Dust heating sources in galaxies

—

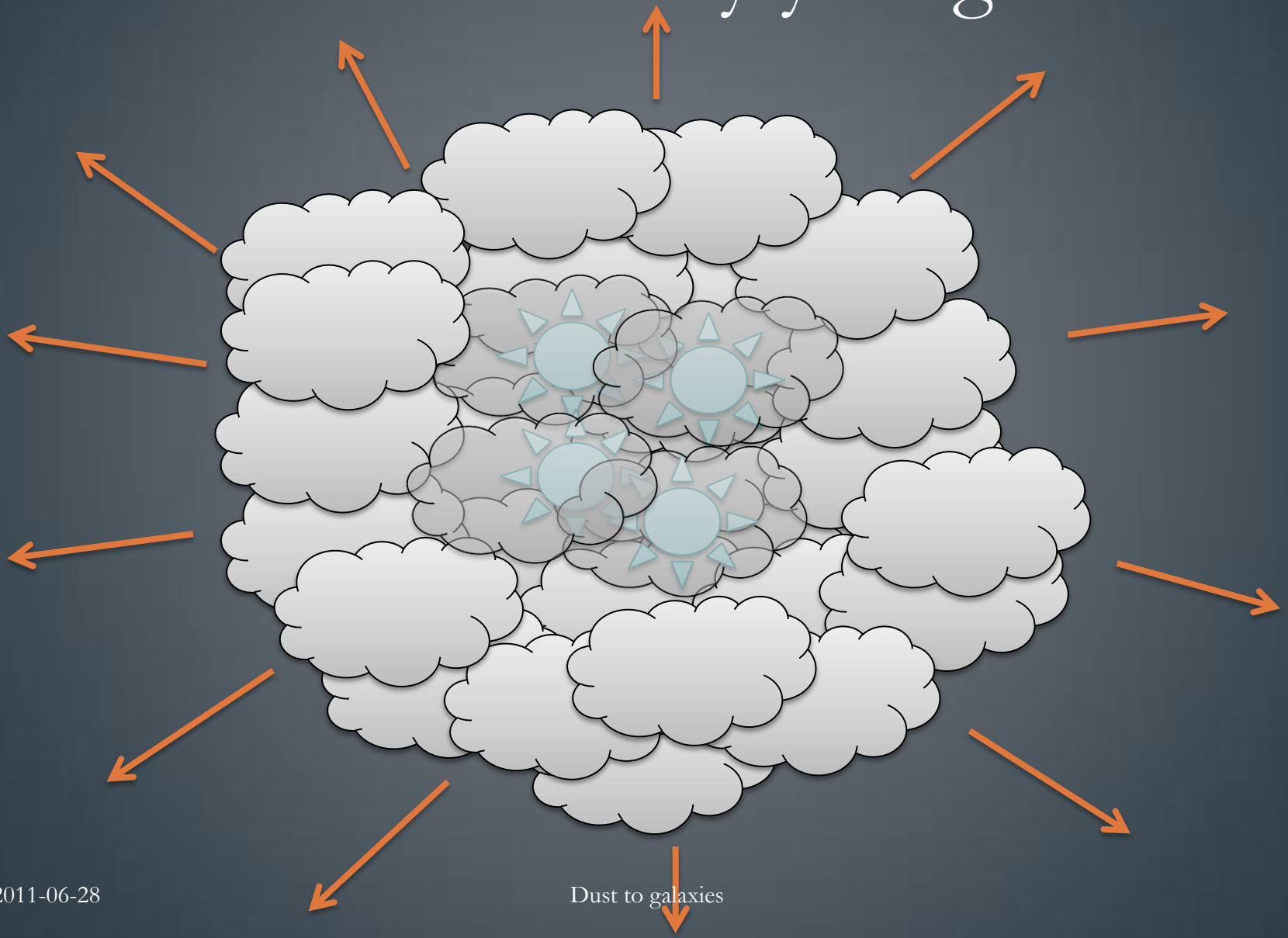
The case of M33

(Boquien et al. 2011a, submitted to AJ)

