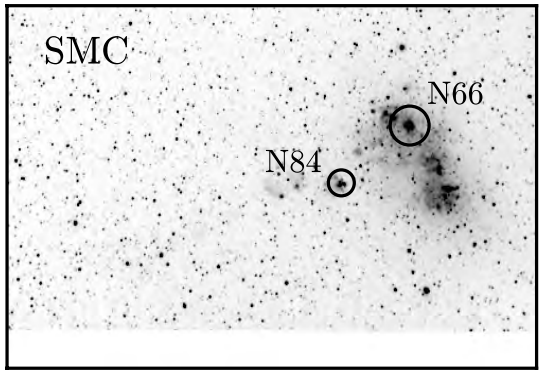
SPIRE 250μm



Band−Matched Catalog Sources



Hα



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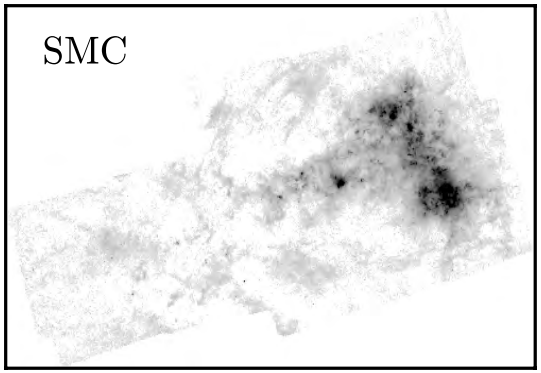

