

Young, Blue, and Cold

A Blind Survey of Nearby Dusty Galaxies
with *Herschel-ATLAS*

Chris Clark

Haley Gomez

Loretta Dunne

Pieter De Vis

Steve Maddox

Simon Schofield

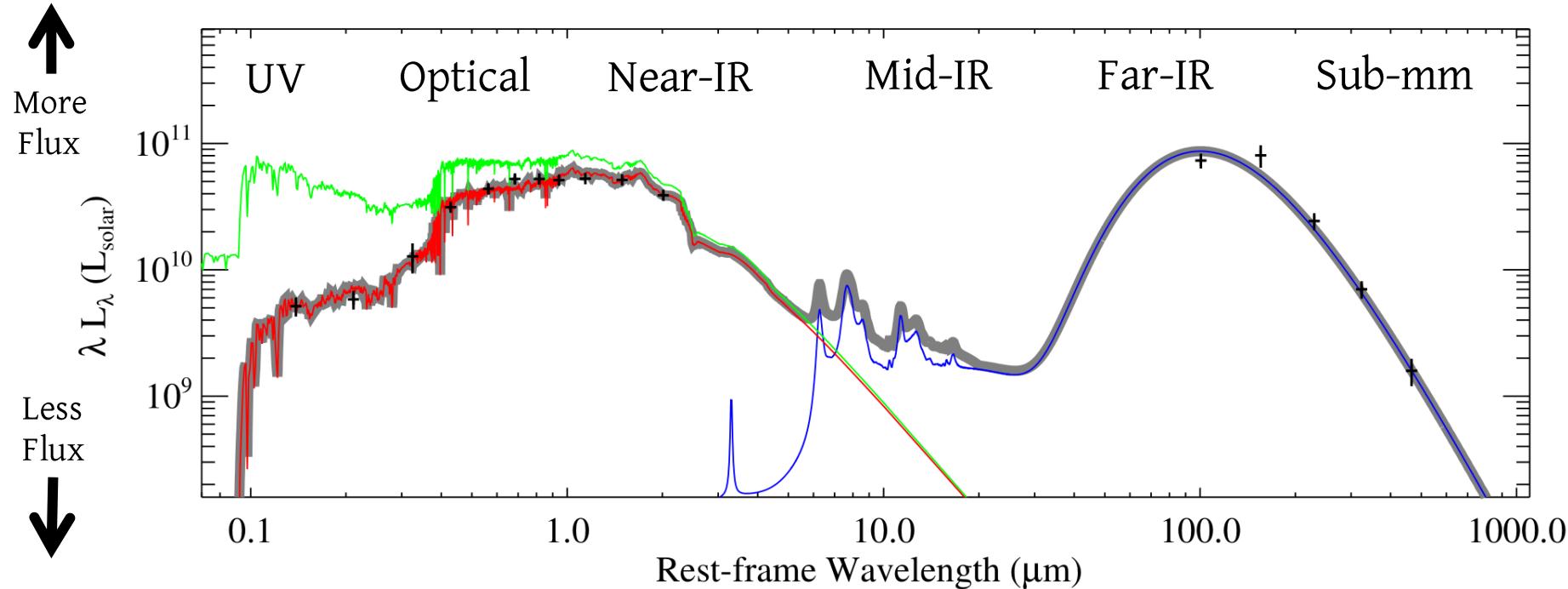
(with the *H-ATLAS* team)



By Matt Smith



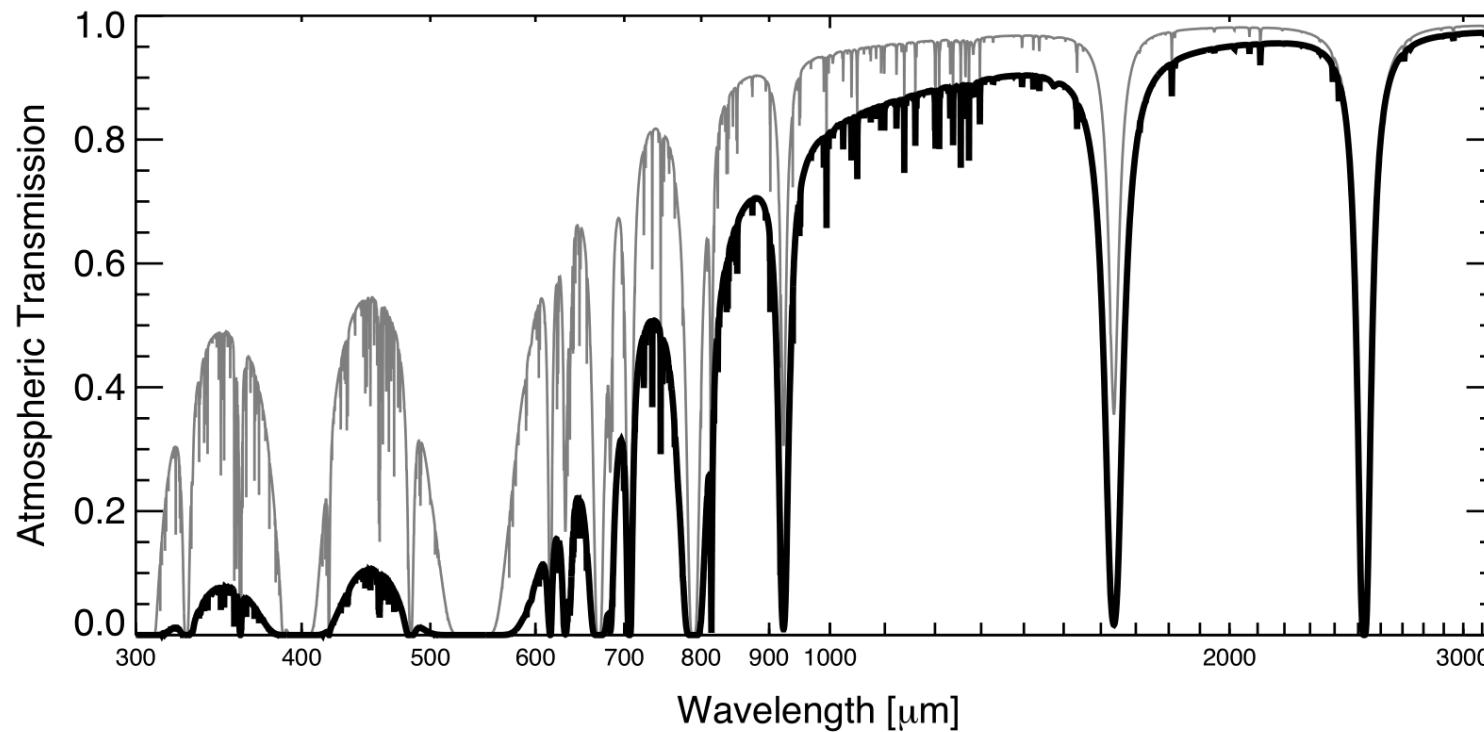
Typical SED of a Dusty Galaxy



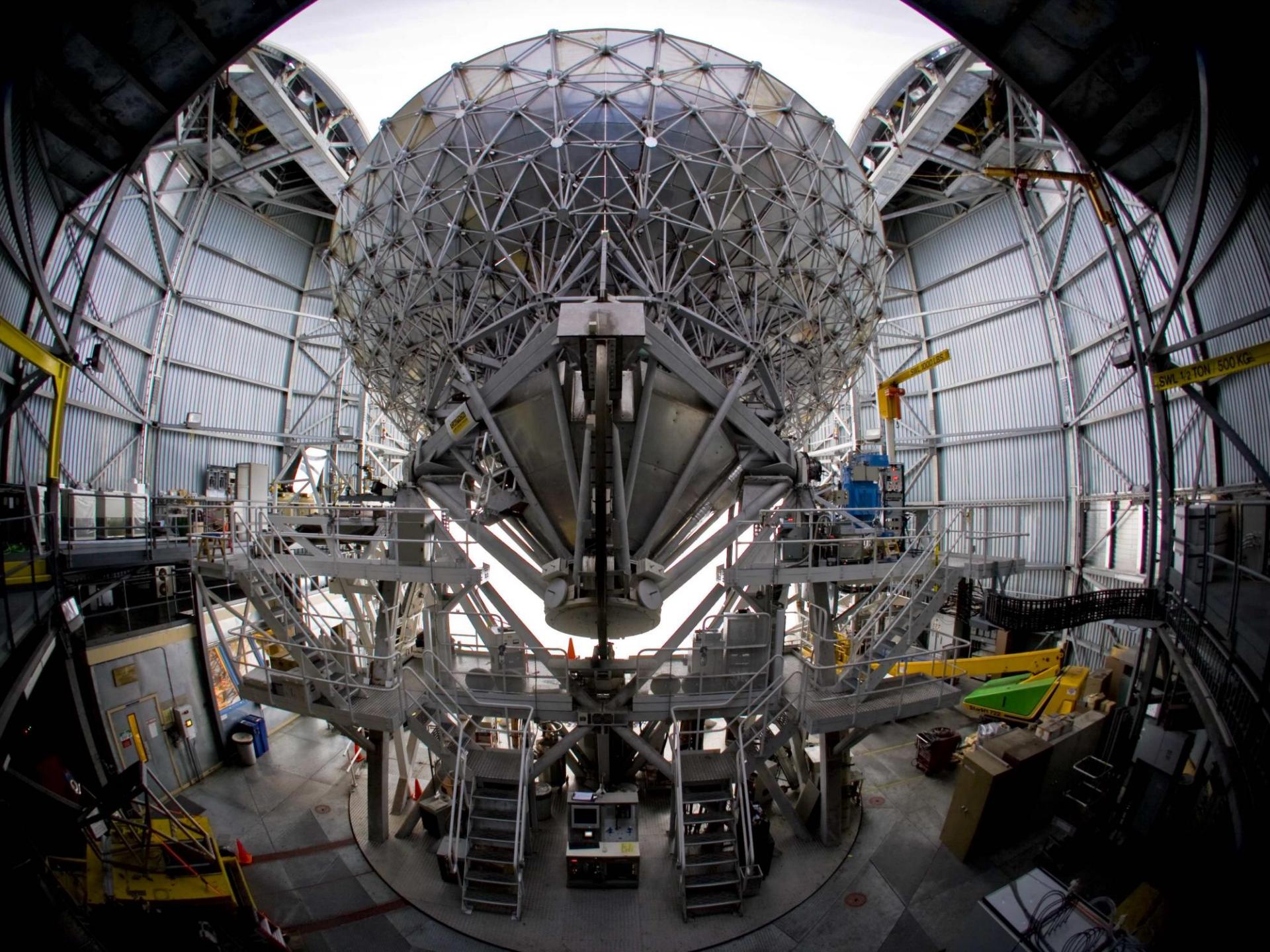
- Un-attenuated stellar emission
- Observed stellar emission
- Observed dust emission
- Combined observed emission

DJB Smith et al (2012)
da Cunha et al (2011)

The Atmosphere Hates You



Casey et al (2014)