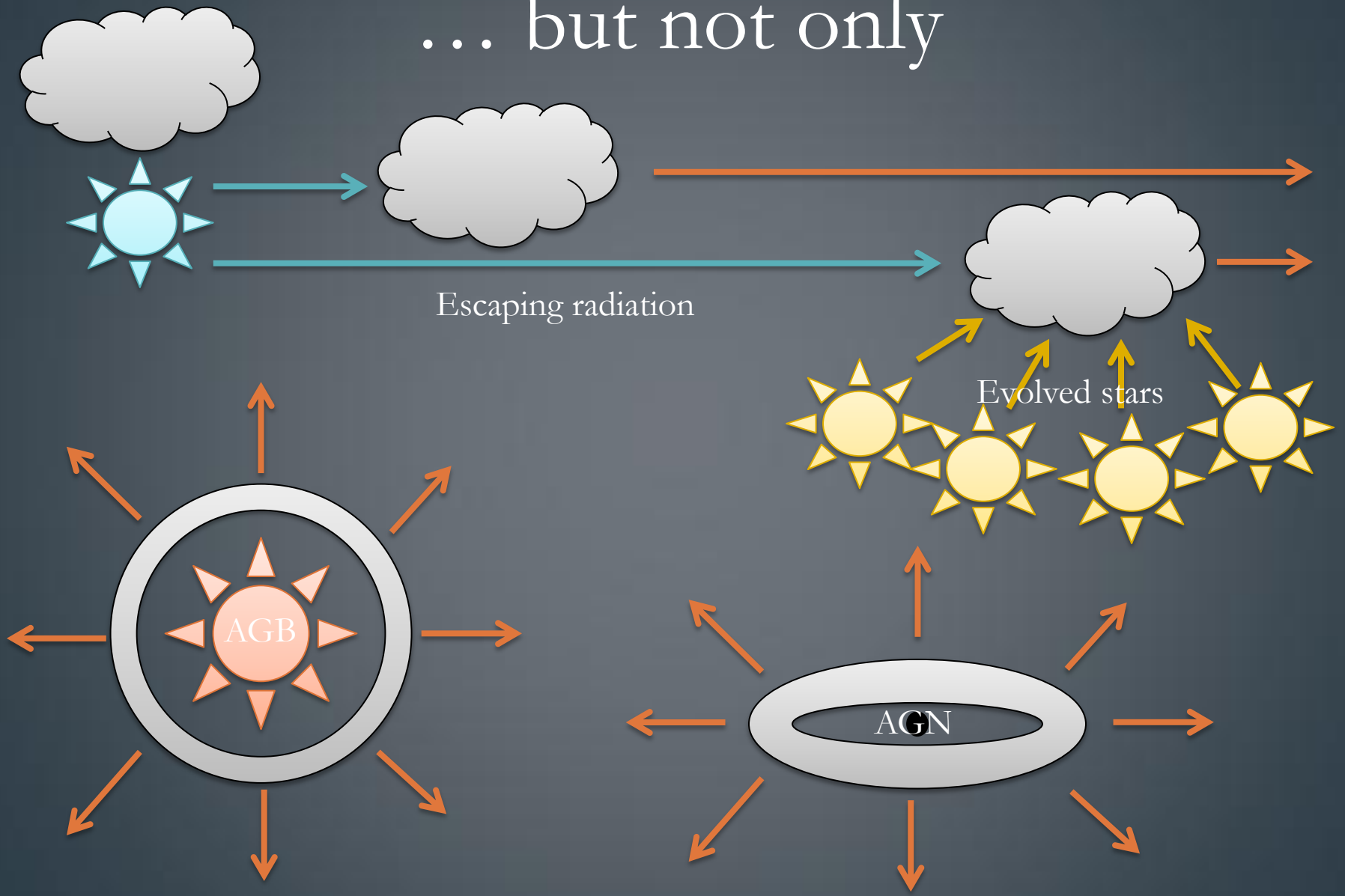
Médéric Boquien
Laboratoire d'astrophysique de Marseille (France)
University of Massachusetts at Amherst (USA)

In collaboration with *D. Calzetti* (UMass), F. Combes (Paris), *C. Kramer* (IRAM, HERM33ES PI), C. Henkel (Bonn), F. Israel (Leiden), M. Relaño (Grenada), S. Verley (Grenada), P. van der Werf (Leiden), M. Xilouris (Athens) & the HERM33ES team

The dust is heated by young stars …



… but not only



The FIR is key to understand galaxy formation and evolution …

- Traces the gaseous content of galaxies
- Traces star formation

} KS law

  - Main assumptions
    - infinite opacity
    - young stellar populations dominate the radiation field
  - Filled for (U)LIRGs. Not so much in quiescent star-forming galaxies.
  - We need to understand what actually heats the dust!