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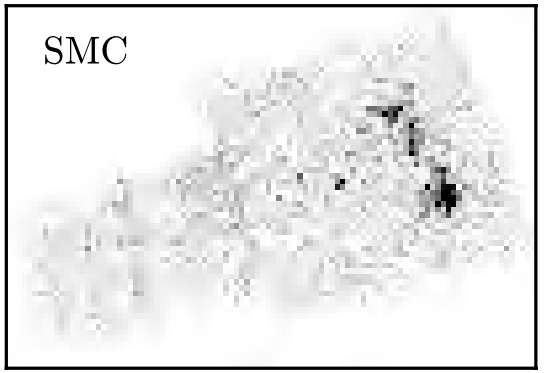
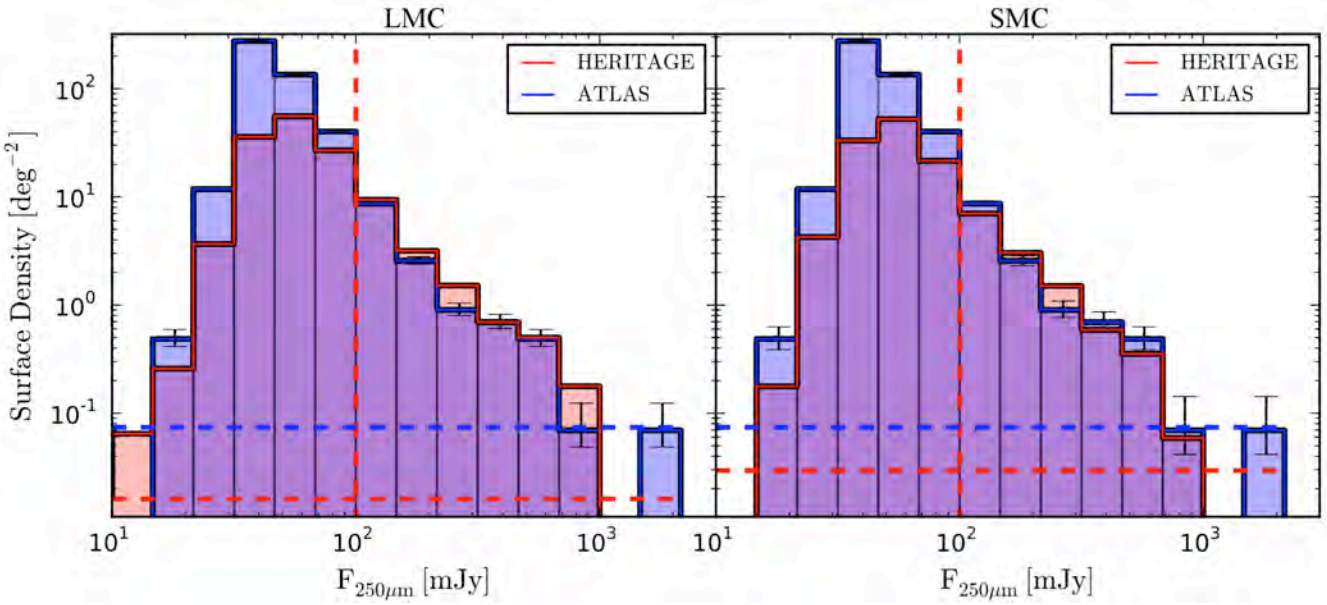
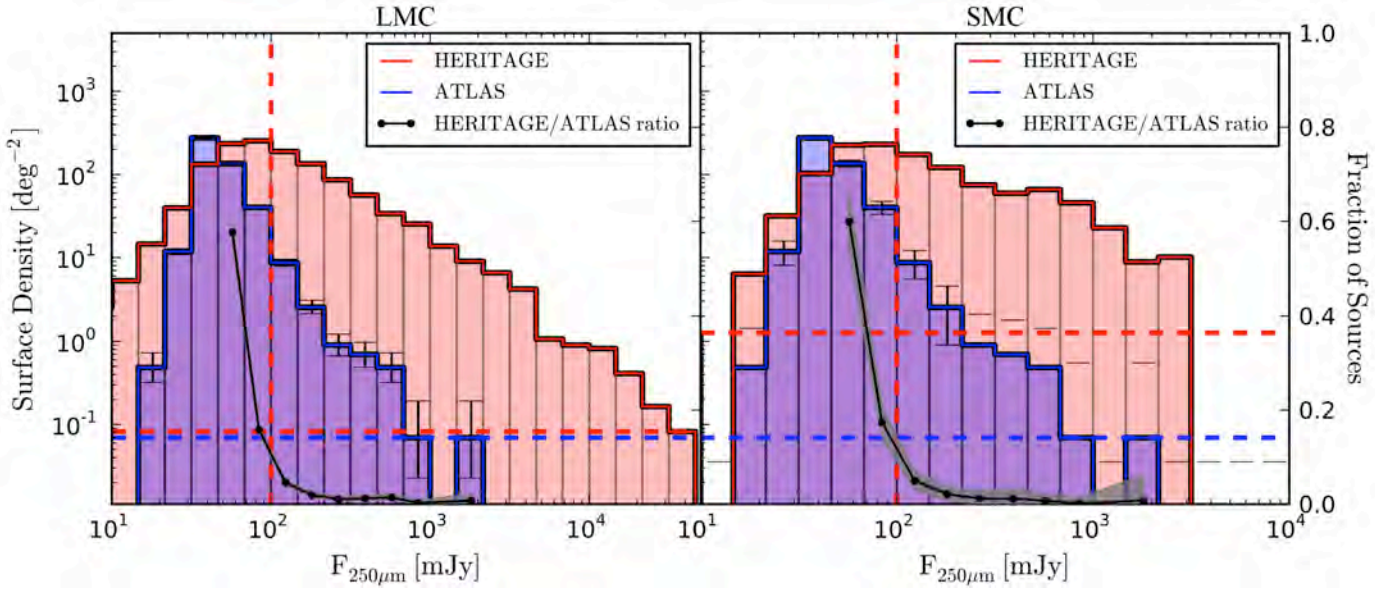


Seale et al.
in prep

HERITAGE Catalog histograms compared to ATLAS (background galaxies)