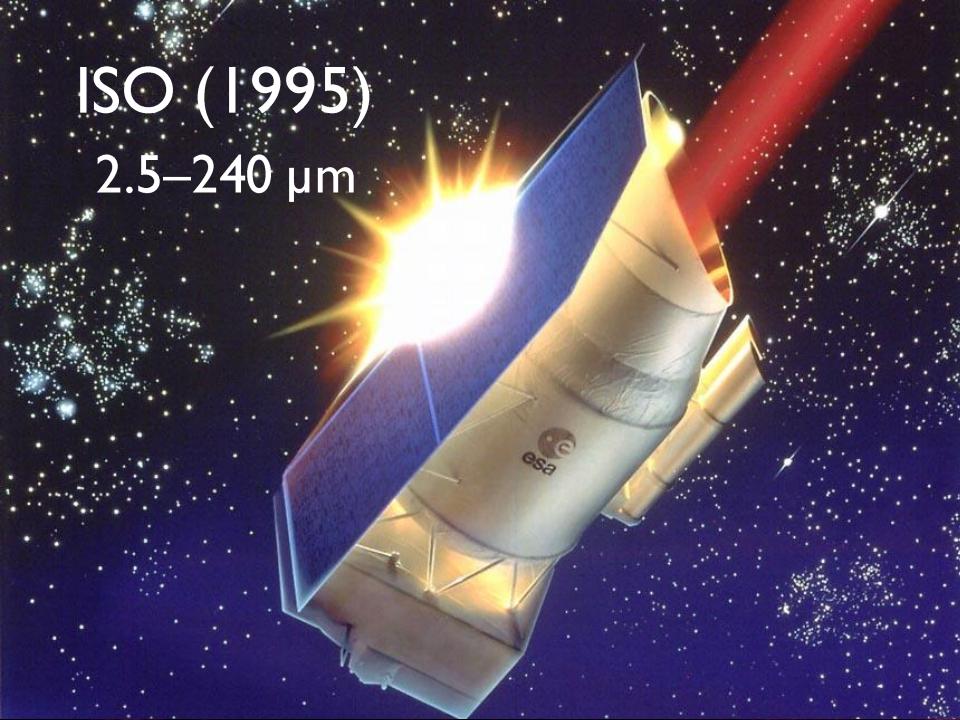
IRAS (1983)

12–100 μm



ISO (1995)

2.5–240 μm



Akari (2006)

9–160 μm



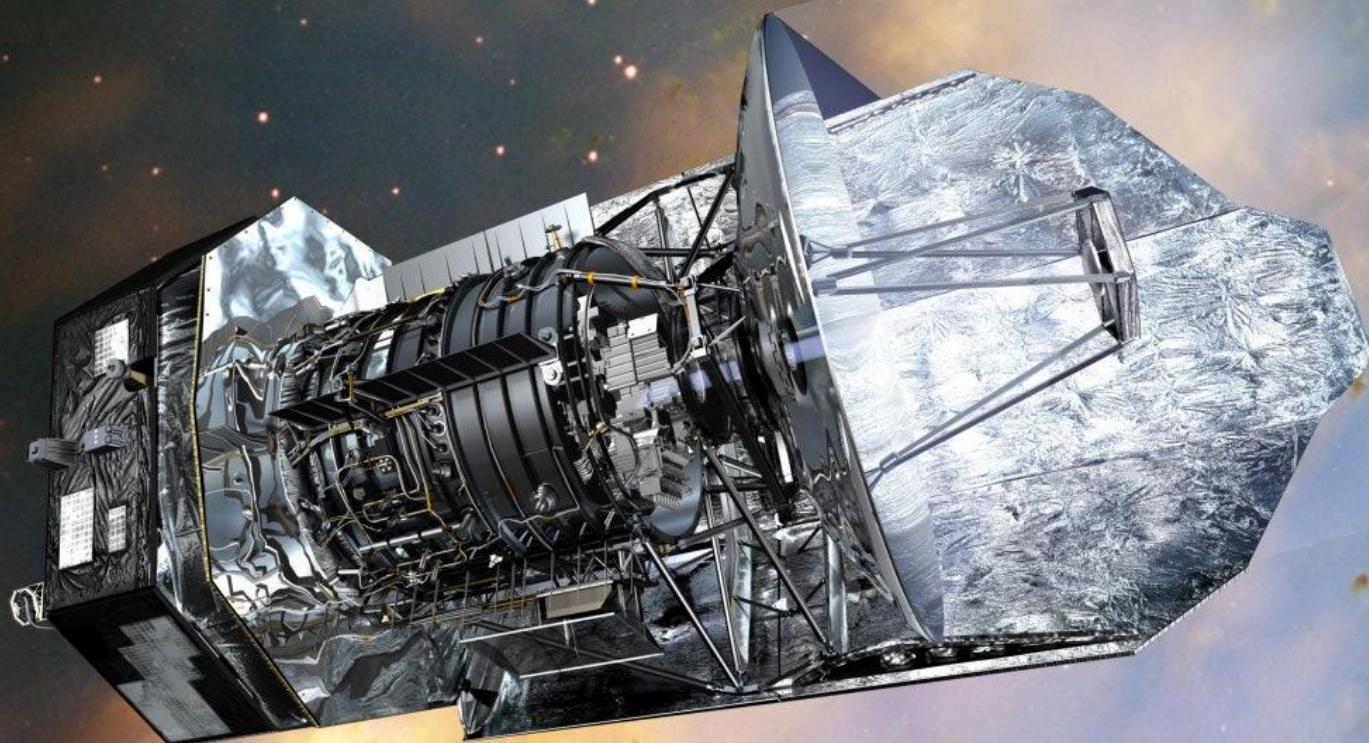
Spitzer (2003)

3.6–160 μm

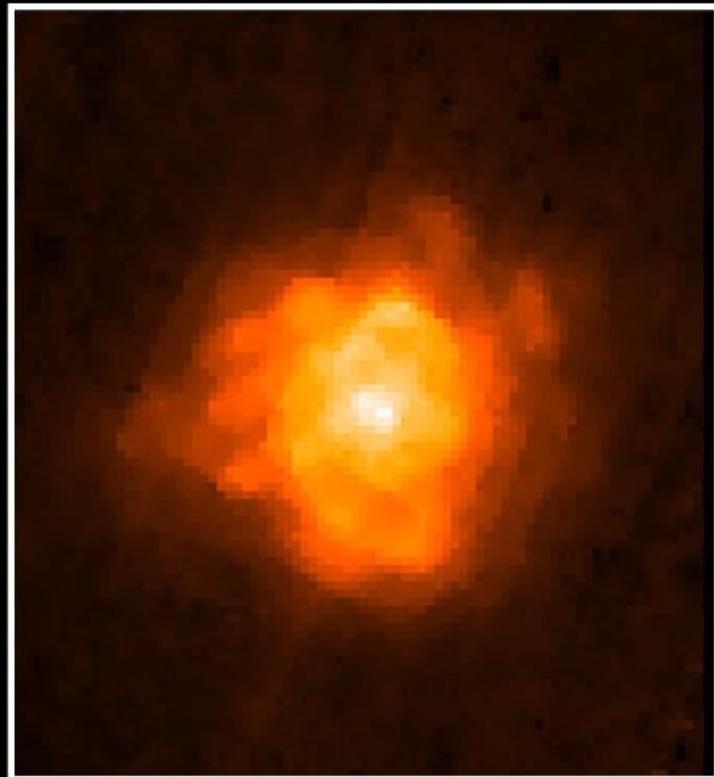


Herschel (2009–2013)