The FIR is key to understand galaxy formation and evolution …

- Traces the gaseous content of galaxies
- Traces star f

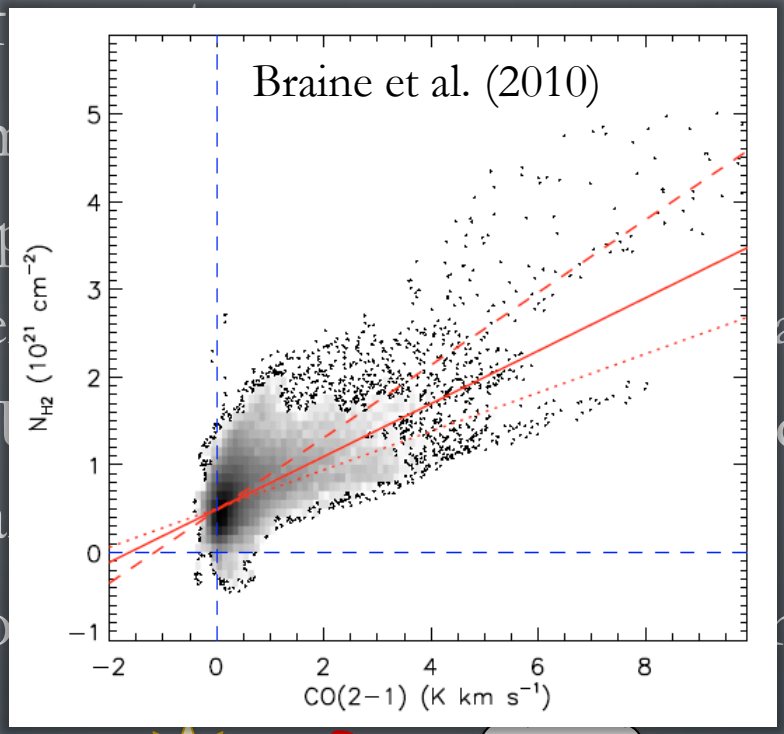
} KS law

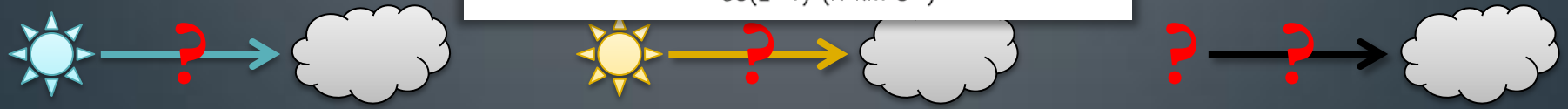
  - Main assun
    - infinite op
    - young ste
  - Filled for (U
    forming ga
  - We need to

adiation field

quiescent star-

heats the dust!





The FIR is key to understand galaxy formation and evolution …

- Traces the gaseous content of galaxies
- Traces star formation

} KS law

  - Main assumptions
    - infinite opacity
    - young stellar populations dominate the radiation field
  - Filled for (U)LIRGs. Not so much in quiescent star-forming galaxies.
  - We need to understand what actually heats the dust!

The FIR is key to understand galaxy formation and evolution …

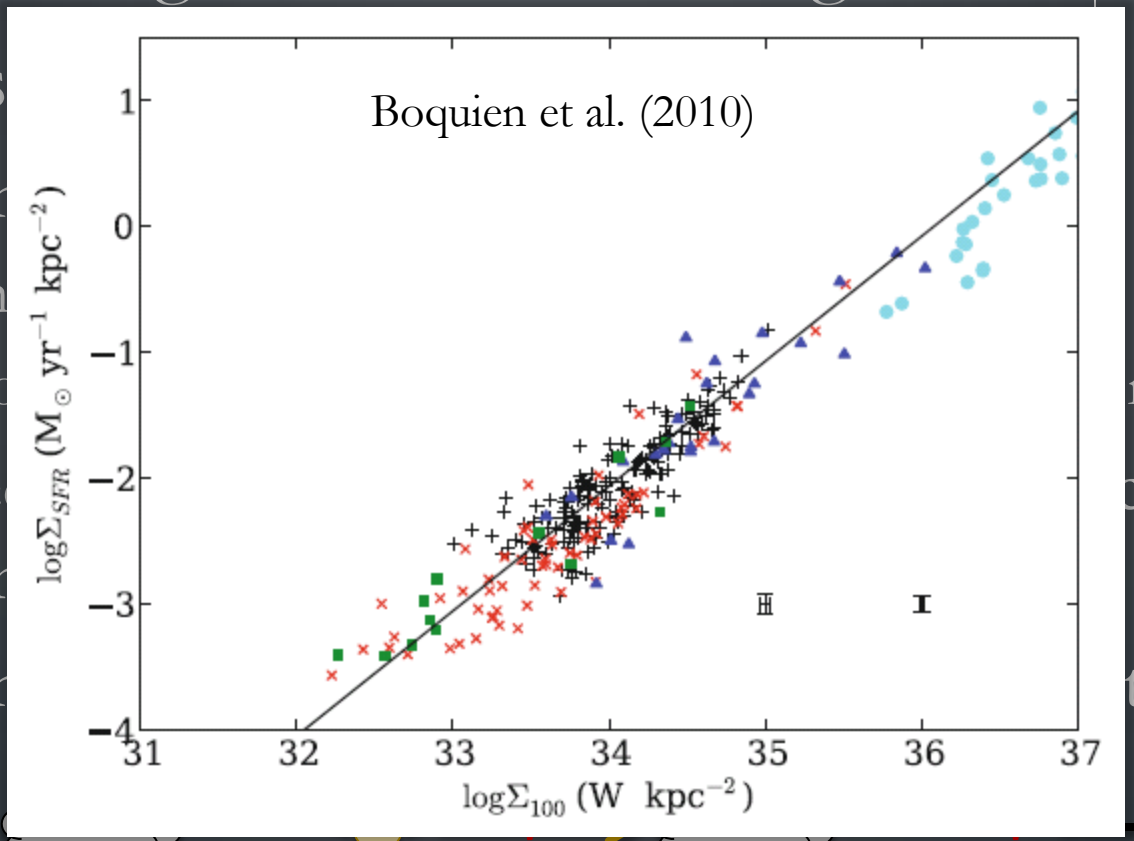
- Traces the gaseous content of galaxies
- Traces
  - Mai
    - in
    - yo
  - Fille
    form
  - We r