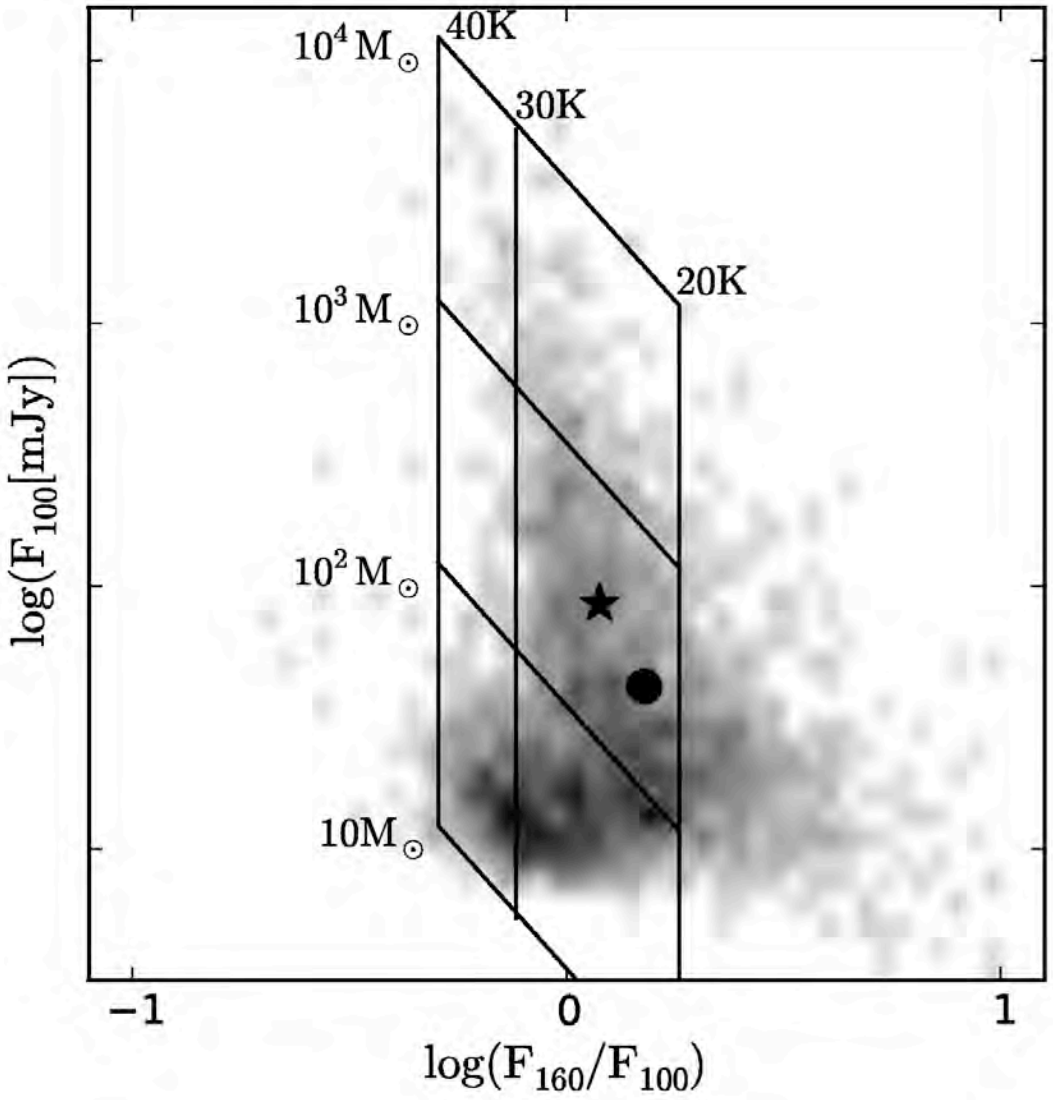
Off galaxy,
low background



On ISM,
high background

Seale et al.,
in prep

Classification of HERITAGE sources

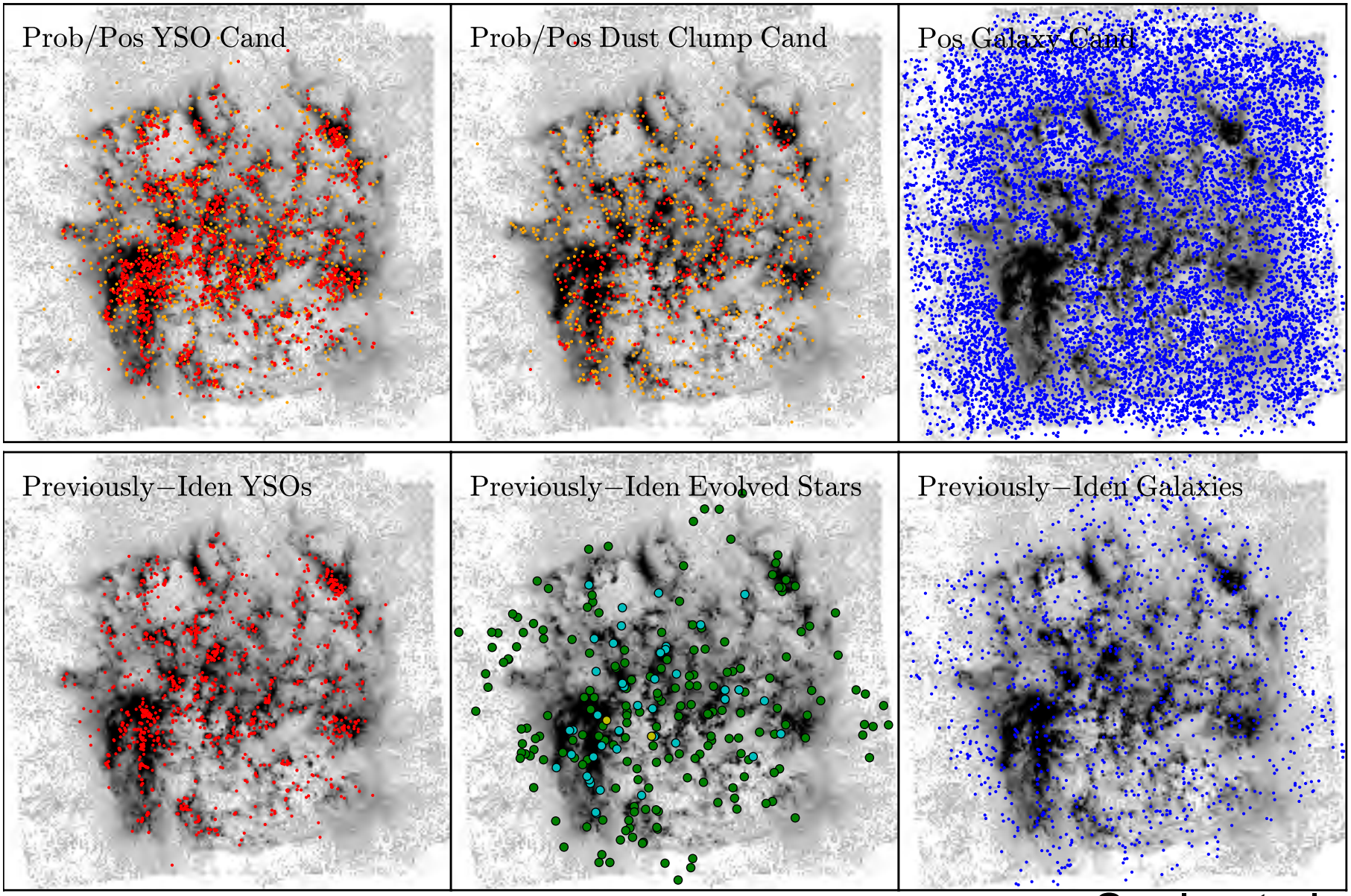


★ Embedded YSO

● Starless dust clump

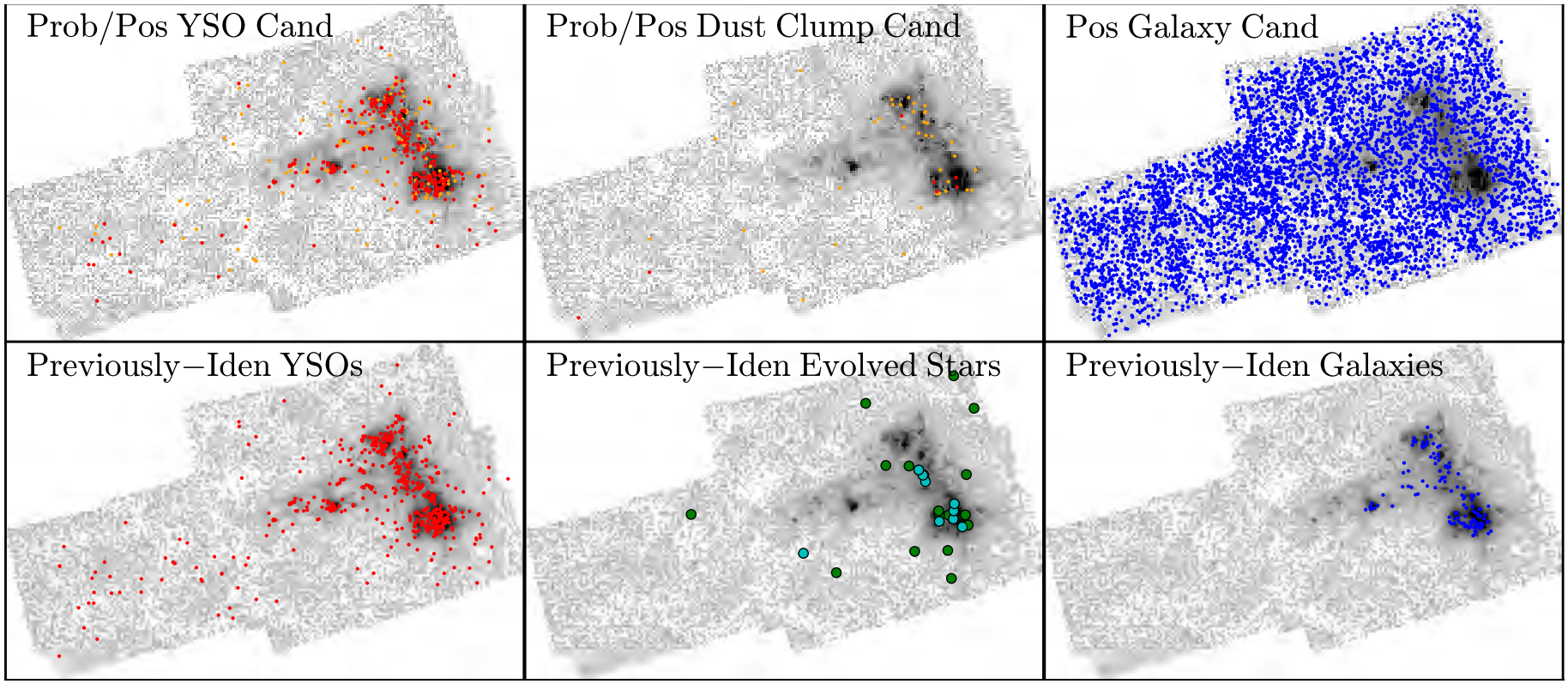