52–670 μm

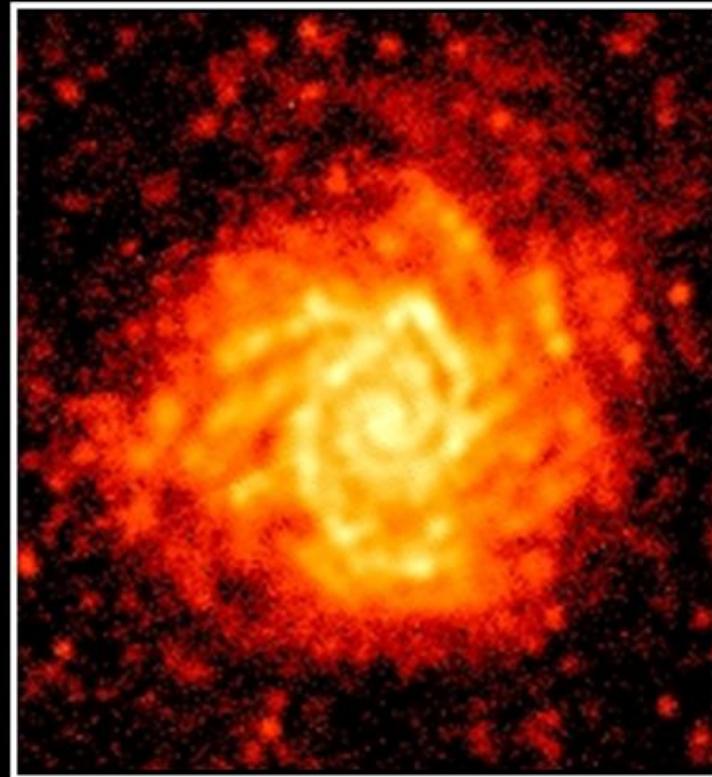


M74 *Spitzer* 160 μ m



NASA / *Spitzer* SINGS

M74 SPIRE 250 μ m



ESA and the SPIRE Consortium

Chris Clark

Previous Surveys of Dust in Galaxies

SINGS

Spitzer Infrared Nearby Galaxy Survey

SLUGS

SCUBA Local Universe Galaxy Survey

KINGFISH

Key Insights on Nearby Galaxies Far-Infrared Survey with *Herschel*

HRS

Herschel Reference Survey

IRAS

InfraRed Astronomical Satellite

Planck

Surprisingly, not an acronym

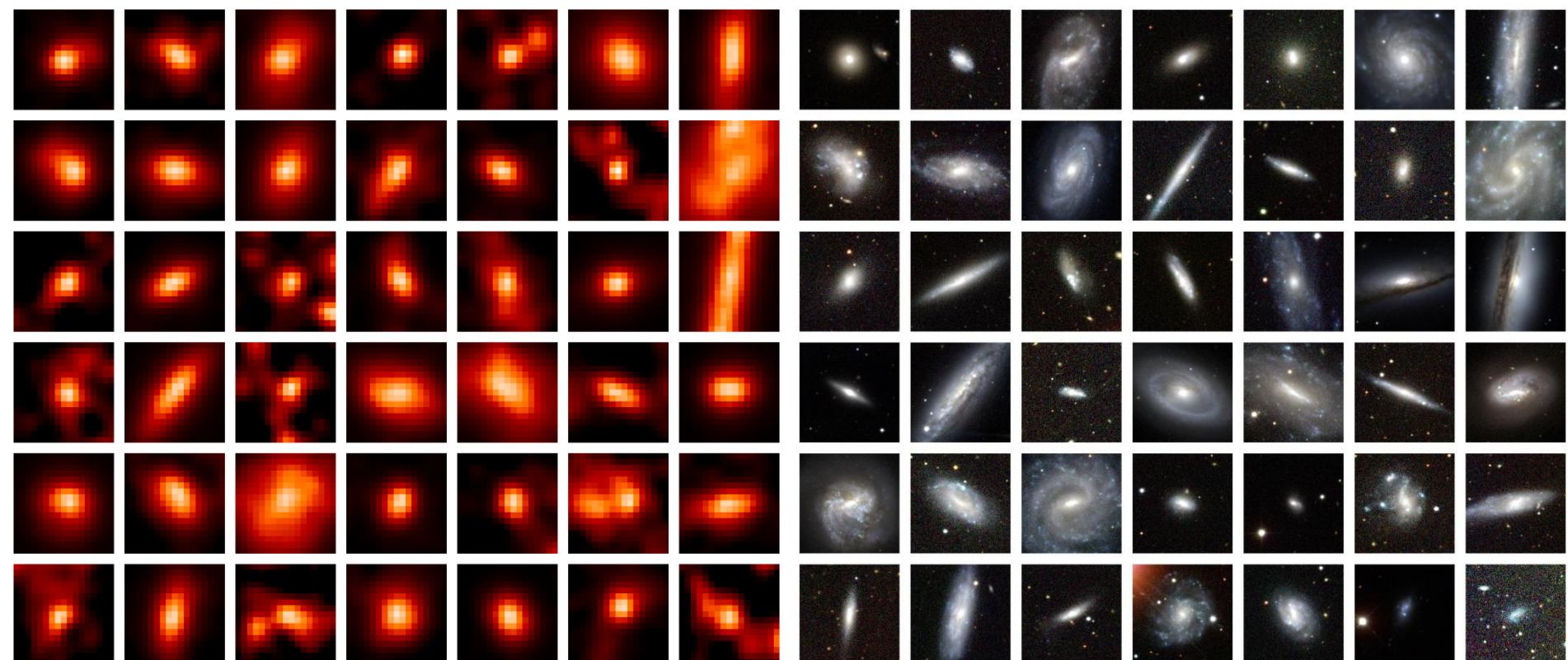
Chris Clark



Herschel Astrophysical Terahertz Large-Area Survey

Principal Investigators: Steve Eales & Loretta Dunne

A Dust-Selected Local Galaxy Sample



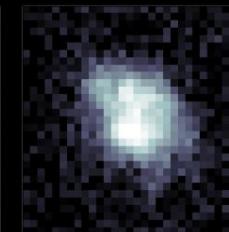
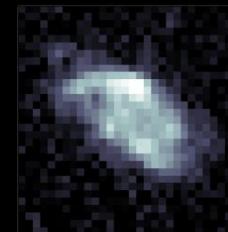
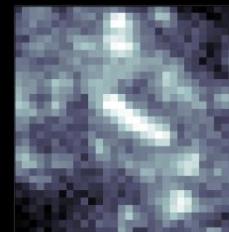
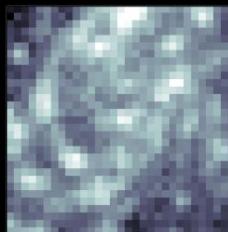
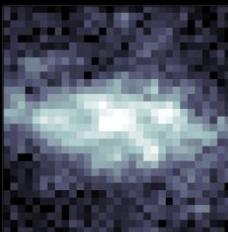
H-ATLAS 250 μm

SDSS *gri*-bands

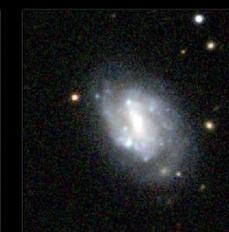
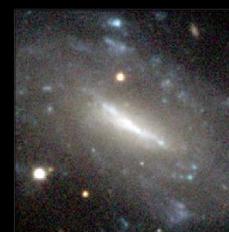
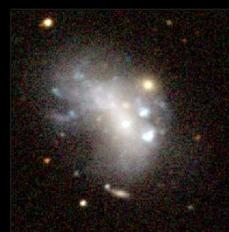
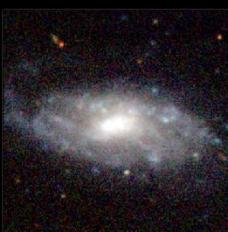
$15 < D < 46 \text{ Mpc}$

BADGRS: Blue And Dusty Gas Rich Sources

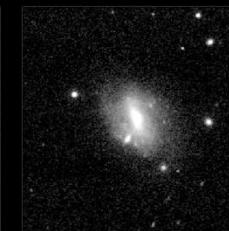
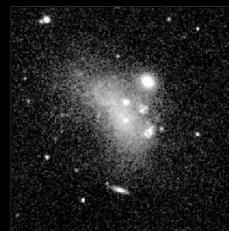
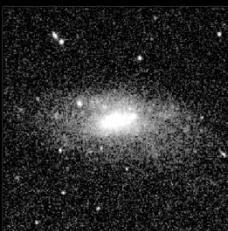
GALEX Far-UV



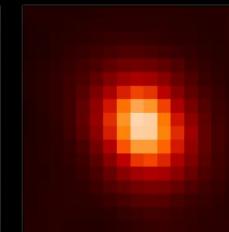
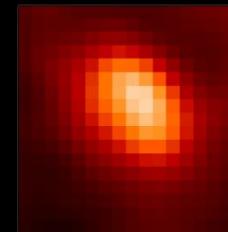
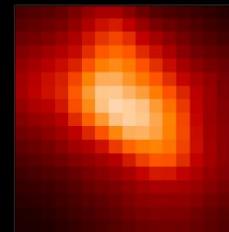
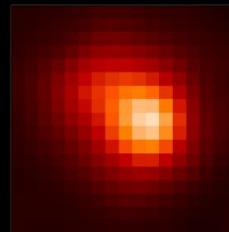
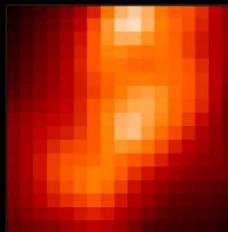
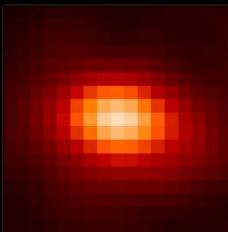
Optical SDSS *gri*



Near-IR VIKING K_s



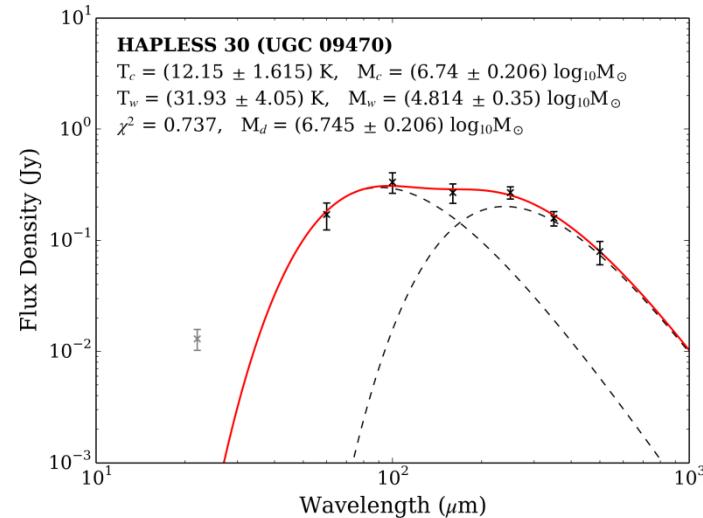
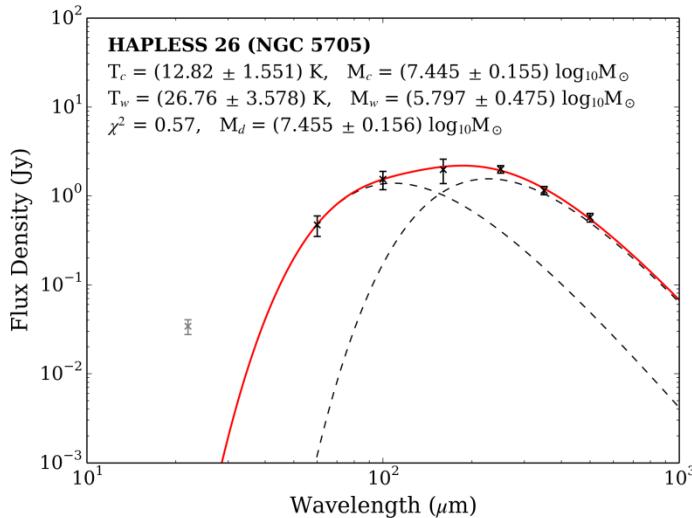
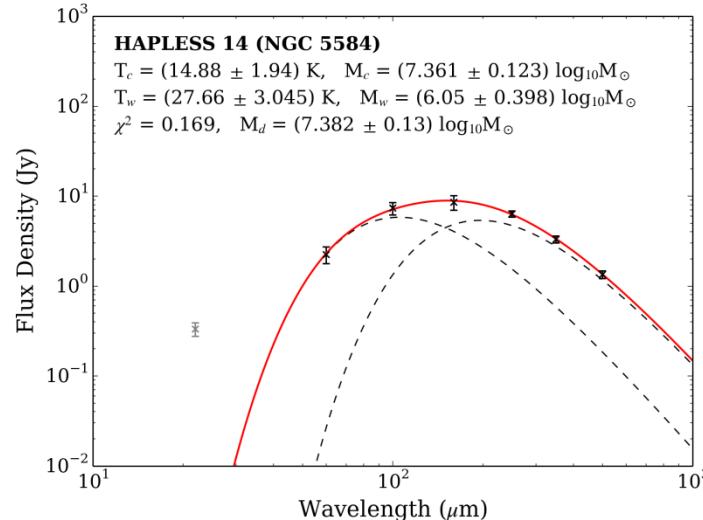
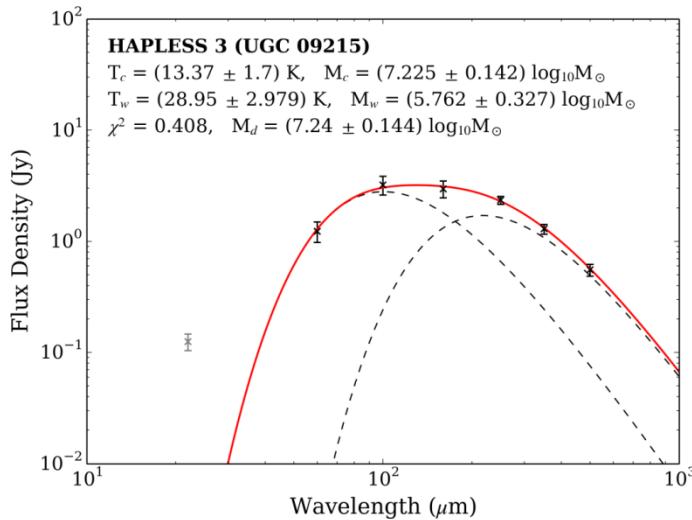
H -ATLAS 250 μ m