KS law

n field

cent star-

the dust!



The FIR is key to understand galaxy formation and evolution …

- Traces the gaseous content of galaxies
- Traces star formation

} KS law

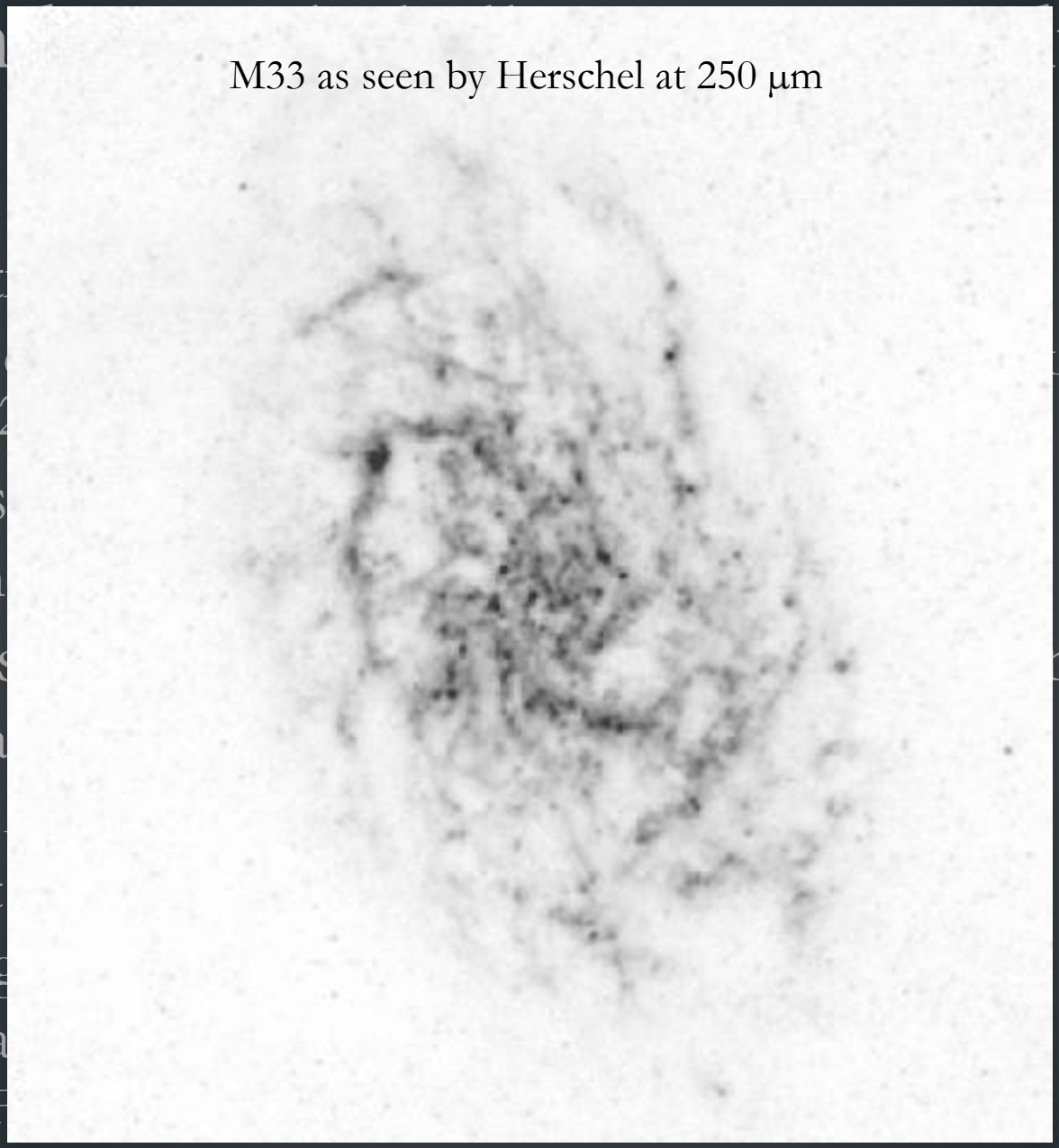
  - Main assumptions
    - infinite opacity
    - young stellar populations dominate the radiation field
  - Filled for (U)LIRGs. Not so much in quiescent star-forming galaxies.
  - We need to understand what actually heats the dust!

