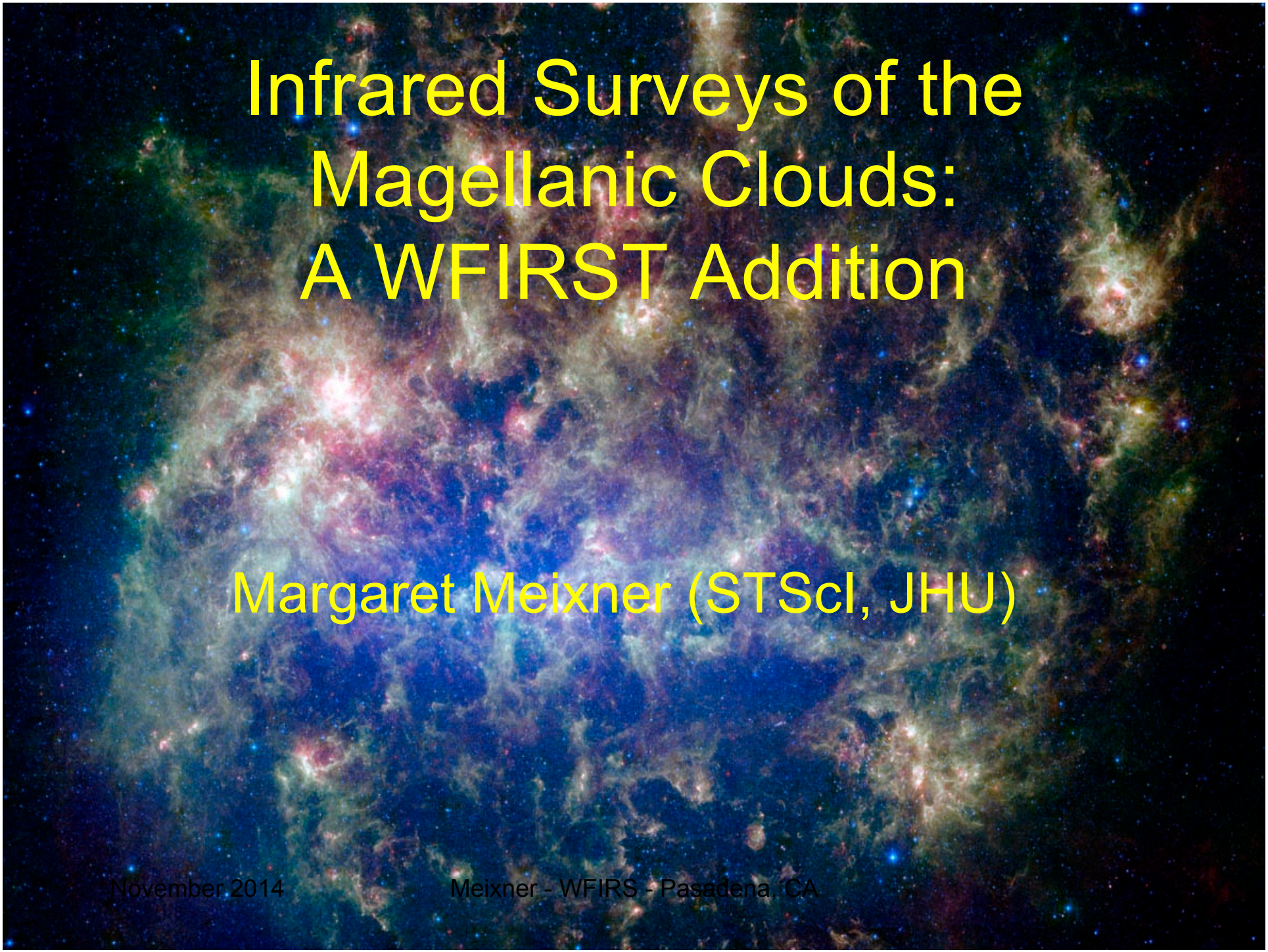


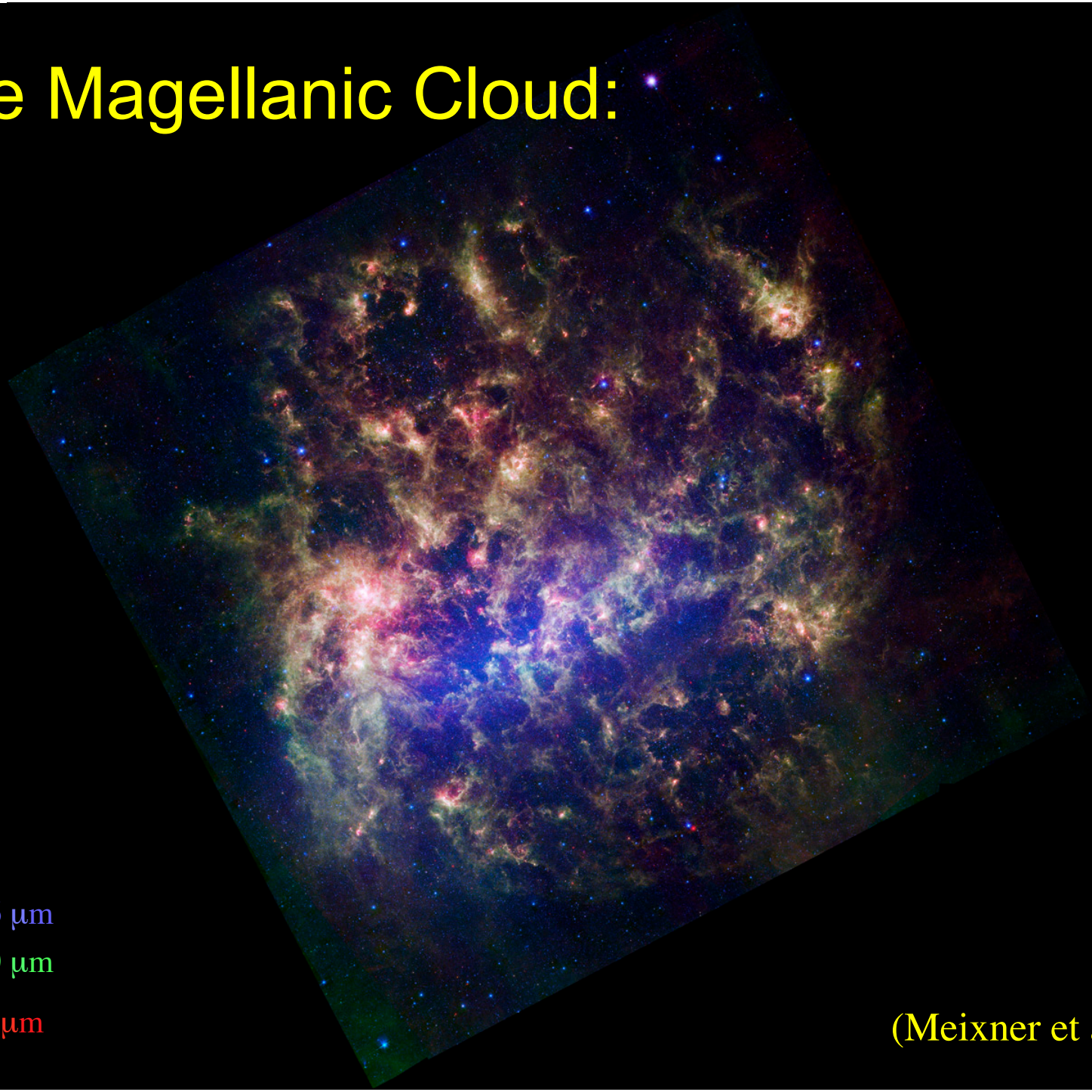
Infrared Surveys of the Magellanic Clouds: A WFIRST Addition

Margaret Meixner (STScI, JHU)

Outline of Talk

- Introducing the Magellanic System:
  - Large Magellanic Cloud (LMC)
  - Small Magellanic Cloud (SMC)
  - Bridge, stream, leading arm = interaction
- Prior and current Surveys
- A WFIRST/AFTA survey of Magellanic System

Large Magellanic Cloud:



IRAC 3.6 μm

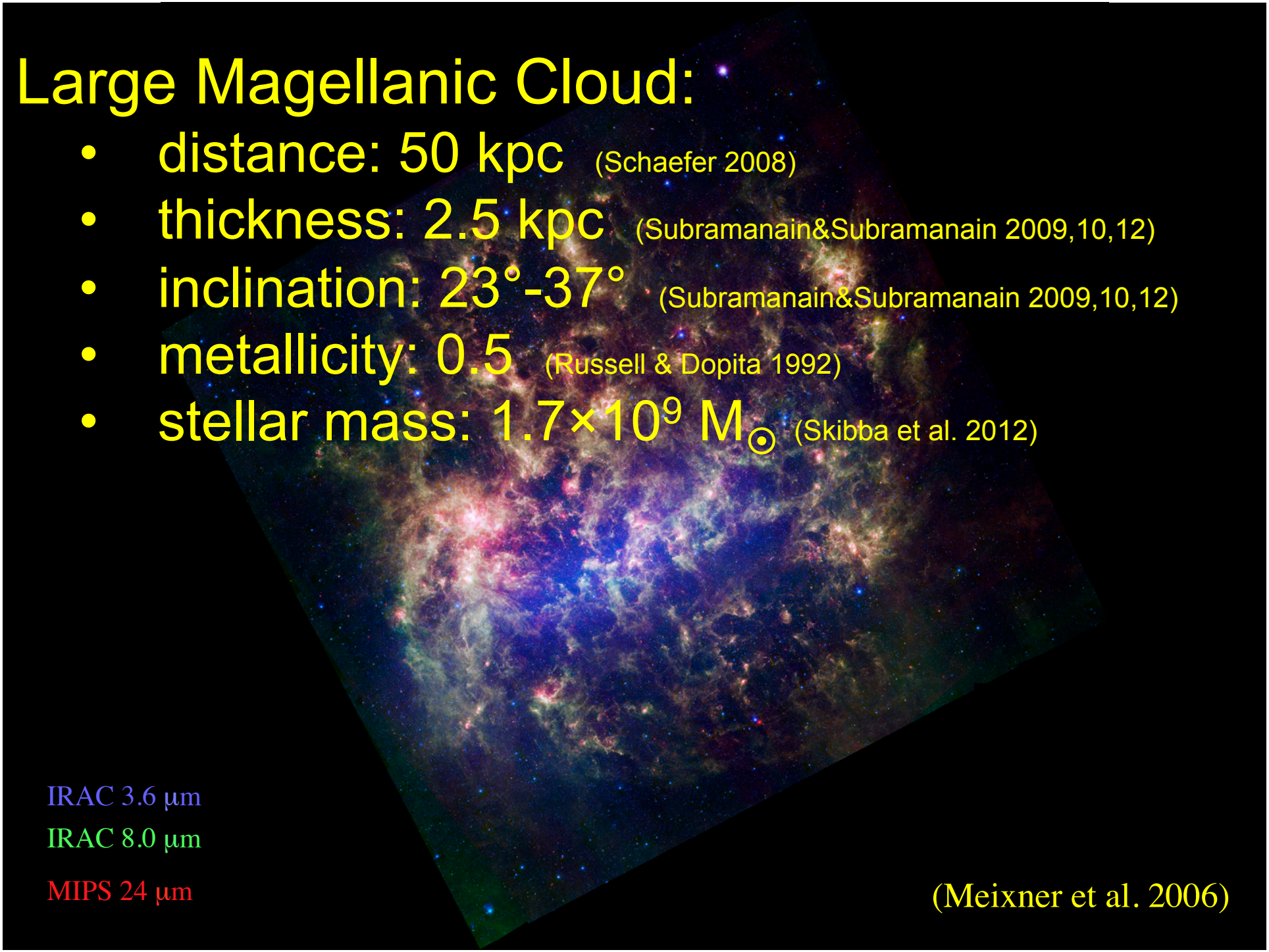
IRAC 8.0 μm

MIPS 24 μm

(Meixner et al. 2006)