FUV- $K_s < 3.5$ _{AB}

Chris Clark

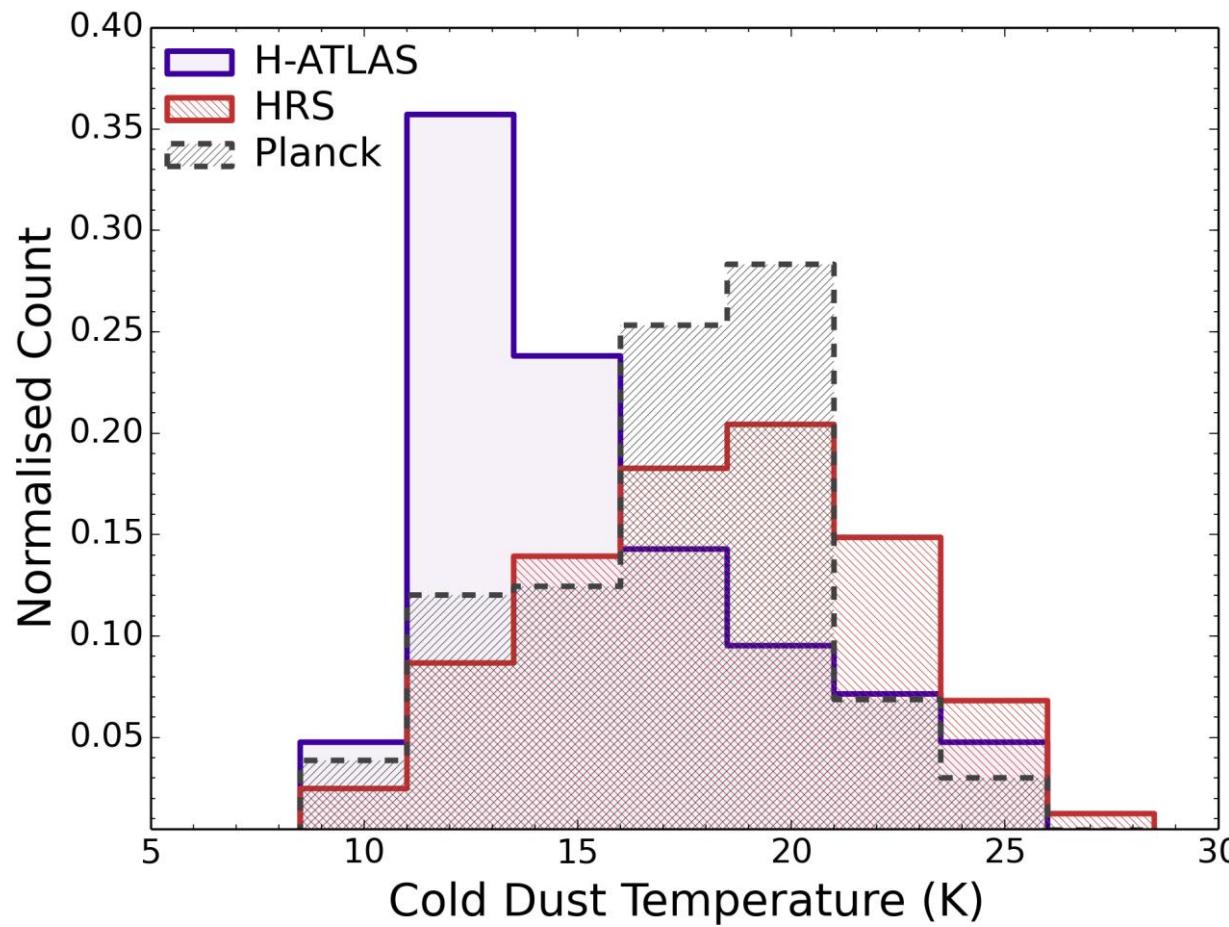
Dust SED Fitting



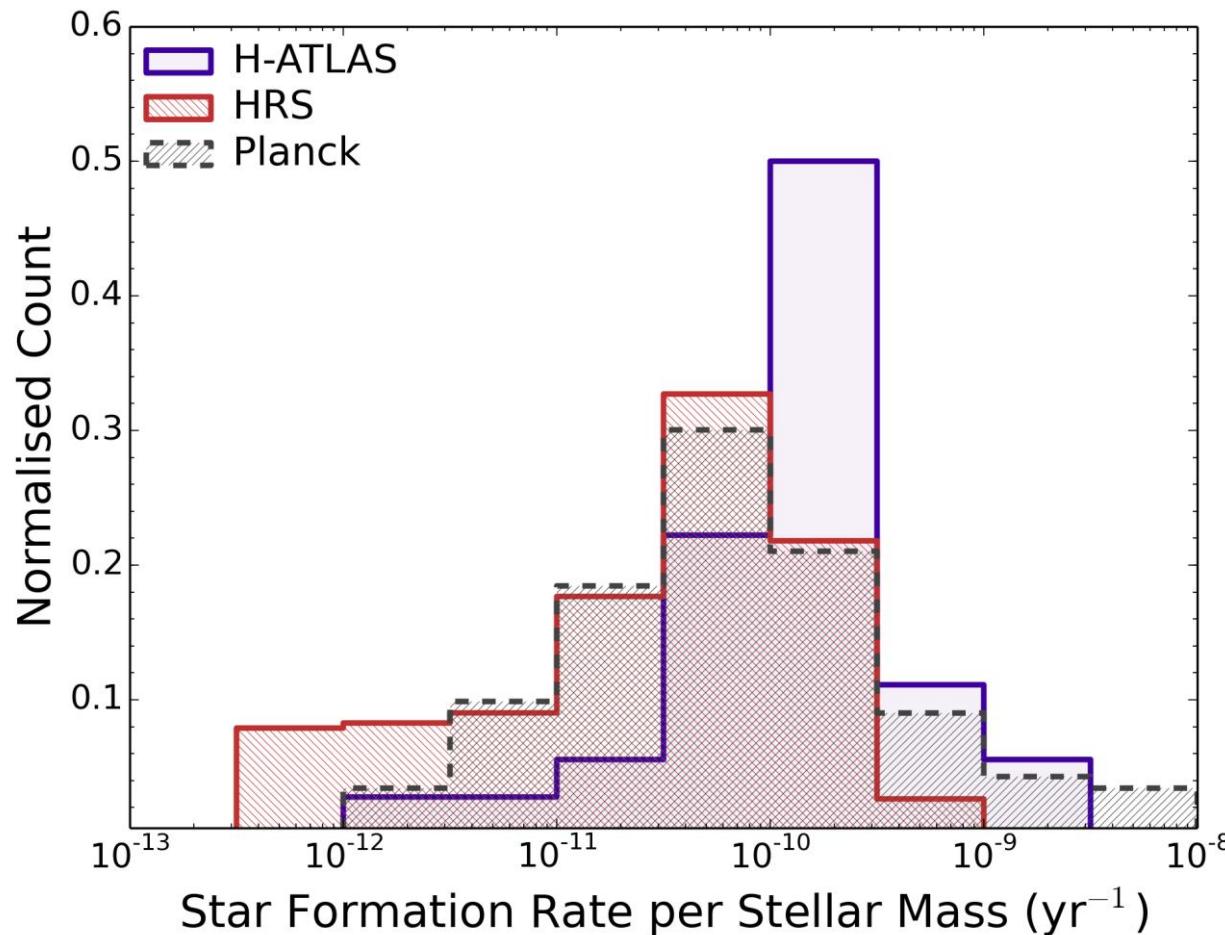
BADGR dust temperatures typically 11–16 K

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Previously Overlooked Cold Dust



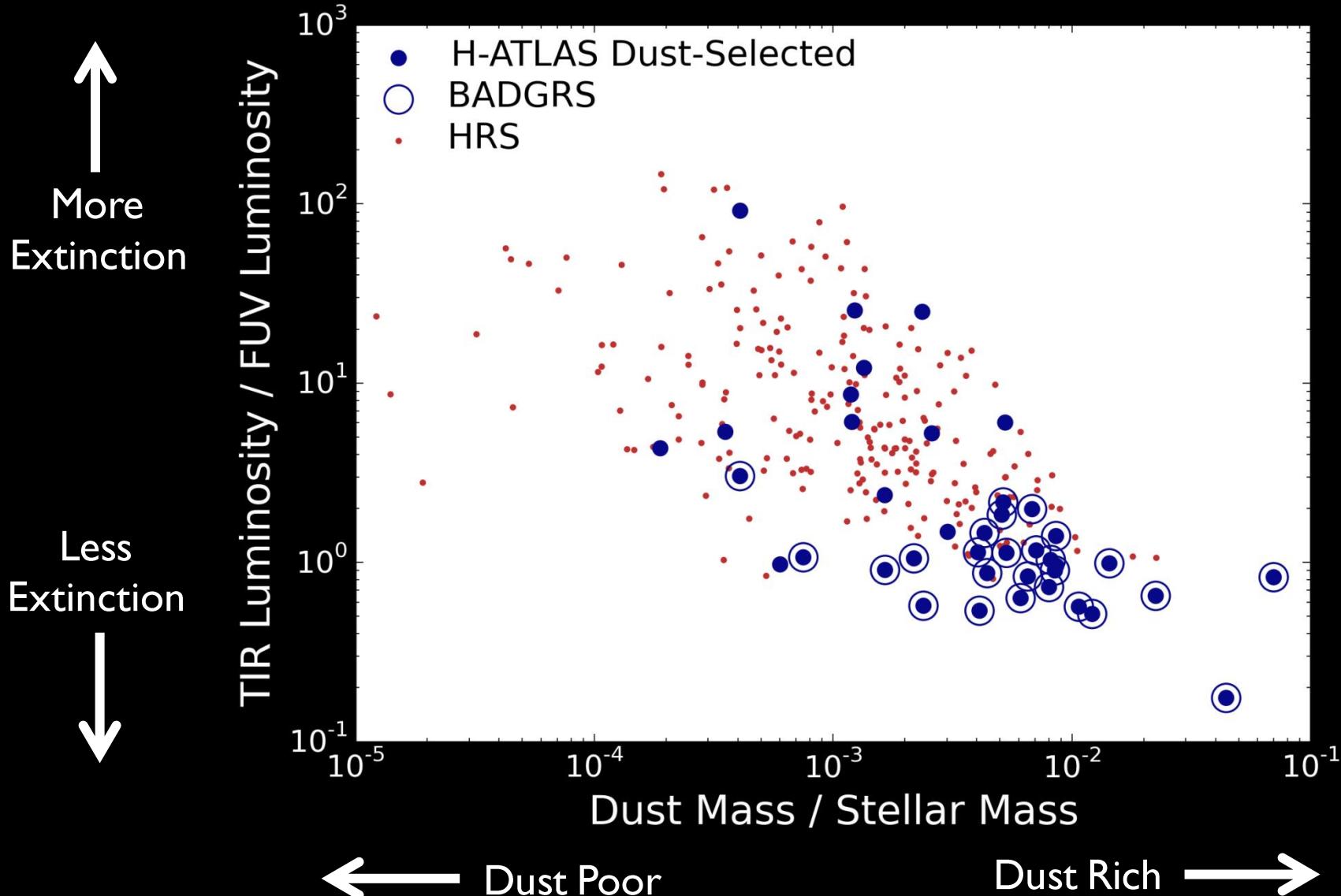
Cold Dust, But Lots Of Heating...?