… and Herschel allows us to study dust heating in exquisite detail

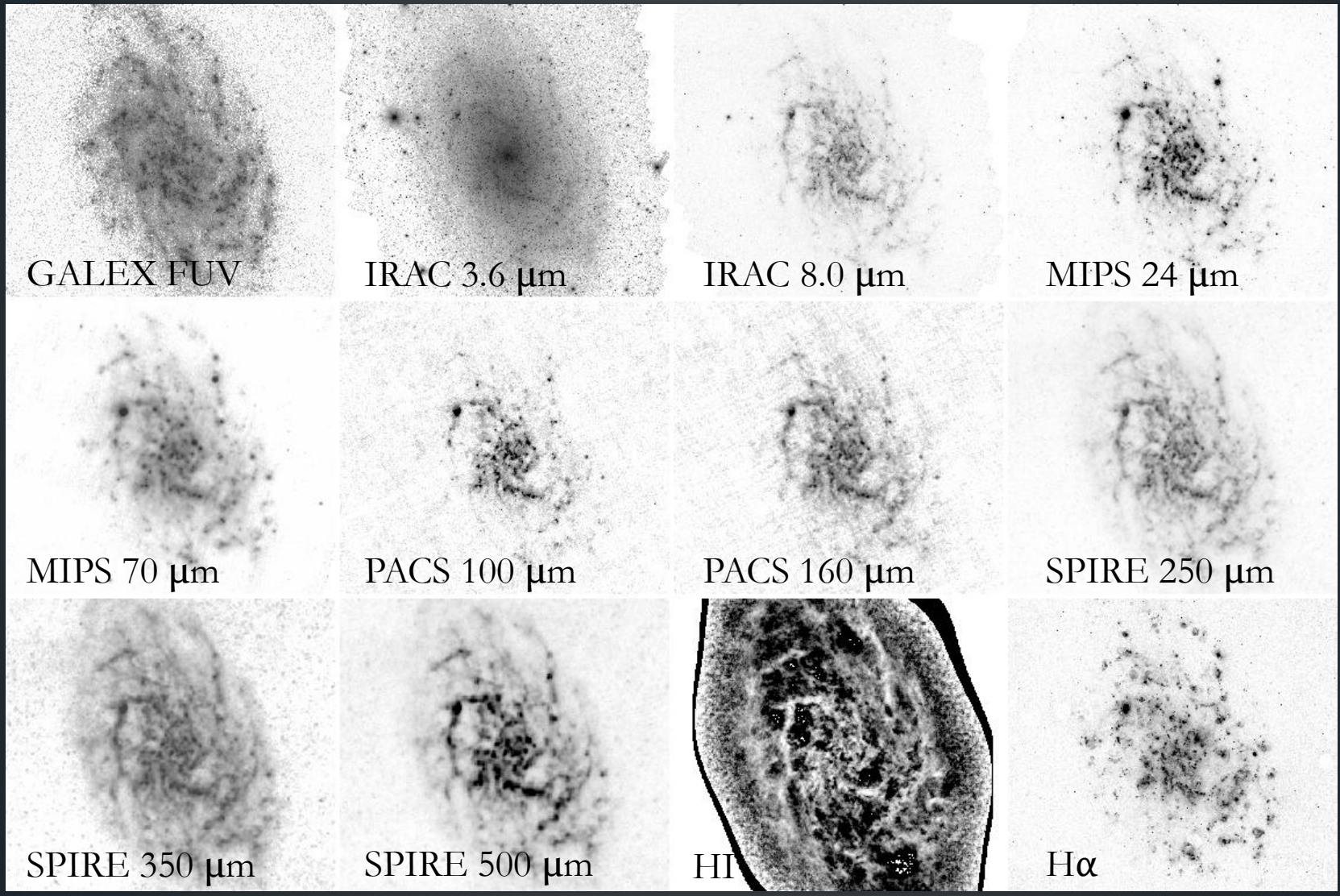
- Statistically in large samples of galaxies
  - Boselli et al. (2011, [about to be] submitted), Skibba et al. (2011), many **many** others
- In a (semi-)resolved way in nearby galaxies
  - Bendo et al. (2010), Engelbracht et al. (2010)
- M33 is an ideal target for such an undertaking
  - Nearby (840 kpc)
  - No AGN
  - Flat(-ish) metallicity gradient
  - Target of the HERM33ES OTKP
  - Wealth of archival multi-wavelength data
    - From the FUV to the radio