Large Magellanic Cloud:

- distance: 50 kpc (Schaefer 2008)
- thickness: 2.5 kpc (Subramanain&Subramanain 2009,10,12)
- inclination: 23°-37° (Subramanain&Subramanain 2009,10,12)
- metallicity: 0.5 (Russell & Dopita 1992)
- stellar mass: $1.7\times10^{9}\ M_{\odot}$ (Skibba et al. 2012)



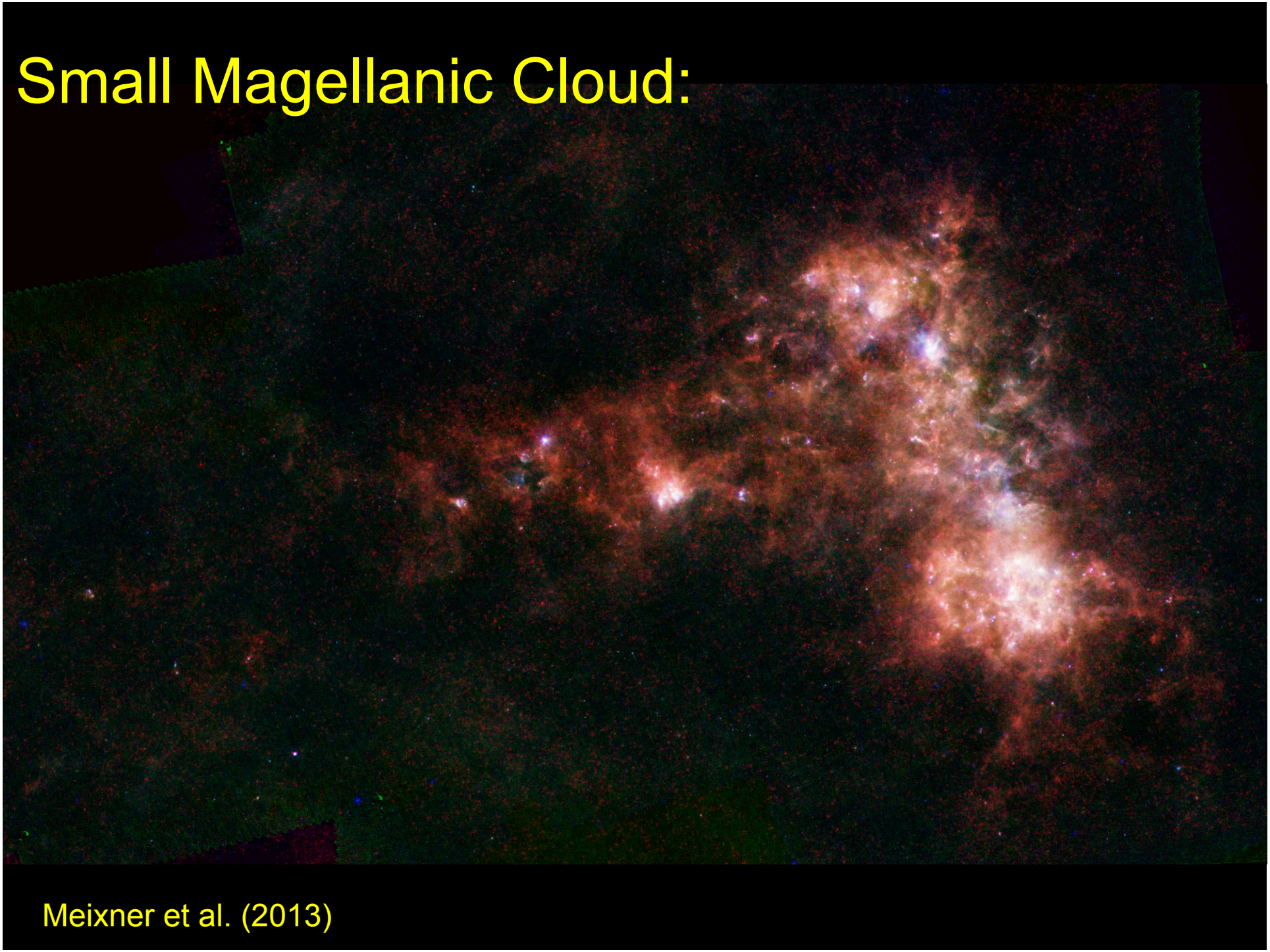
IRAC 3.6 μm

IRAC 8.0 μm

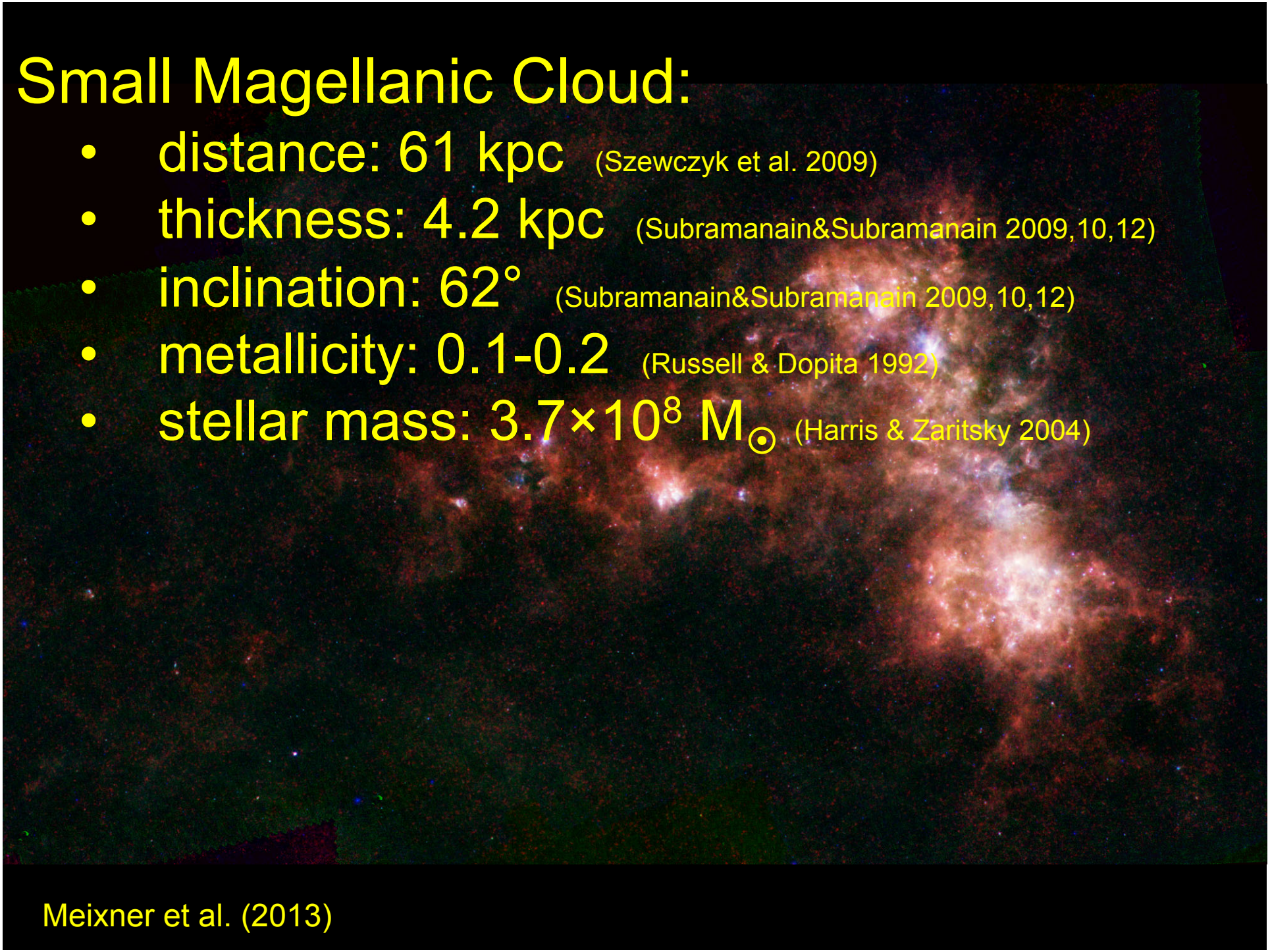
MIPS 24 μm

(Meixner et al. 2006)

Small Magellanic Cloud:



Meixner et al. (2013)