Average SSFR of dust-selected *H*-ATLAS sample is 4–5 times higher than average of HRS or *Planck* samples

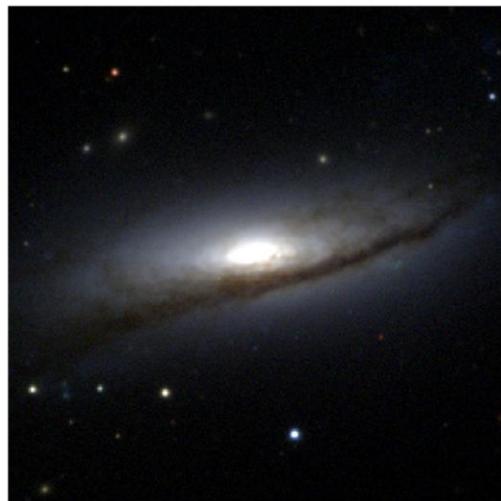
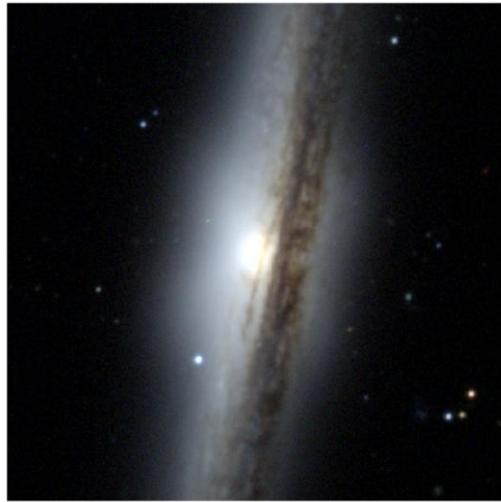
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Lots of Dust, Little Extinction

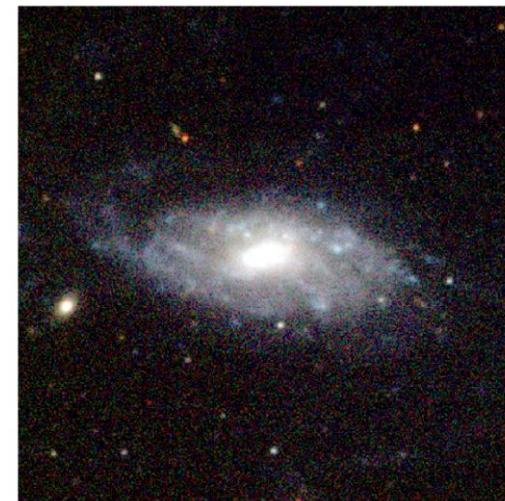
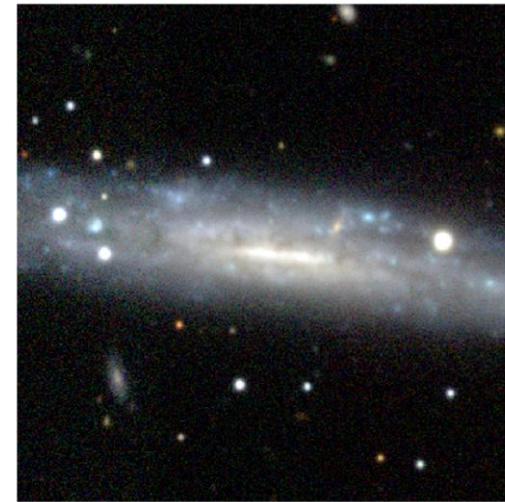


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Dust Lanes \neq Dust Rich

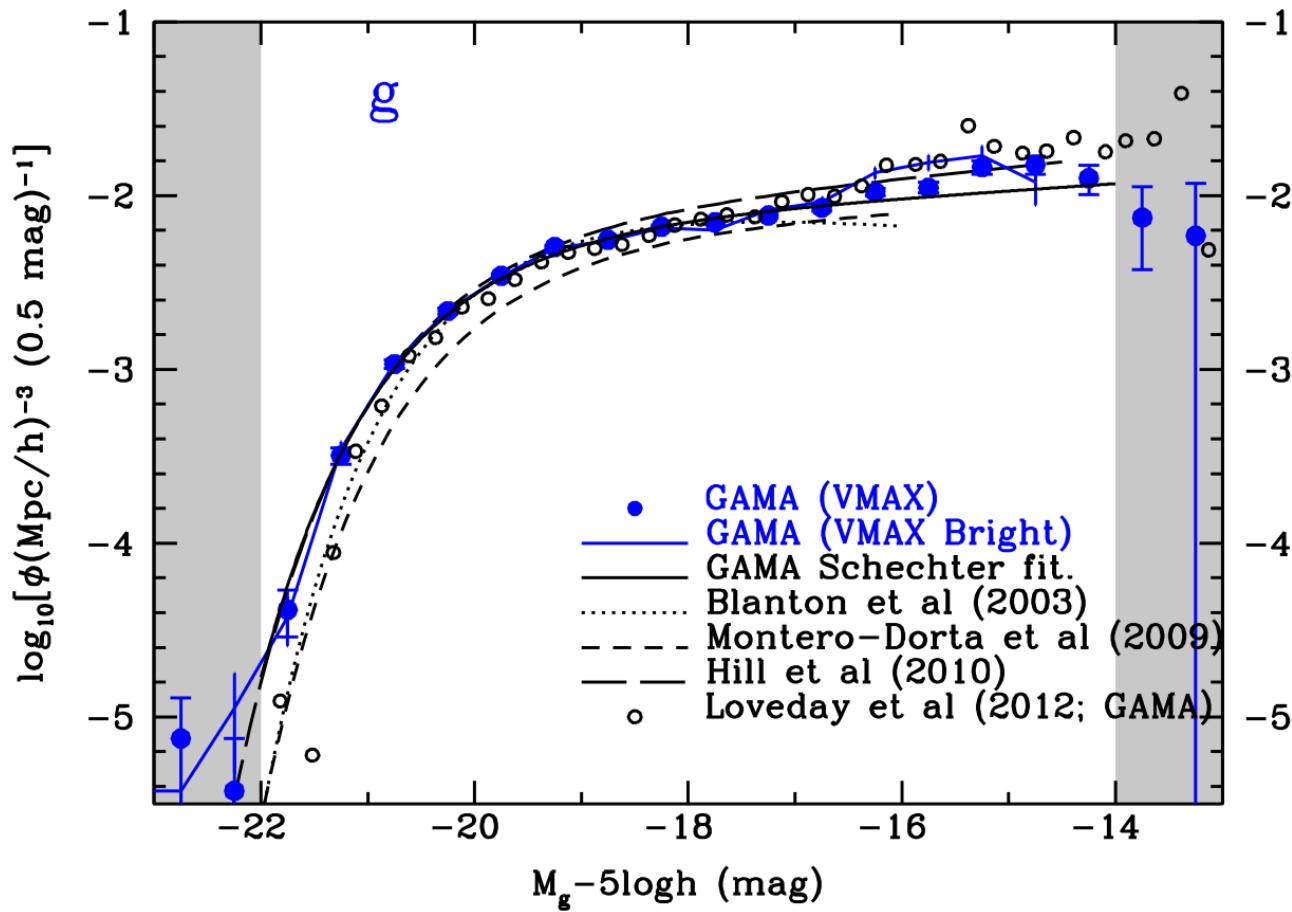


$M_D/M_S \sim 0.0005$



$M_D/M_S \sim 0.01$

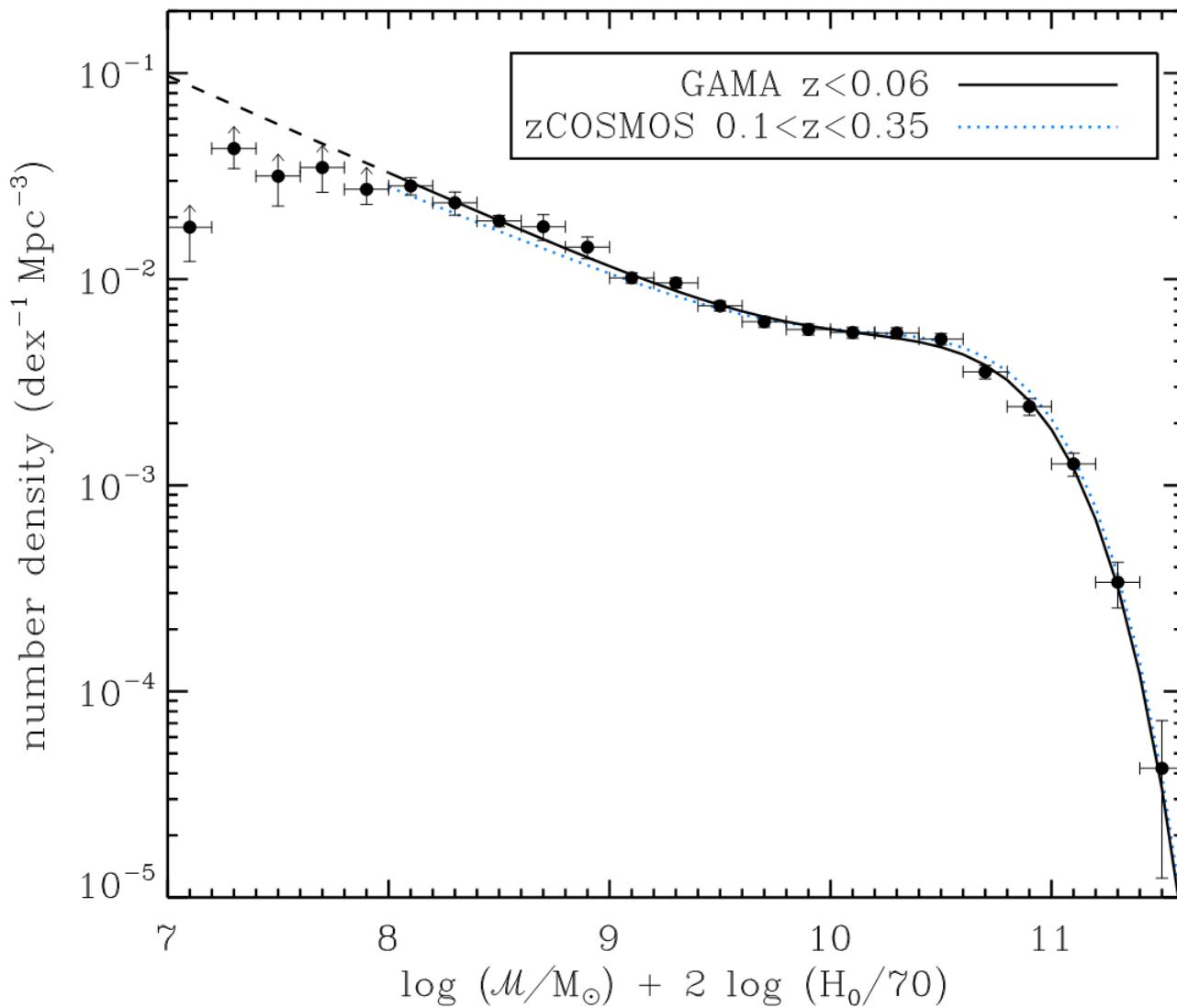
Luminosity Functions...



$$\phi = \phi^* \left(\frac{L}{L^*} \right)^\alpha e^{-\frac{L}{L^*}}$$

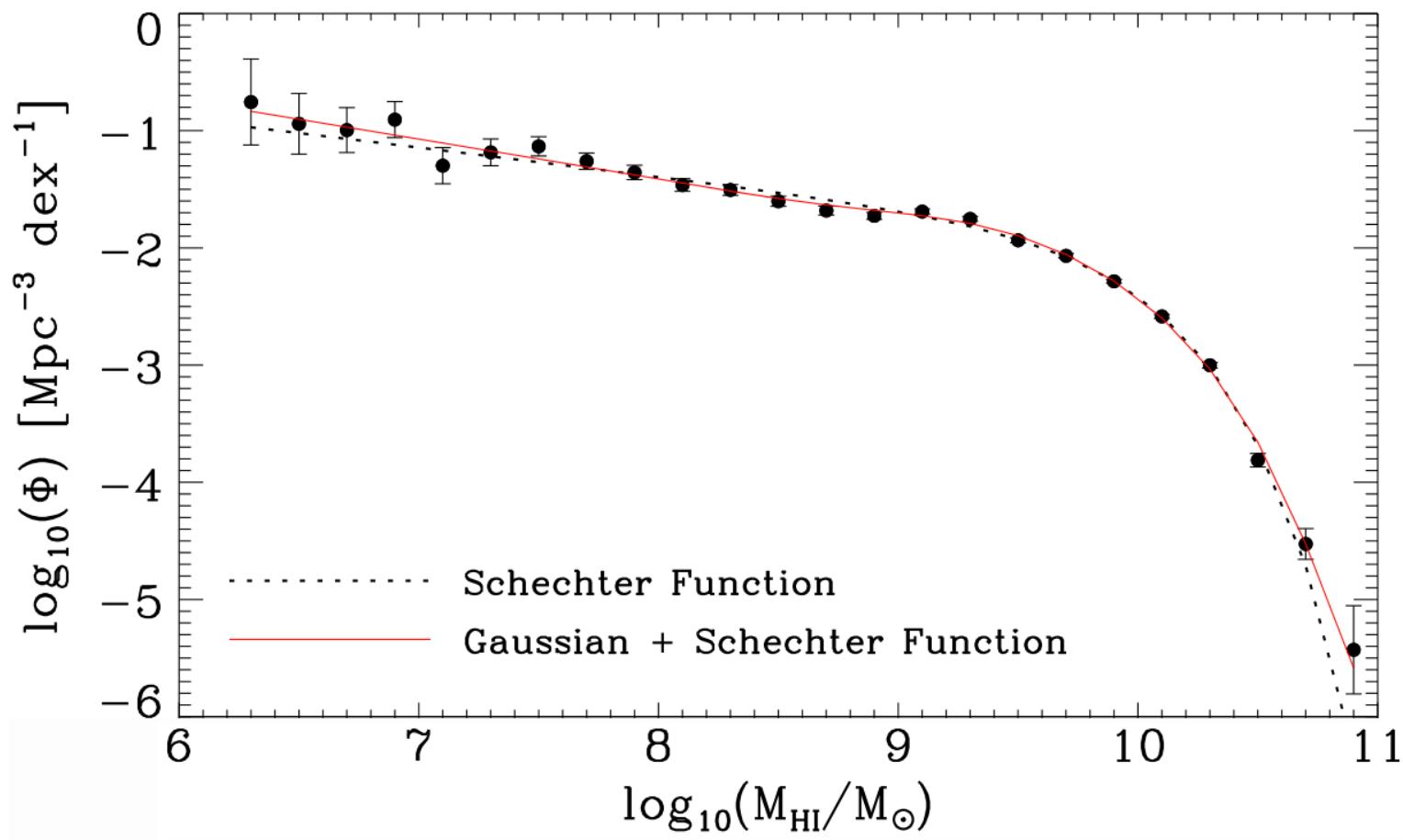
From Loveday et al (2012)