… an … y dust

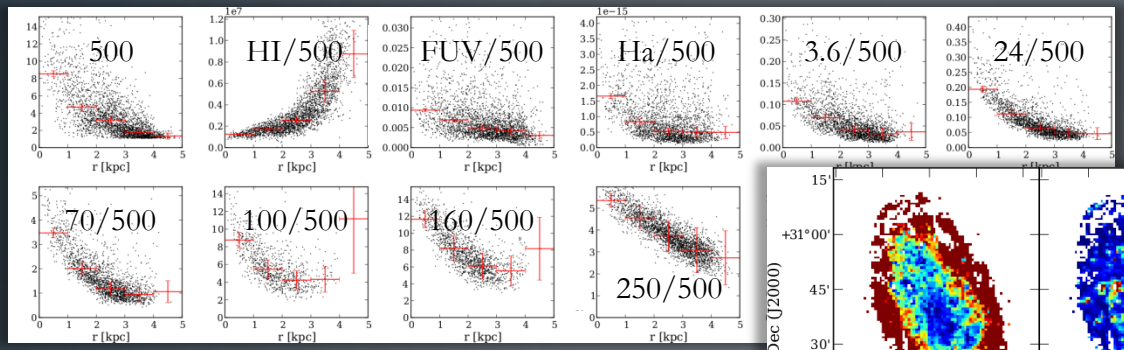
- Statist…
  - Bos… …ibba et al. (…
- In a (s…
  - Ben…
- M33 is… …ng
  - Nea…
  - No …
  - Flat…
  - Targ…
  - Wea…
    - F…