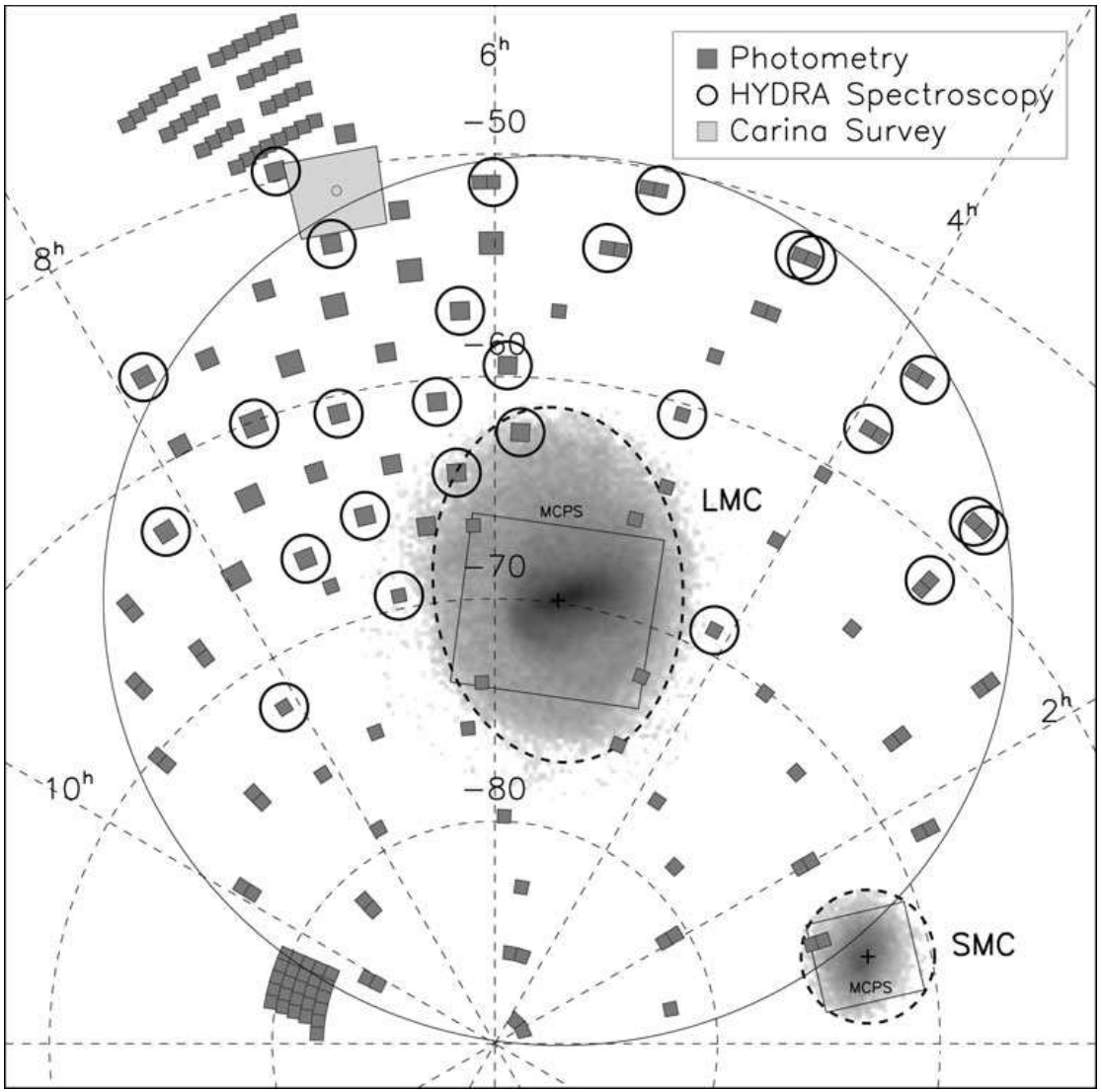


Small Magellanic Cloud:

- distance: 61 kpc (Szewczyk et al. 2009)
- thickness: 4.2 kpc (Subramanain&Subramanain 2009,10,12)
- inclination: 62° (Subramanain&Subramanain 2009,10,12)
- metallicity: 0.1-0.2 (Russell & Dopita 1992)
- stellar mass: $3.7\times10^{8}\ M_{\odot}$ (Harris & Zaritsky 2004)

Meixner et al. (2013)

How big is the stellar distribution of Magellanic System?

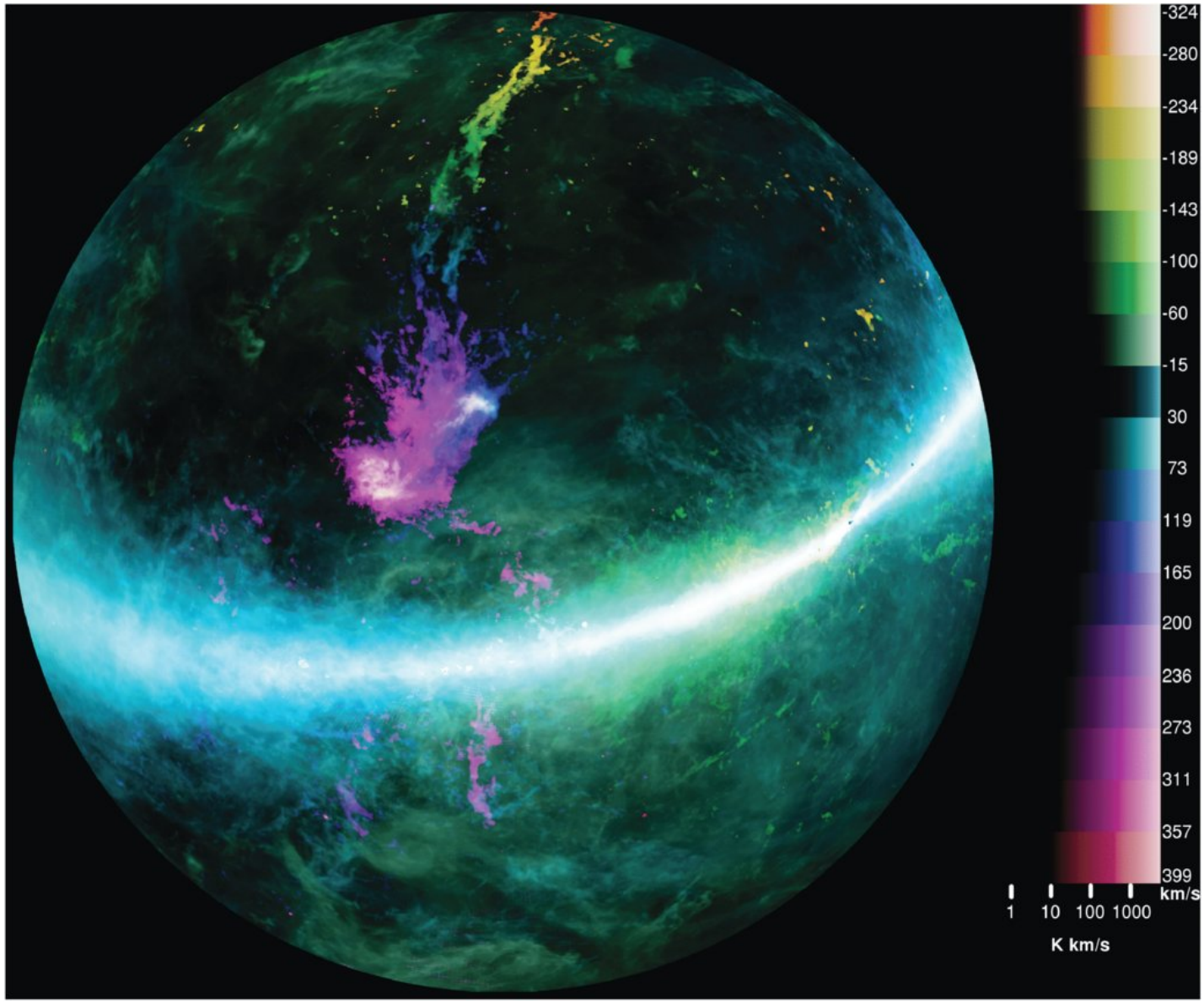


Photometric identification of stars & spectroscopic confirmation

LMC stellar halo Extends R~23°

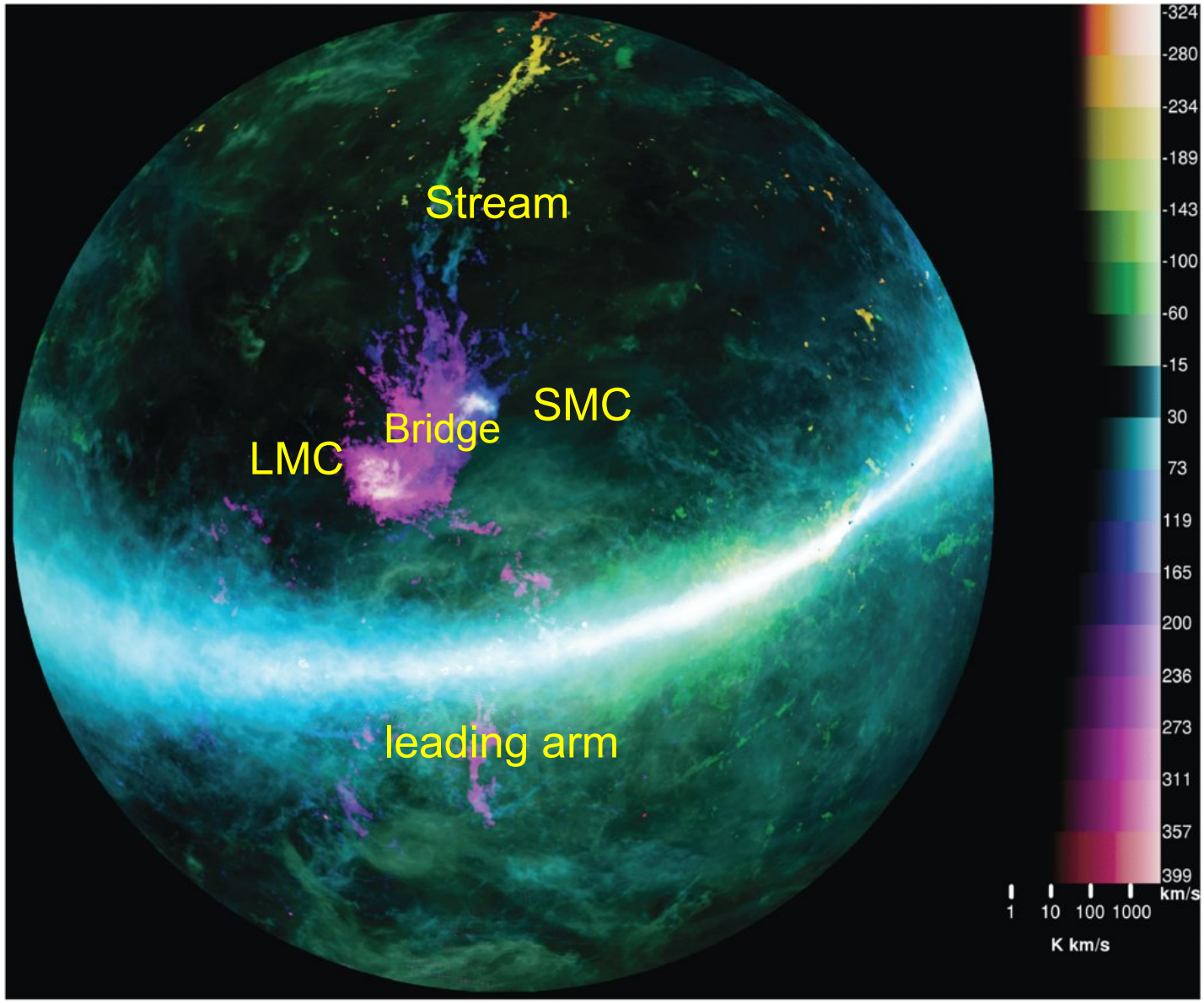
Majewski, Nidever et al. (2009)

The Magellanic System is HI is Huge!