...And Stellar Mass Functions...



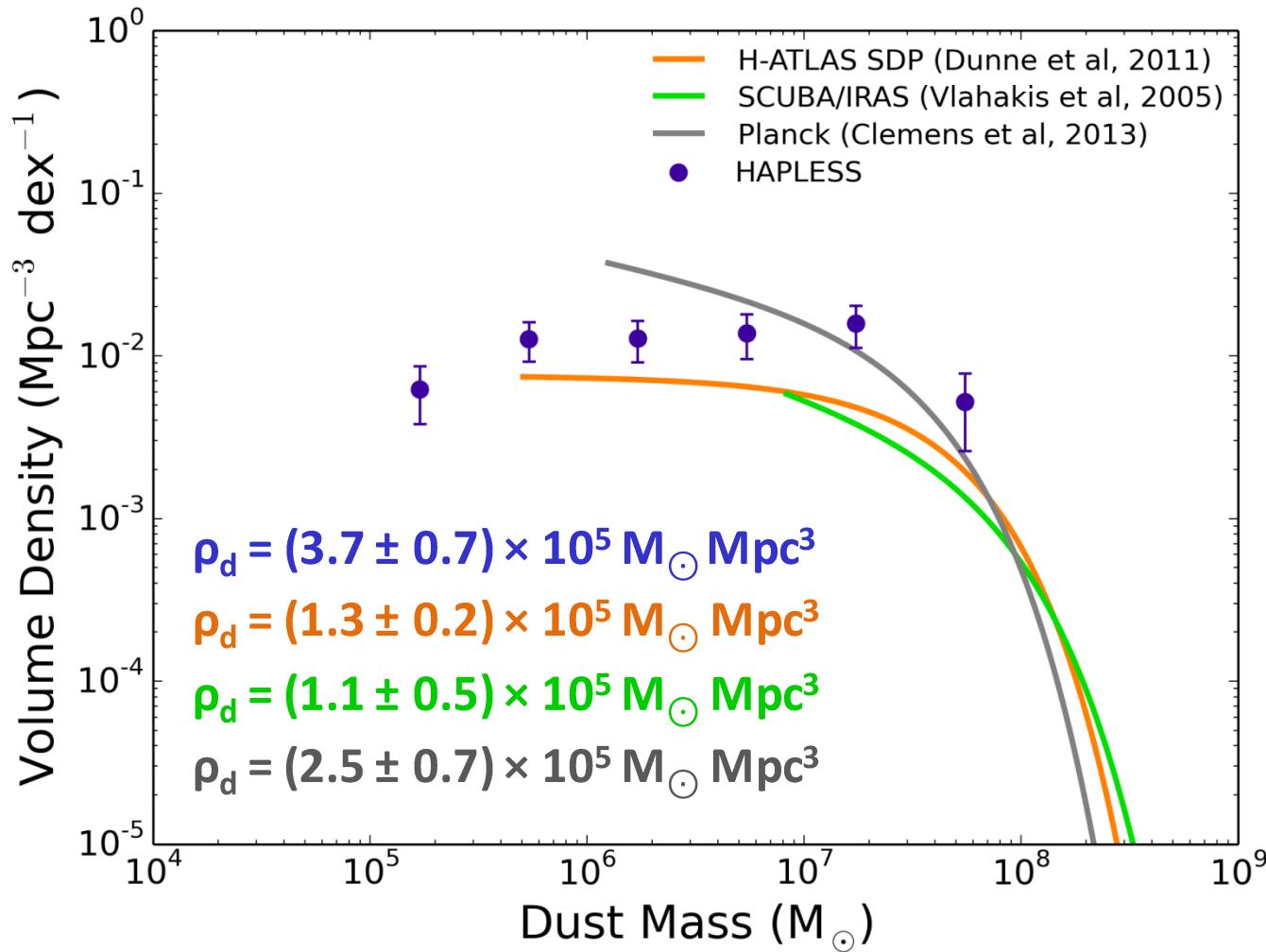
From Baldry et al (2012)

...And HI Mass Functions...



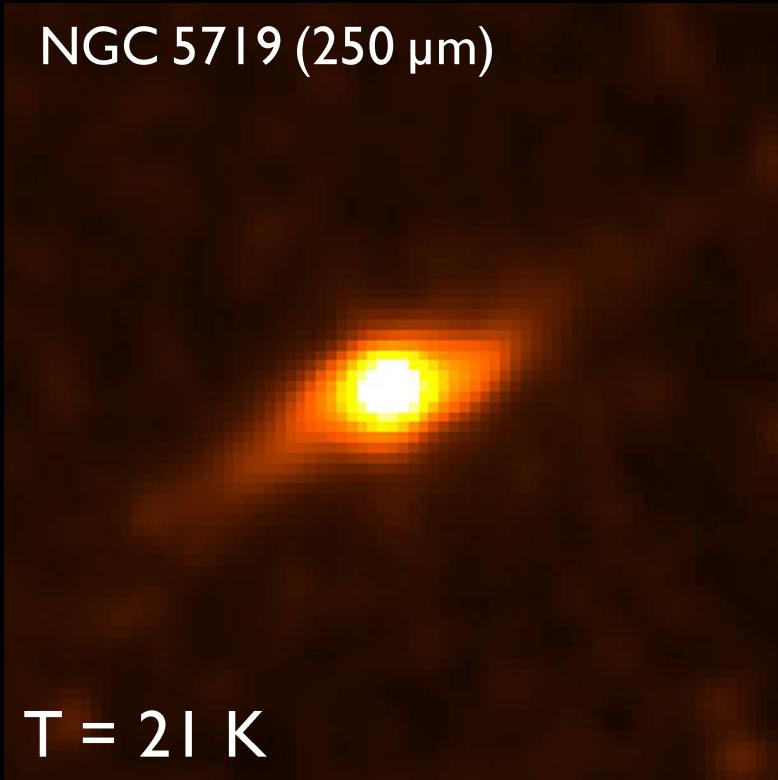
From Martin et al (2014)

The Dust Mass Function



Cold & Very Faint

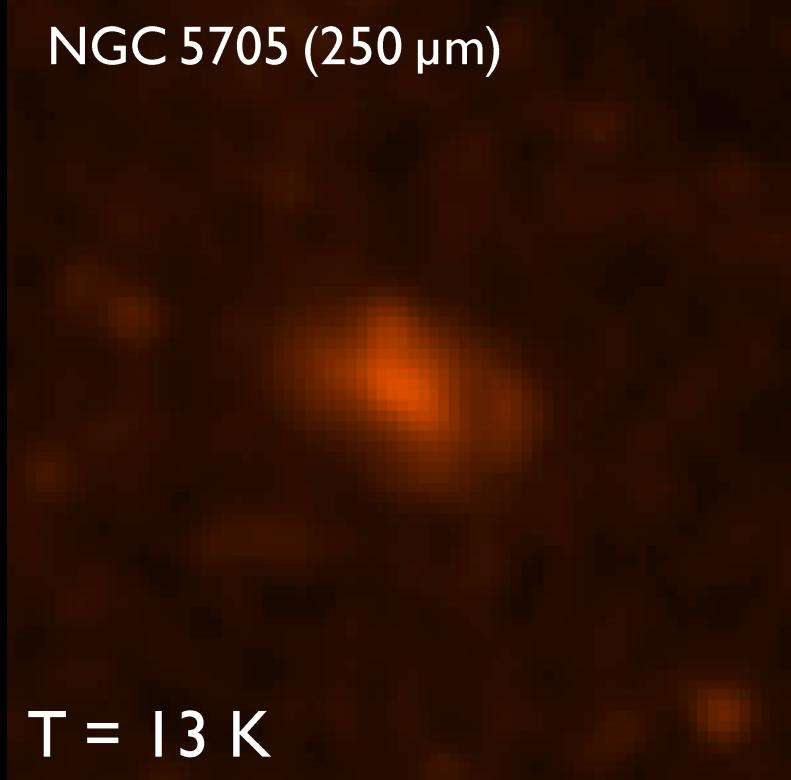
NGC 5719 (250 μm)