A very rich multiwavelength dataset



One galaxy but many datapoints

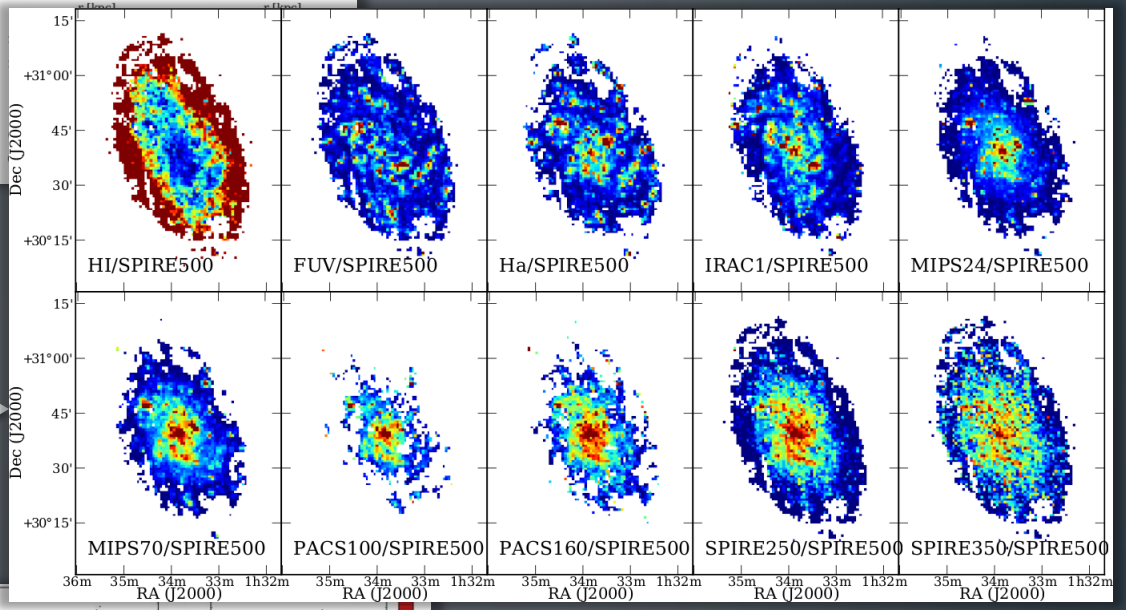


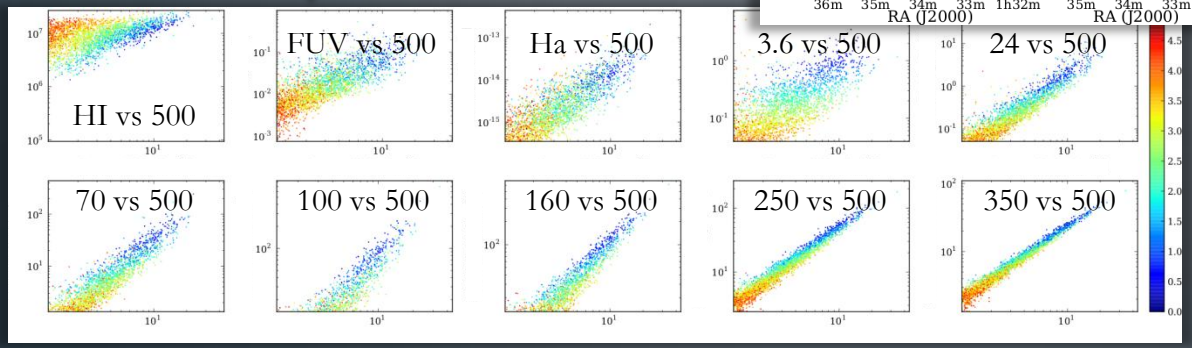
≥851 42" pixels in each plot

Radial colours trends

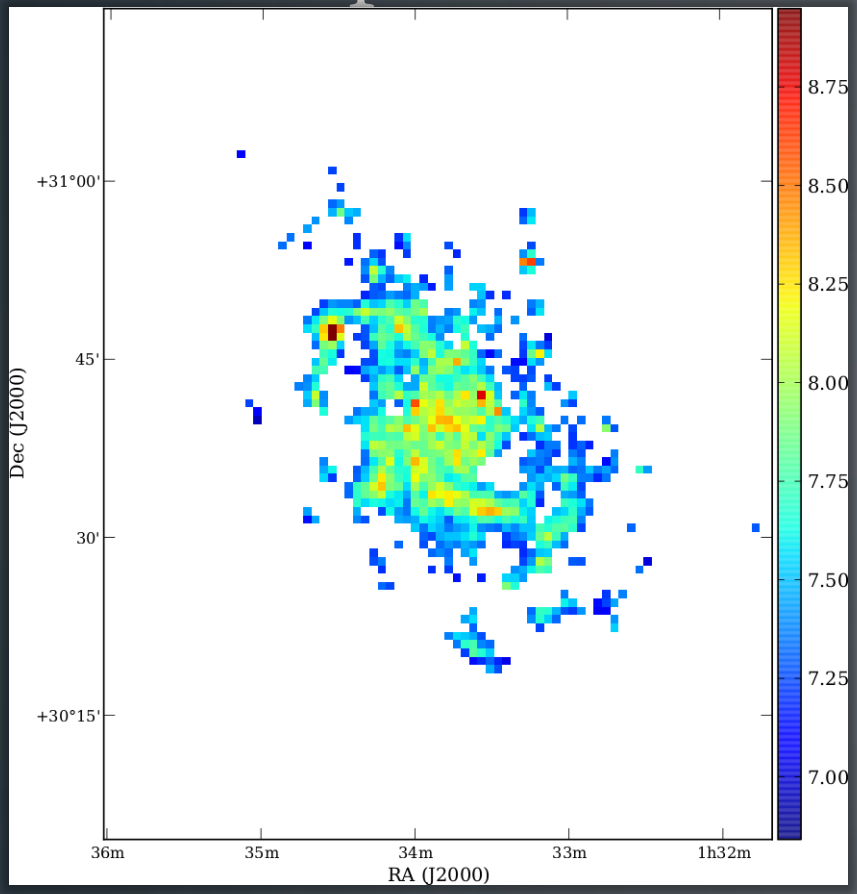
Spatially resolved colour maps