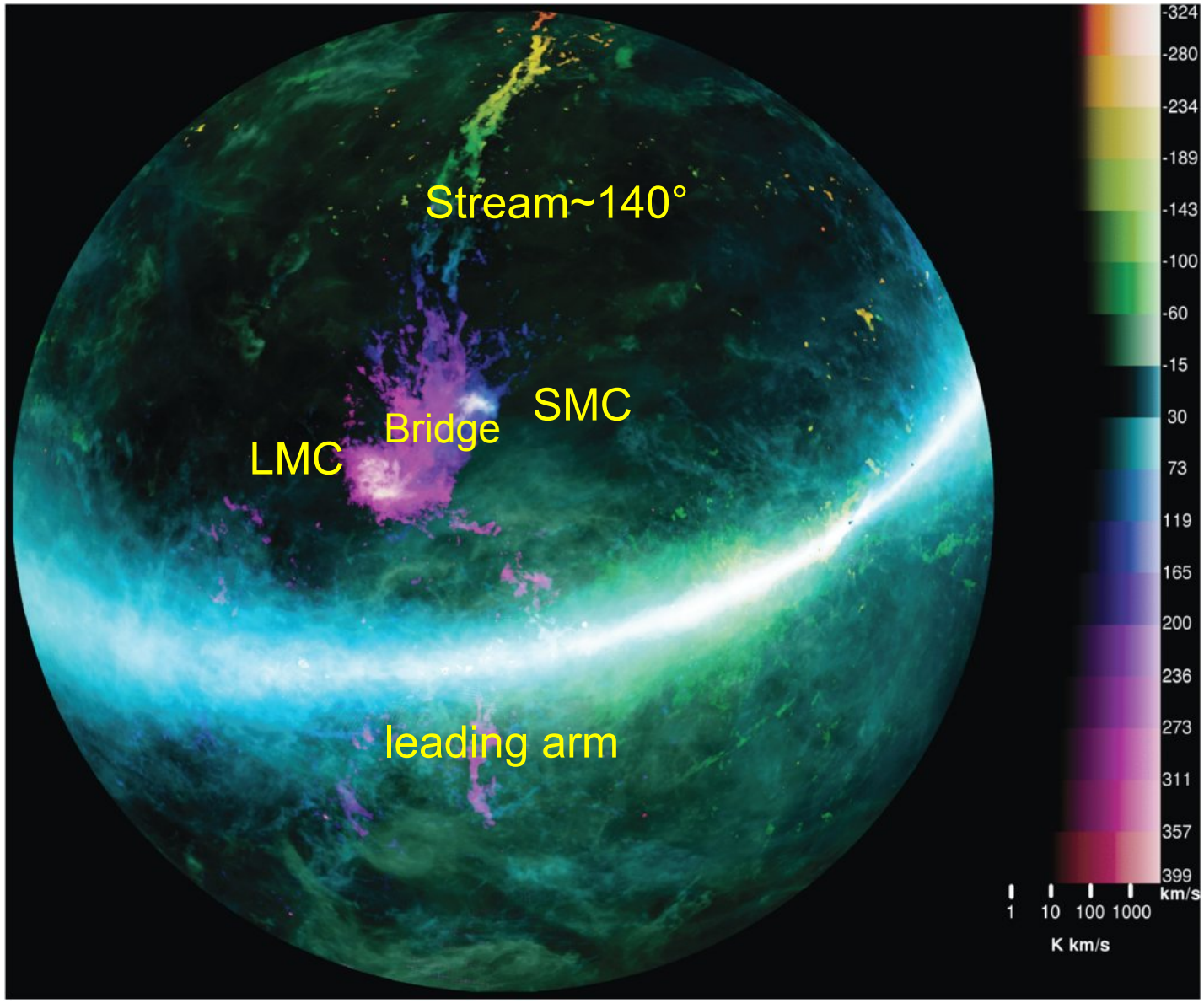
McClure-Griffiths et al. (2009)

The Magellanic System is HI is Huge!

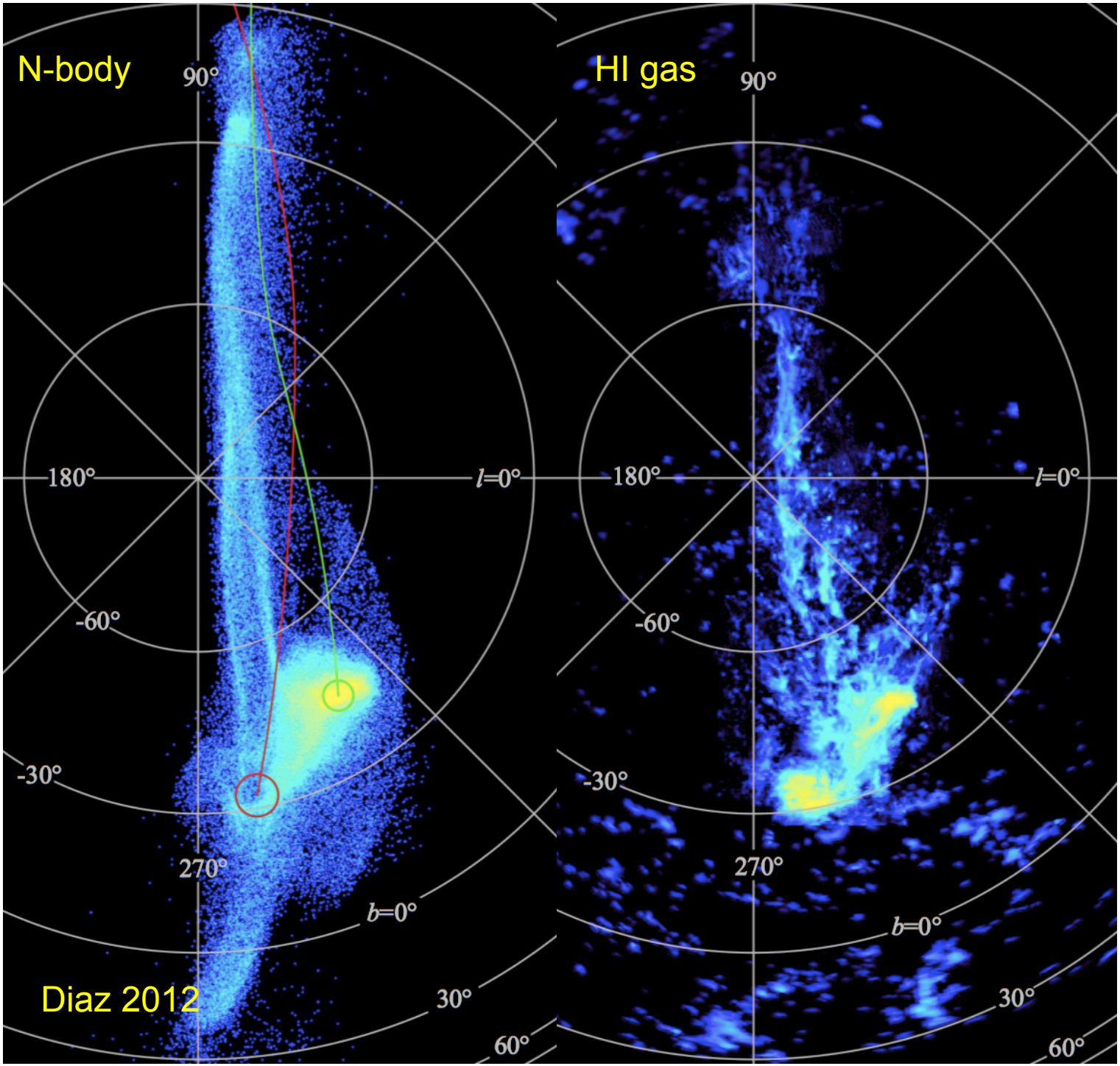


McClure-Griffiths et al. (2009)

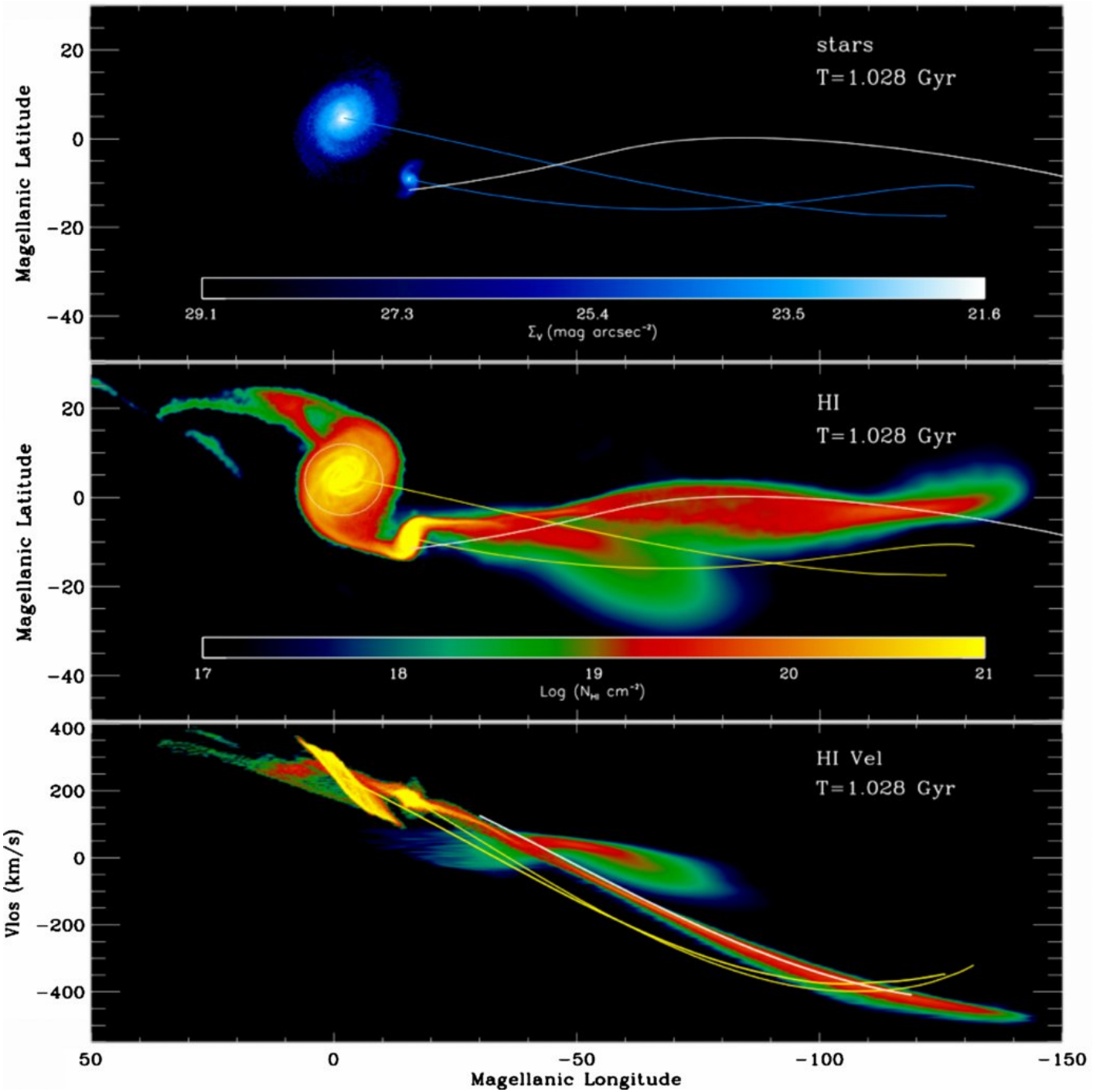
Leading arm to stream tip ~200° (Nidever et al 2010)