$T = 21 \text{ K}$

“Normal” galaxy

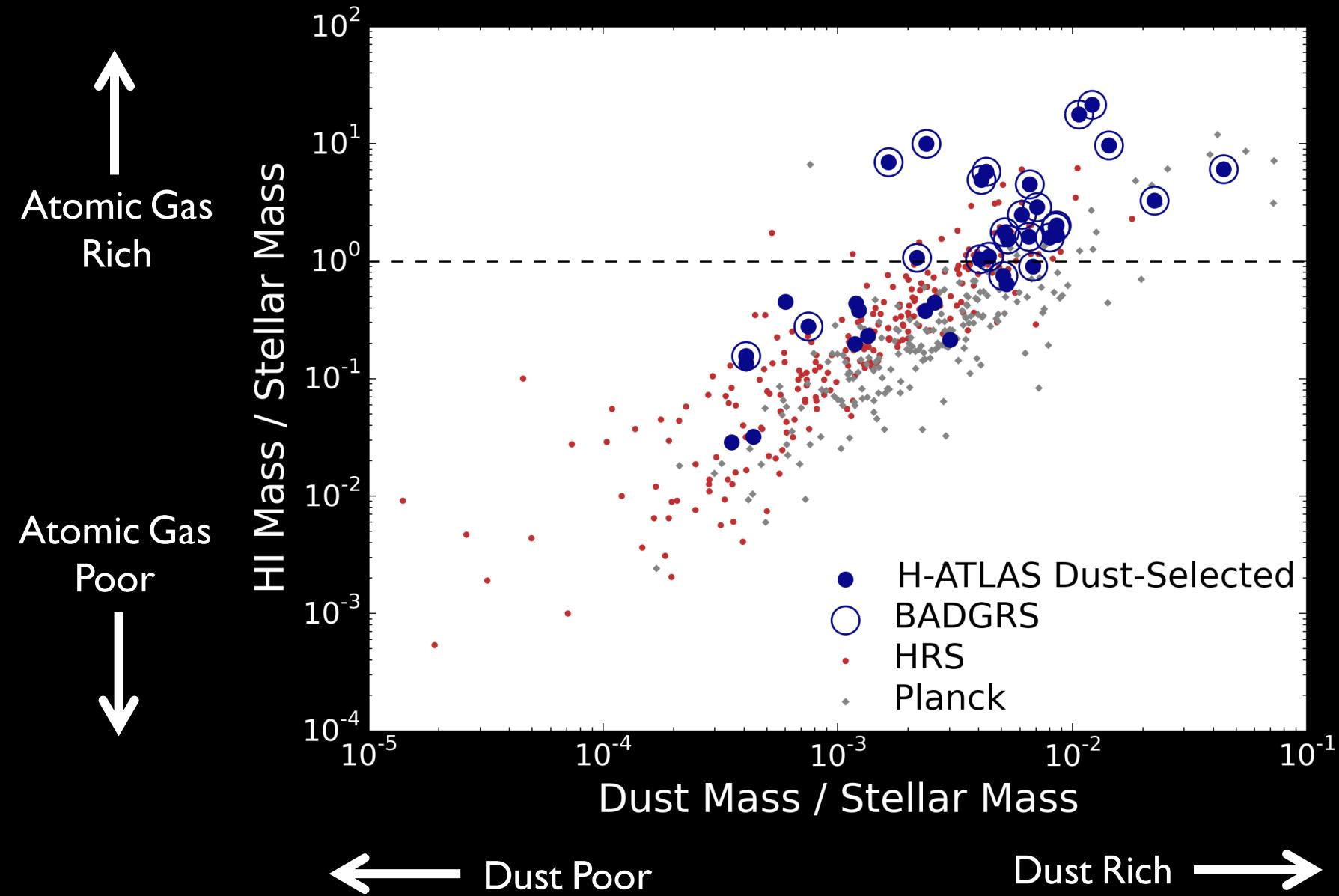
NGC 5705 (250 μm)



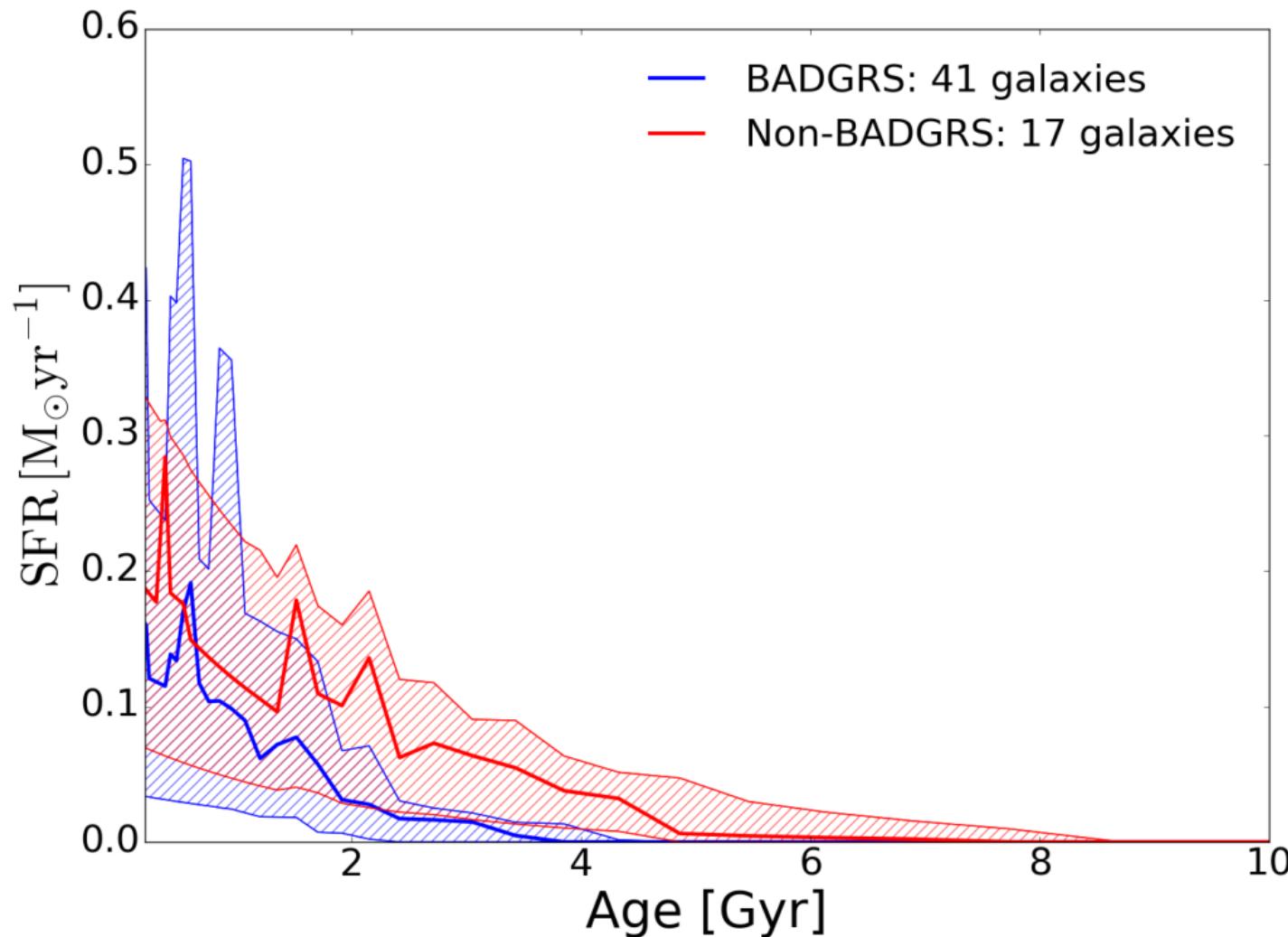
$T = 13 \text{ K}$

BADGR
Blue And Dusty Gas Rich source

Dust-Rich and Gas-Rich



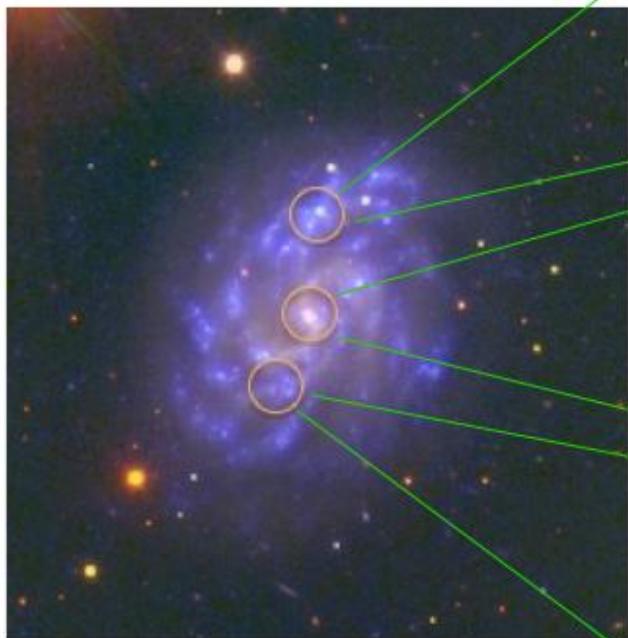
Star Formation Histories of BADGRS



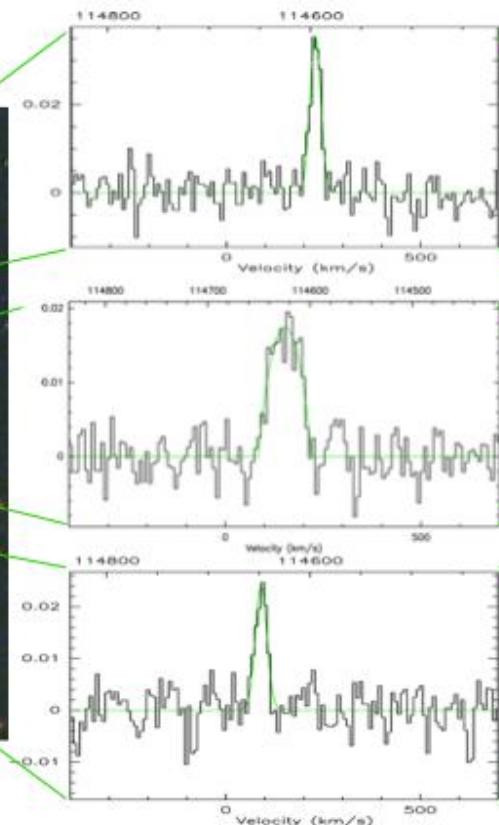
By Simon Schofield

The Highly Unusual ISM of BADGRS

Blue And Dusty
Gas Rich Sources



frZ-bands



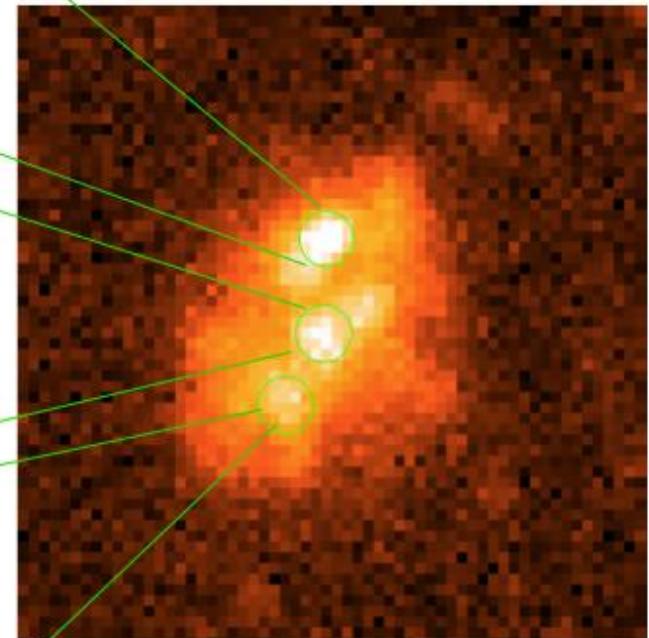
IRAM CO(1-0)