Seale et al., in prep

LMC



Seale et al., in prep

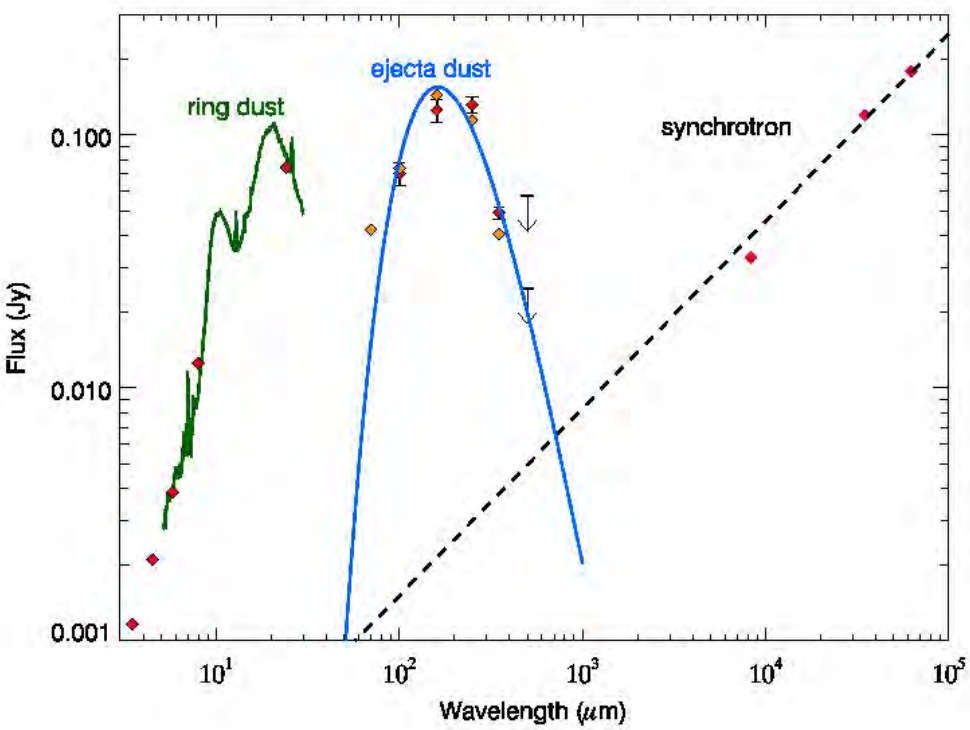
SMC

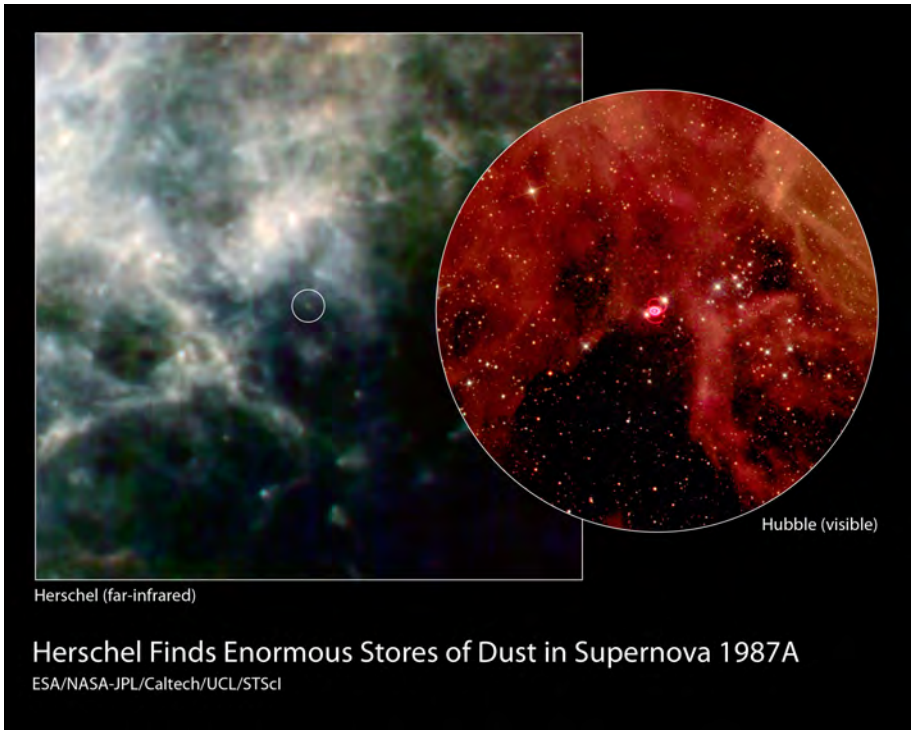


Seale et al., in prep

First Far-IR detection of SN 1987A: ~0.4-0.7 $M_\odot$

See talk by Matsuura et al. Thursday Session 11b





Matsuura, Dwek & Meixner et al. 2011

HERITAGE Catalog – Classification stats

	LMC	SMC
Total	**35,323**	**7,503**
Galaxy Candidates	10,558	5,410
Probable YSO	1,994	335
Possible YSO	912	154
Probable Dust Clumps	453	7
Possible Dust Clumps	738	38
Evolved Stars*	196	51
PNe*	45	9
SNRs*	2	0

*Previously-identified

Seale et al., in prep

HERITAGE Team members: September 2013
BIG THANK YOU
to all the Herschel Space Observatory Teams

Interested in HERITAGE? sage.stsci.edu
HERITAGE Data Products now in the Herschel Science Archive