McClure-Griffiths et al. (2009)



Stream is a tidal stream from a disrupted SMC.

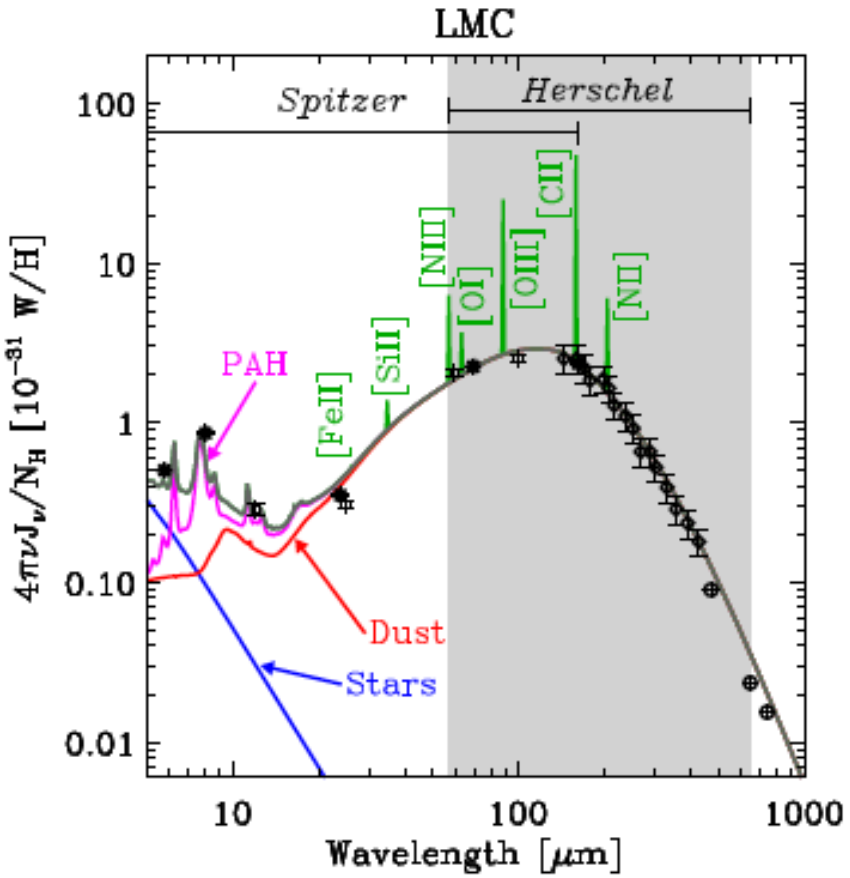


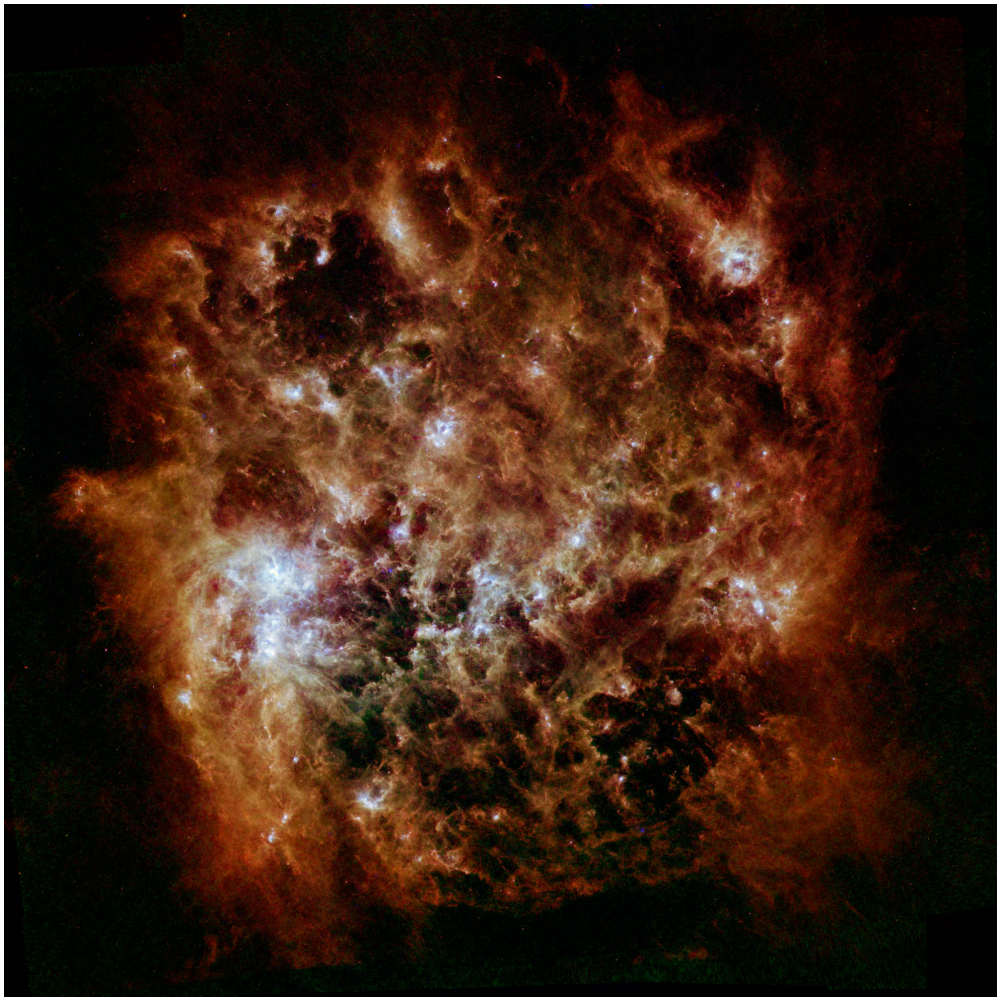
Stream is a tidal stream from a disrupted SMC.

Is there a stellar debris tail?

Besla et al. (2010)

Surveying the Agents of Galaxy Evolution (SAGE): Spitzer & Herschel probe old stars, dusty stars and ISM in LMC and SMC