$$I_{CO} = 0.2 - 2 \text{ K km s}^{-1}$$

$$\text{FWHM} = 30 - 100 \text{ km s}^{-1}$$

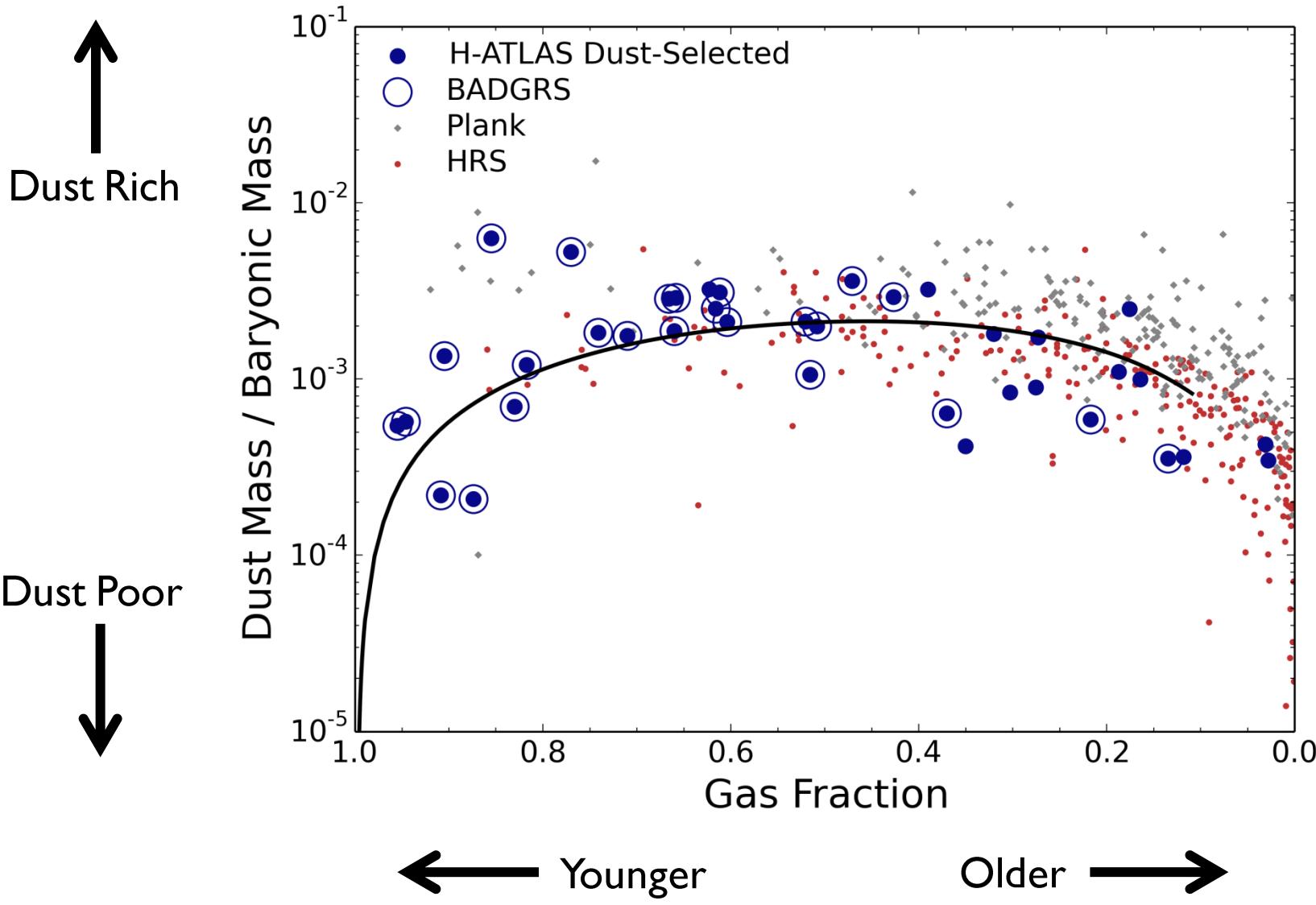
$$M_{H_2}/M_d = 2 - 27 \text{ (MW } X_{CO})$$

$$Z = 0.5 - 1 Z_\odot$$



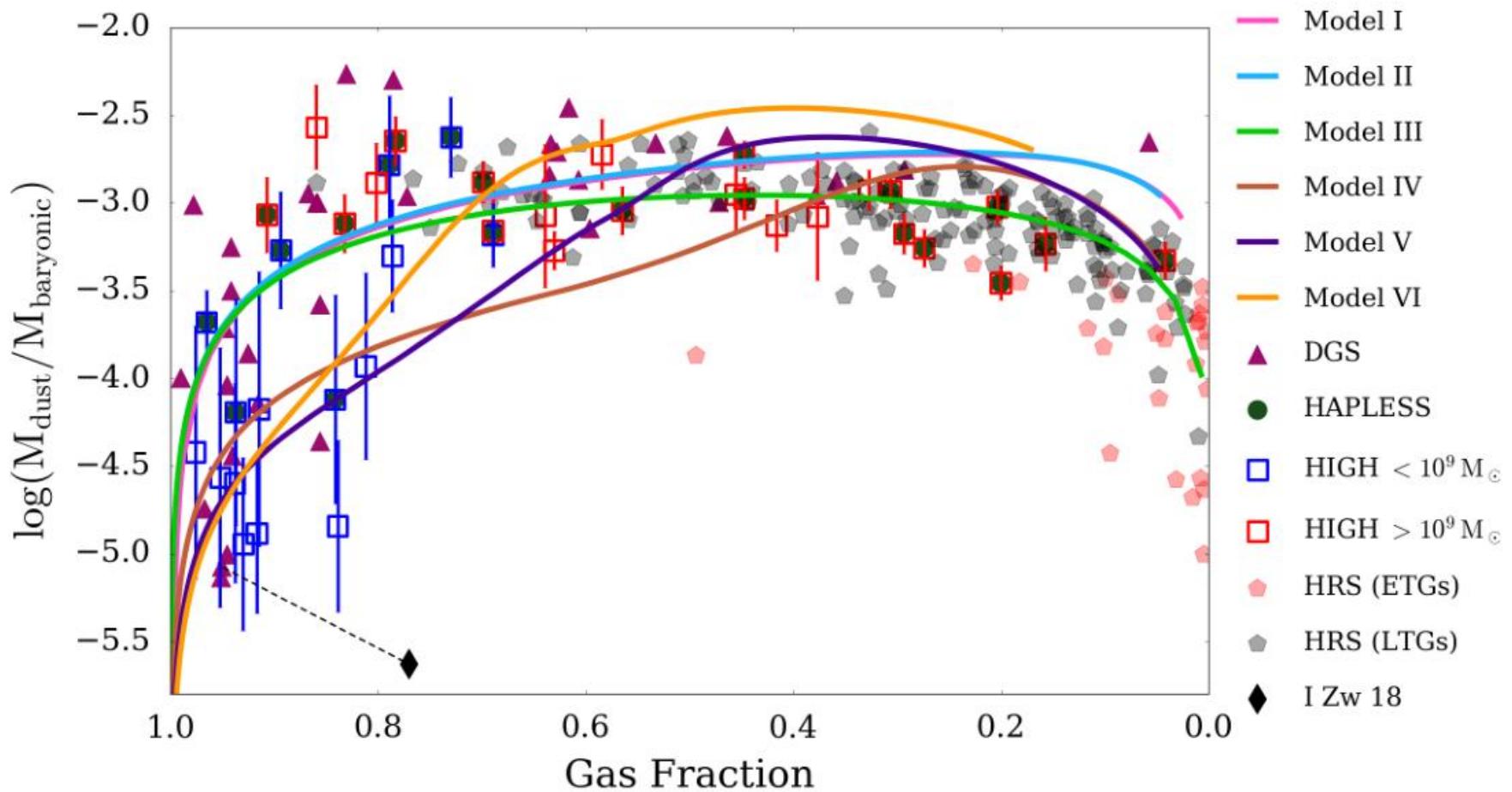
H-ATLAS 250 μm

A Dusty Window On Young Galaxies



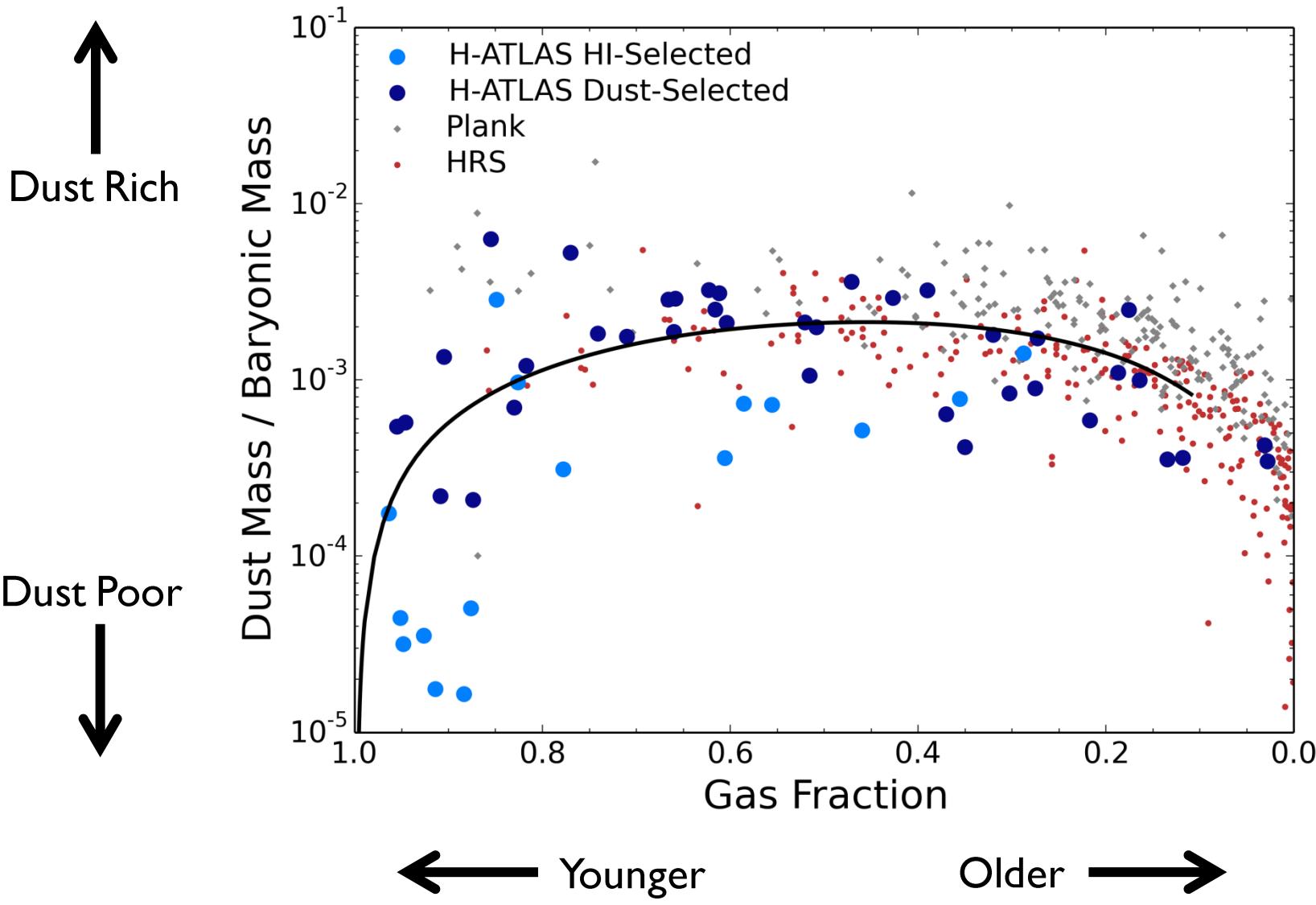
Chris Clark

Chemical Evolution in Action



By Simon Schofield

Extremely Young, Dust-Poor Galaxies



Part II - Key Results

- A dust-selected nearby galaxy survey with *Herschel-ATLAS* reveals that very blue ($\text{FUV-K}_S < 3.5$) irregular/flocculent galaxies dominate the local dusty universe.
- These **B**lue **A**nd **D**usty **G**as **R**ich **S**ources – **BADGRS** – have been severely under-sampled by previous surveys. They account for 5% of the stellar mass, 35% of the dust mass, and 50% of the HI mass in our dust-selected sample.
- The more dust-rich a galaxy, the less UV absorption occurs; hence the BADGRS have very cold dust temperatures of 11–16 K.
- The BADGRS appear to be in an intermediate stage of evolution; they contain more HI than stars, but have processed a lot of raw material into dust very quickly.