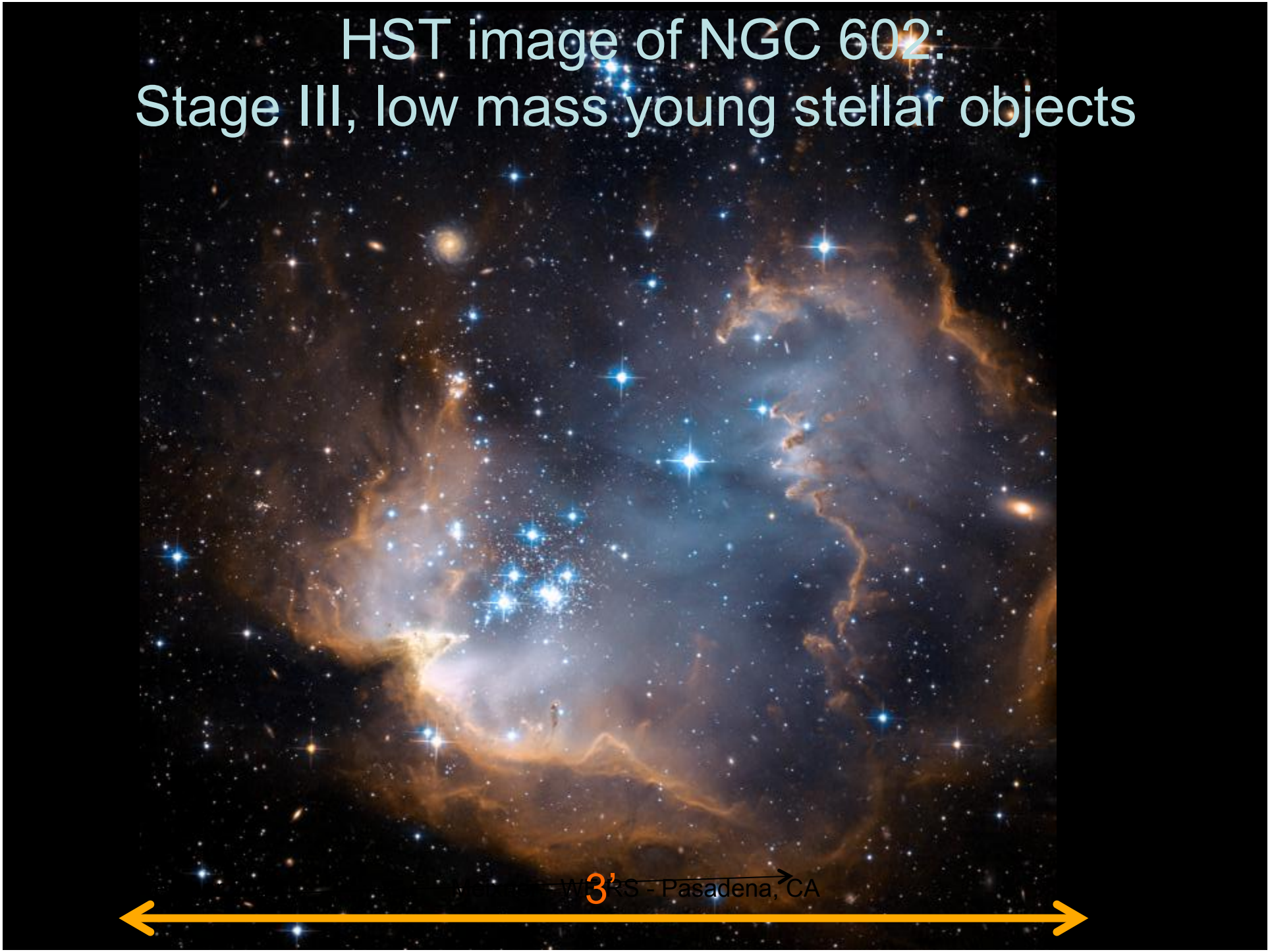


Meixner et al. 2013

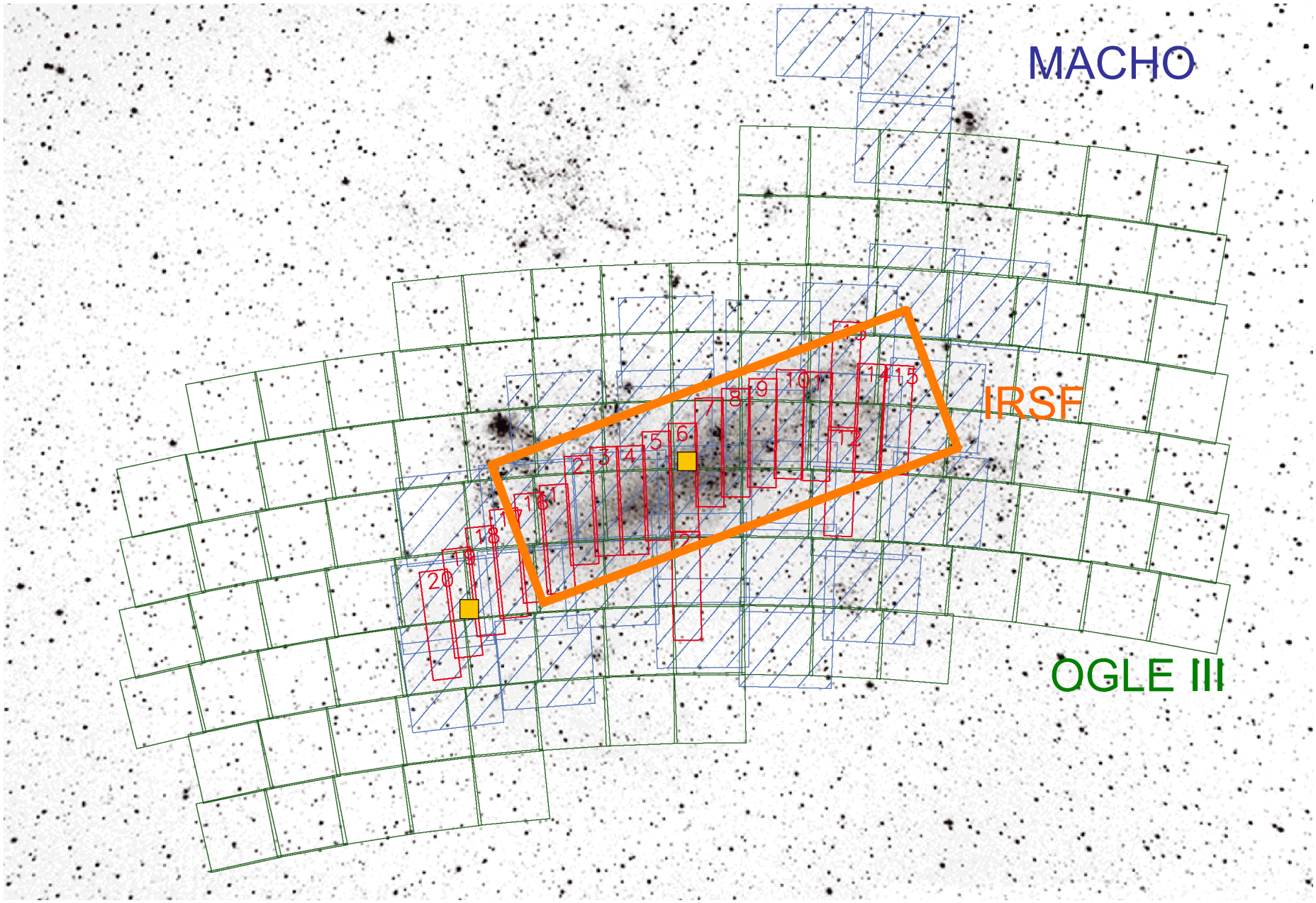
SAGE & HERITAGE: highlights

- Star Formation: discovered thousands of embedded YSO candidates in the LMC and SMC enabling:
  - star formation studies at low metallicity for the first time
  - bottoms up star formation rate estimates based on IMFs
- Evolved stars:
  - SAGE data enables population wide estimates of mass loss return from evolved star populations
  - HERITAGE detects SN 1987A: ~0.4-0.7 $M_{\odot}$
- ISM: SAGE & HERITAGE data can provide dust mass estimates for the ISM, but:
  - Herschel bands suggest dust in LMC is different than Galaxy
- Combing all results, we are pursuing a dust evolution model of the LMC and SMC
- More information: sage.stsci.edu

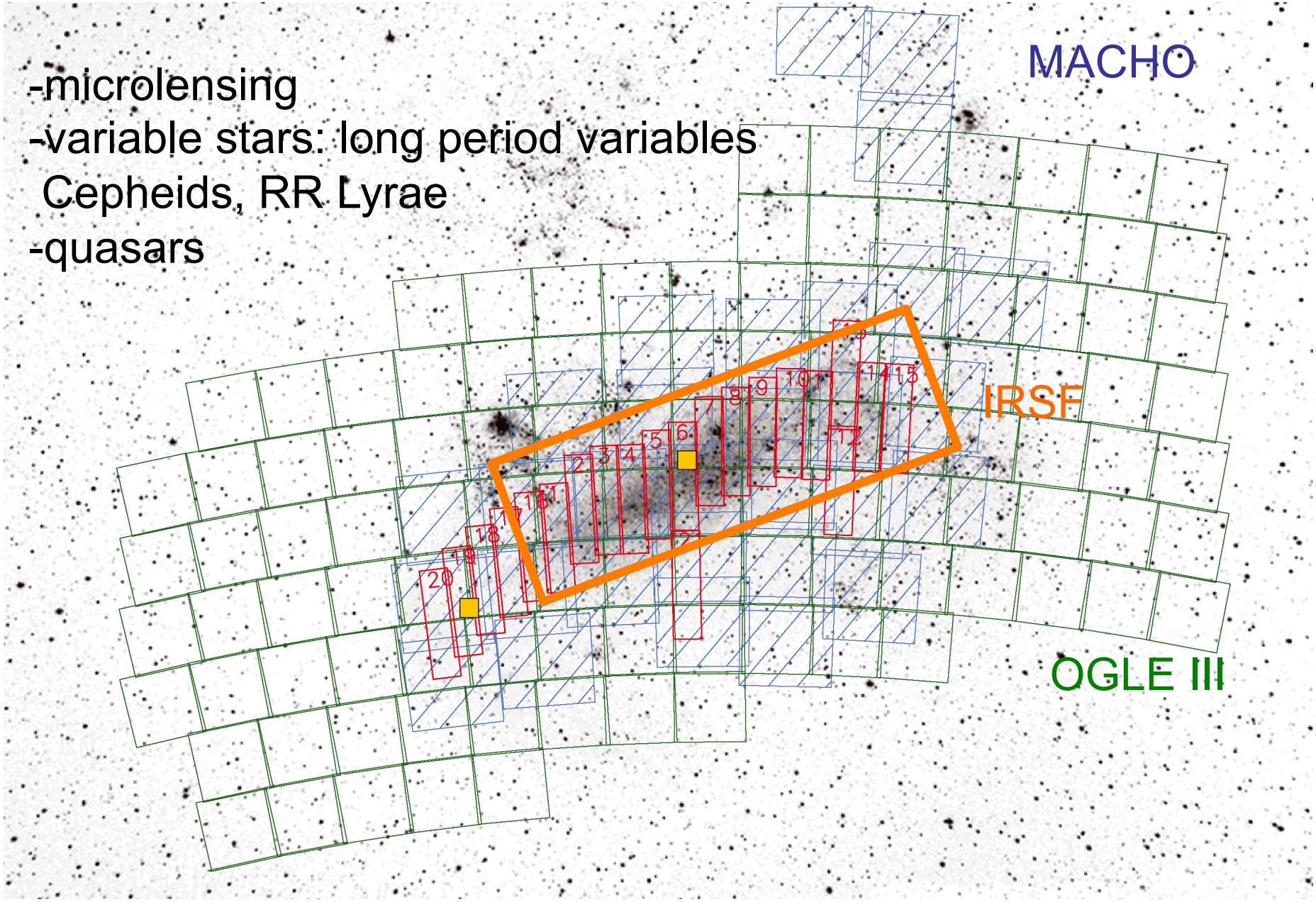
HST image of NGC 602: Stage III, low mass young stellar objects



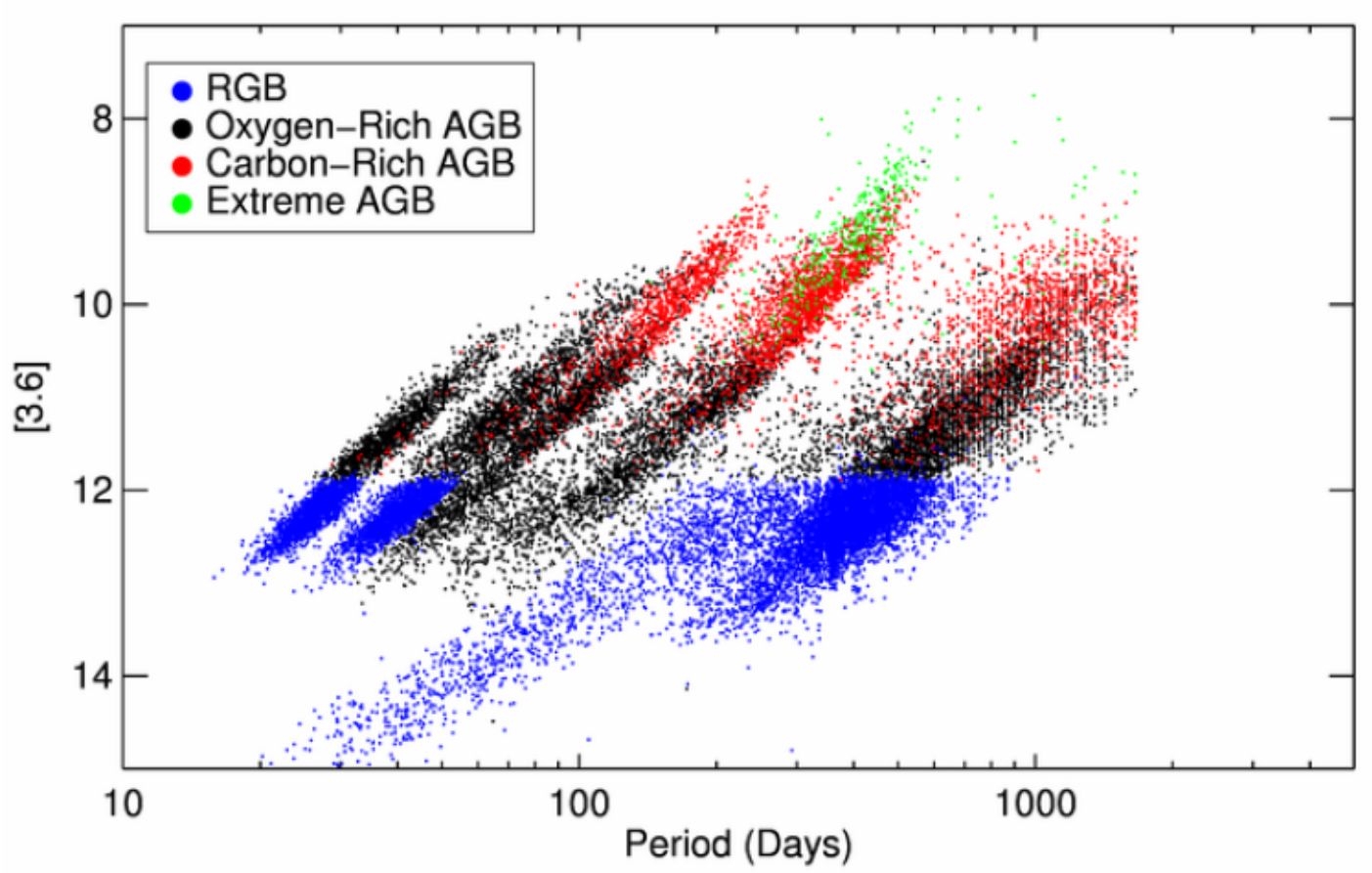
Synoptic Surveys of LMC



Synoptic Surveys of LMC

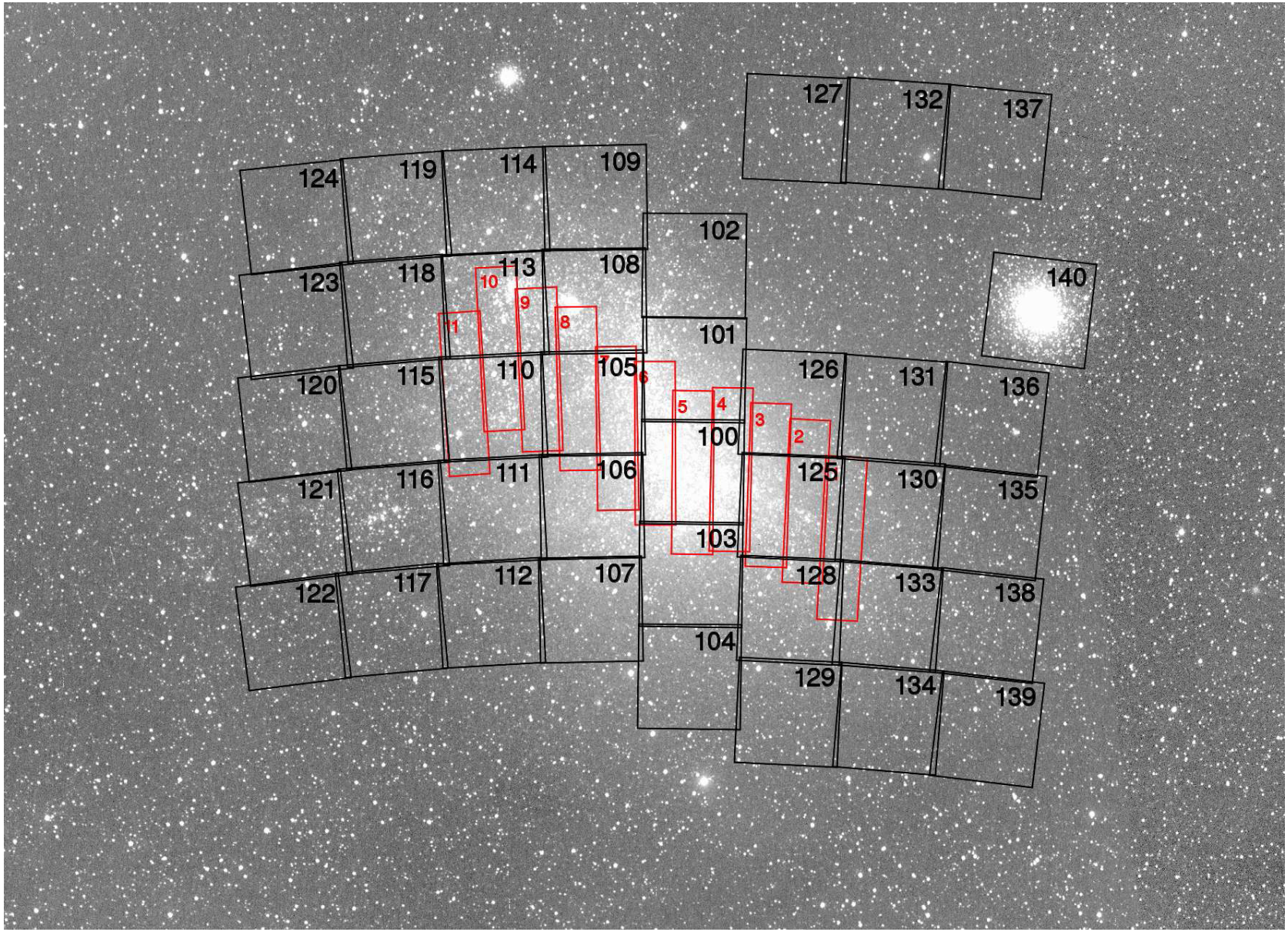


Comparing SAGE & MACHO LMC data: Period-luminosity relations for RGB & AGB stars

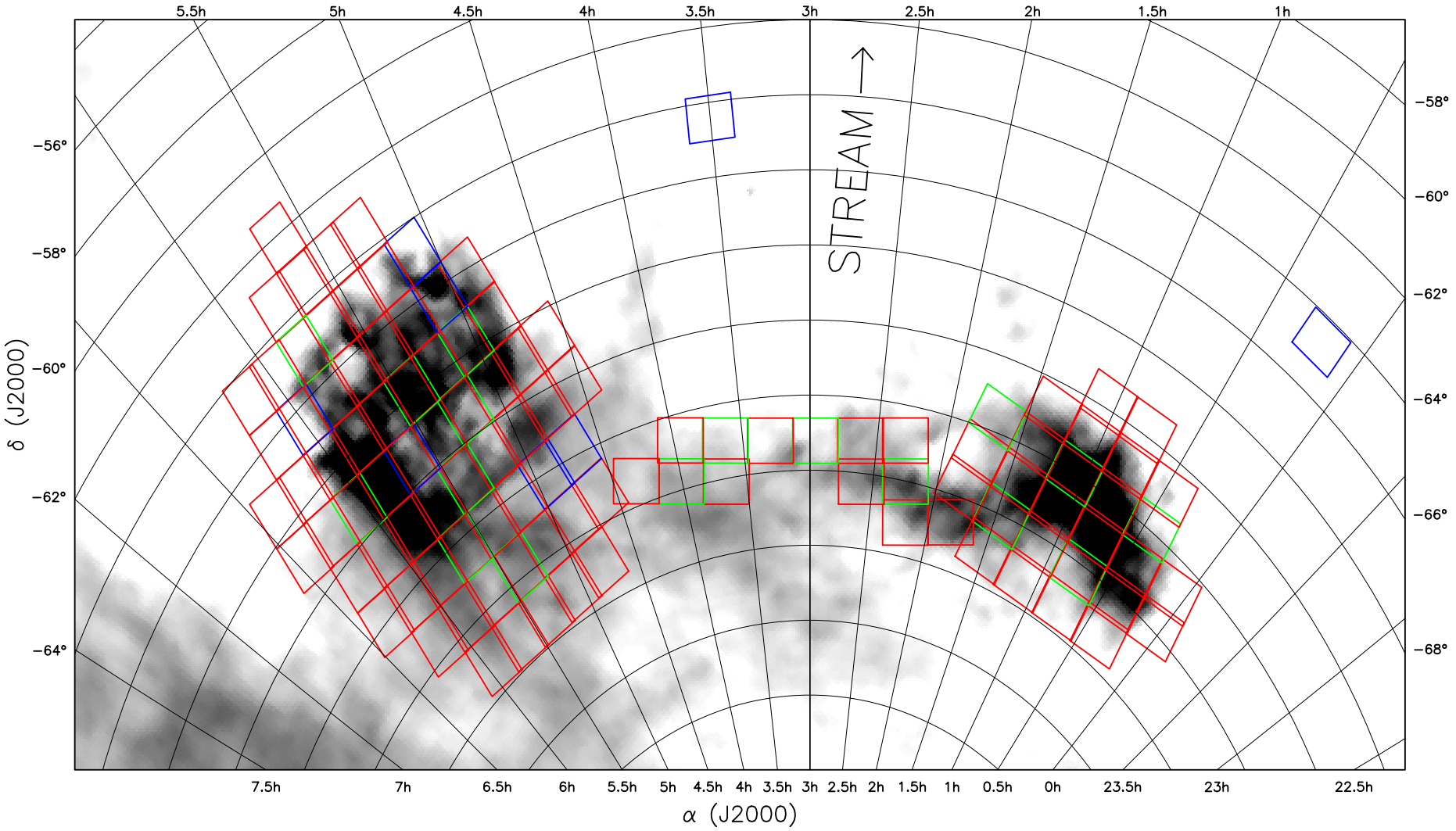


Riebel et al. 2010

Synoptic Surveys of SMC



VISTA Magellanic Cloud (VMC) Survey



November 2014

Meixner - WFIRS - Pasadena, CA

Cioni et al. (2011)

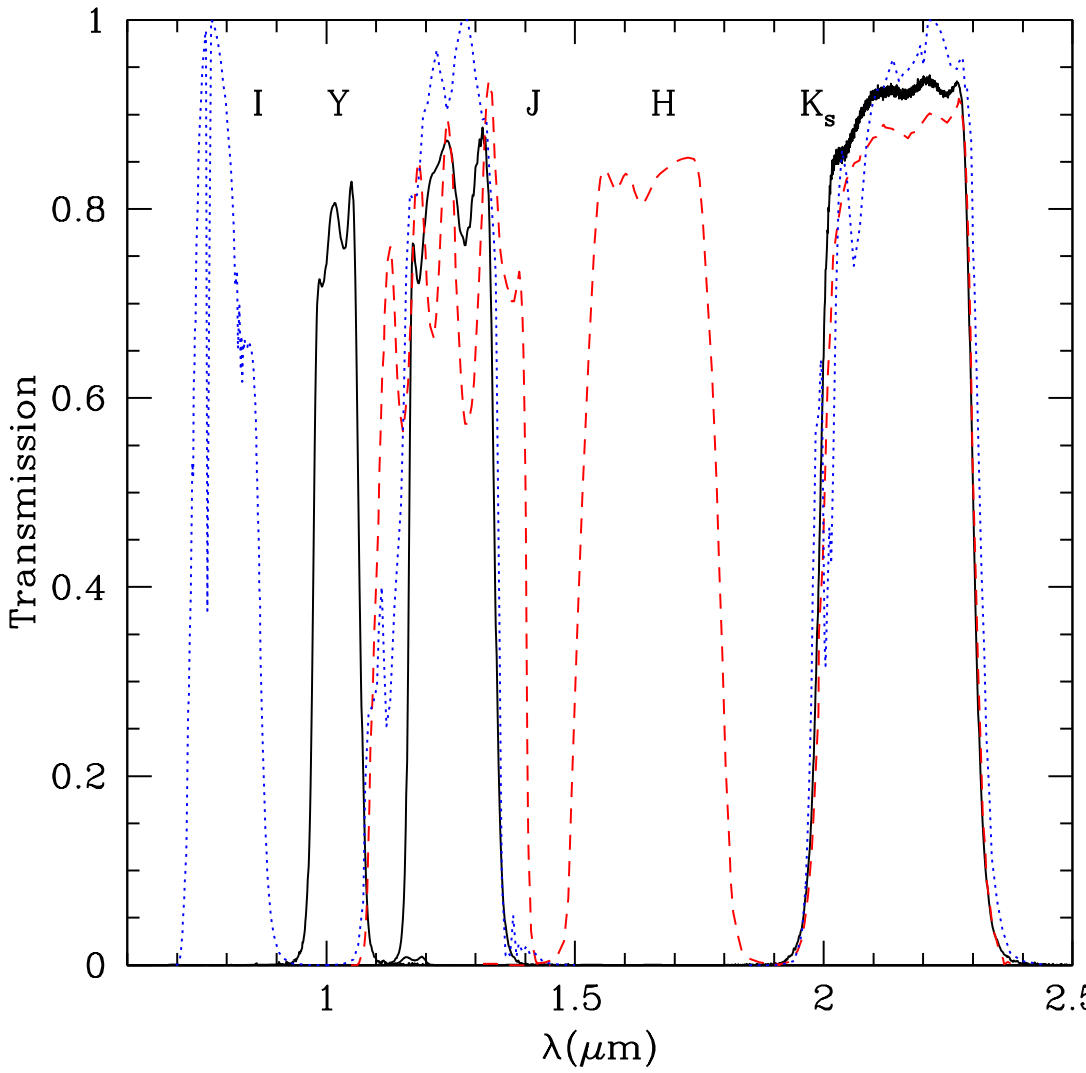
VISTA Magellanic Cloud (VMC) Survey:
30 Doradus tile

-12 epochs K_s optimized for Cepheids
-Limiting Magnitudes:
Y~21.9
J~21.4
K_s~20.3

CA

Cioni et al. (2011)

VISTA Magellanic Cloud (VMC) Survey



Science topics:

-AGB stars (Gullieuszki et al. 2011)

-star formation history

(Rubele et al. 2013)

-planetary nebulae

(Miszalski et al. 2011)

-dust reddening (Tatton et al.2013)

-Cepheids, RR Lyrae, eclips. Binaries -> 3-D structure

(Moretti et al. 2014)

-proper motions (Cioni et al. 2014)

See van der Marel talk

-star clusters (Piatti et al. 2014)

Cioni et al. (2011)

Magellanic Clouds with WFIRST/AFTA

- Wide field imaging: depth and precision will break new ground on
  - How big and what is the structure of the LMC and SMC halo?
  - Is there a stellar component to the Magellanic Stream?
  - Completing a census of young stellar objects including Stage III, low mass stars to probe star formation with metallicity
  - Well below main sequence turn off stellar populations

- What would it take?
  - LMC w/halo: R~23°, 1662 deg^2, 5935 WFIRST FOV's
  - Stream: length ~140°, width~10°, 1400 deg^2, 5000 WFIRST FOV's
  - Depth for Stage III, young stellar objects H>25 mag., this could be accumulated over a period of time

Magellanic Clouds with WFIRST/AFTA

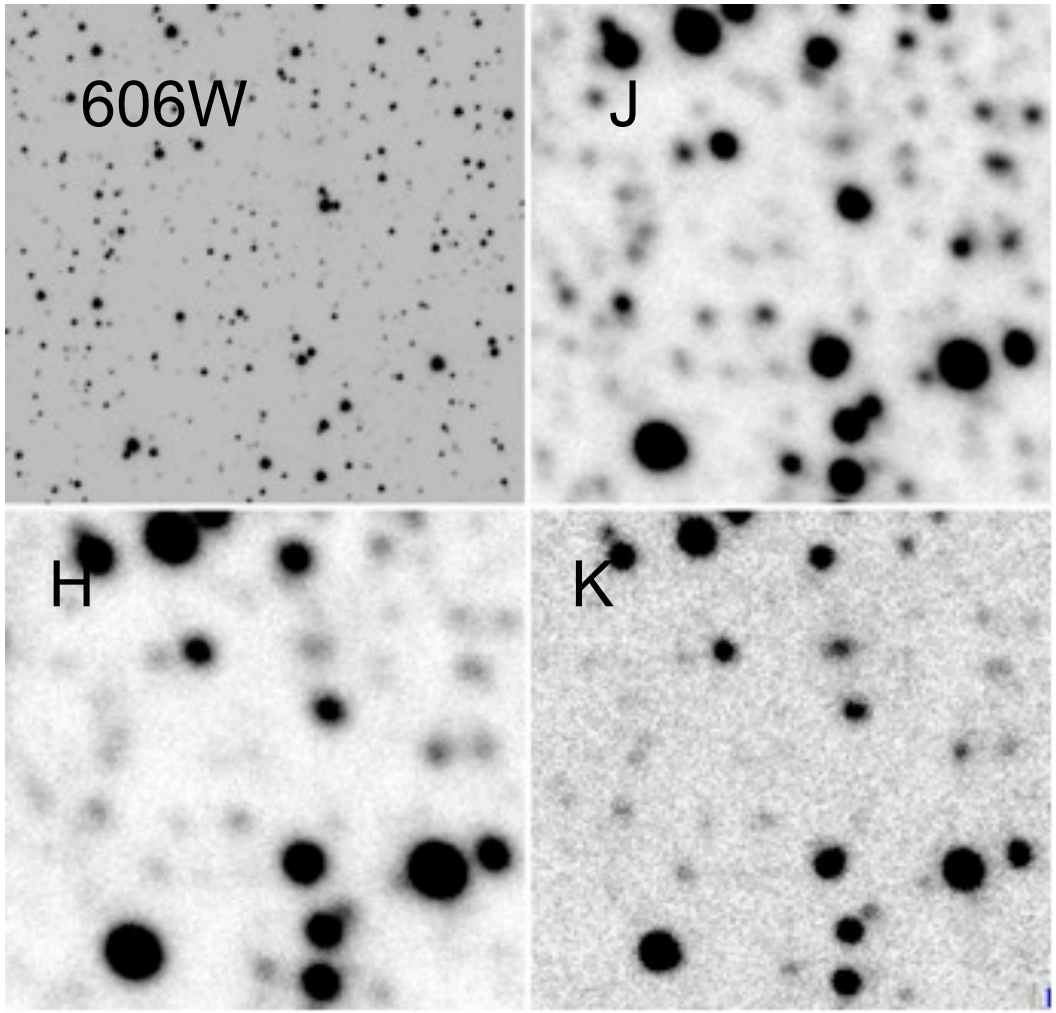
- Widefield Imaging Techniques: Synoptic study
  - Short time periods (days to a year) for variability info:
    - Cepheids, RR Lyrae: 1-100 days
    - young stellar objects: 1-30 days +
    - asymptotic giant branch stars: 30-1000 days
  - Large time baseline for proper motions:
    - efficient means to separate out Magellanic Populations from foreground and background objects: done currently for globuar clusters with HST
    - Means to study the dynamics of stellar populations in the complex system: van der Marel & Kallivayalil 2014
- Techniques: stacked, deep images
  - Discovery of new, Stage III young stellar objects, ***long wavelength extension very useful***
  - Probe of stellar populations down to and below main sequence turnoffs:
    - better determined star formation histories
    - Probe of lower mass initial mass function in clusters

Magellanic Clouds with WFIRST/AFTA

- Coronagraphy: 100 mas to 1.8 arcsec
  - probes 100-1000 AU size scales for LMC & SMC targets
  - Suited to image the detached shells of asymptotic giant branch stars, e.g TT Cyg or U Ant , star with large target list from SAGE/ HERITAGE
- IFU, R~75 over 0.6-2.0 (2.5?) microns
  - Complete SED for older stars, but largely known via photometry
  - Fast time variable phenomena: supernova explosions
- Slitless Grism spectroscopy: R<900, 1.35-1.95 microns
  - Probe for [FeII] 1.644 micron line in shocked outflows of young stellar objects
  - Covers H_2 and H recombination lines, star formation region studies
  - Complex region issues: but has been tackled e.g. with Akari, Shimonishi et al. 2013, AJ, 145, 32

Large Magellanic Cloud calibration field

JWST calibration field: 5’×5’ HST/ACS,
near-IR, astrometry, photometry



Anderson (2008)