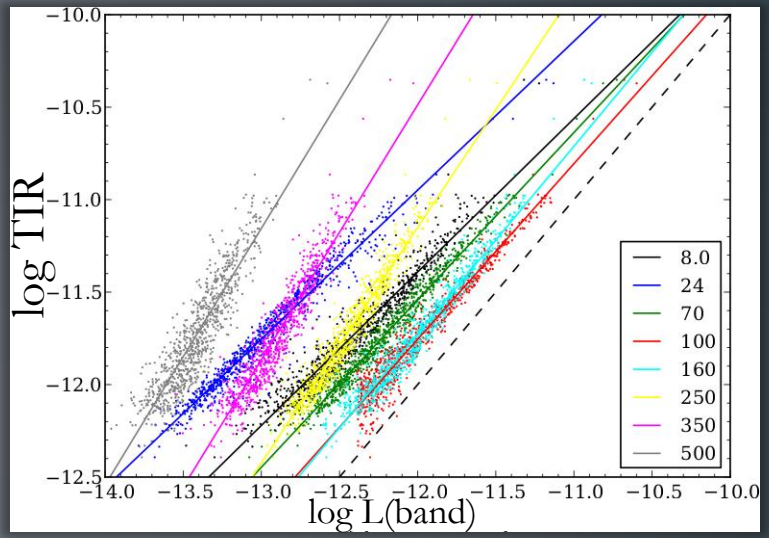
Luminosity-luminosity plots

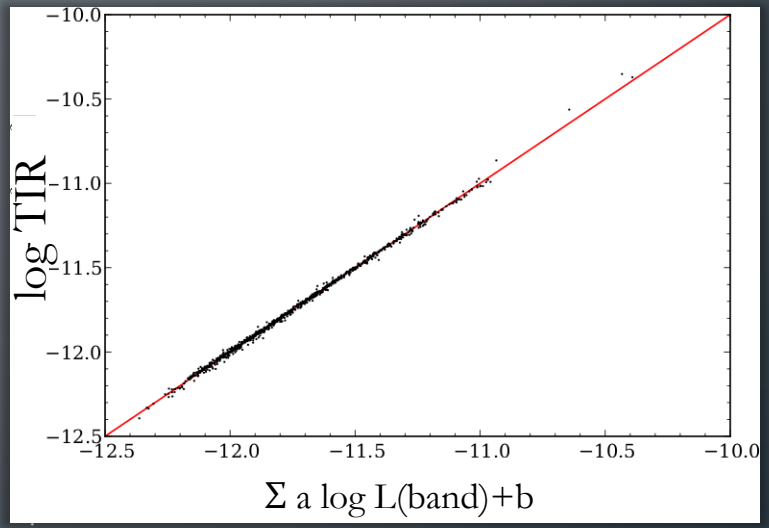




Bands tracing the warm dust are most important to trace the TIR/SFR

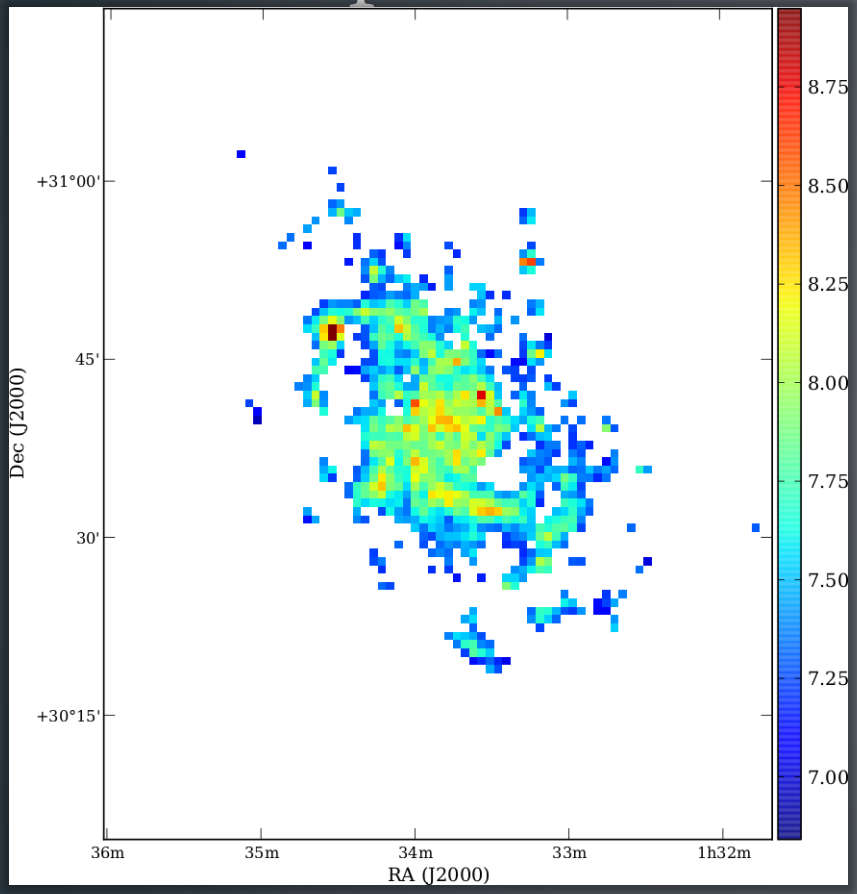


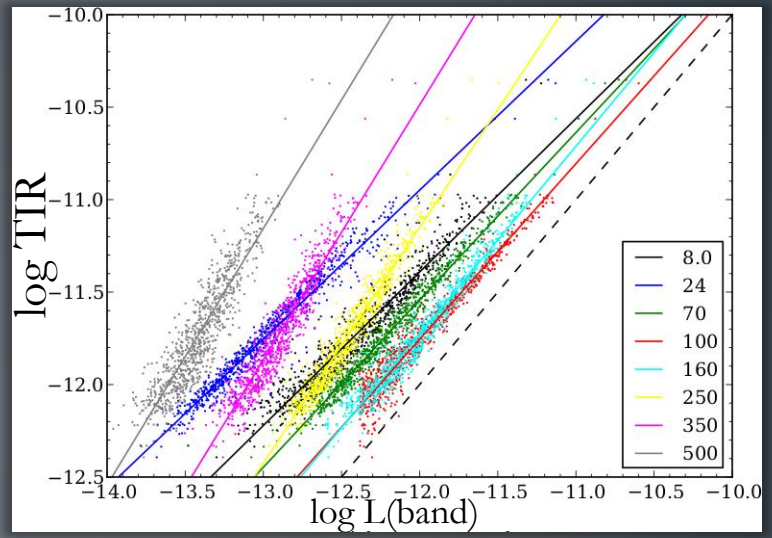


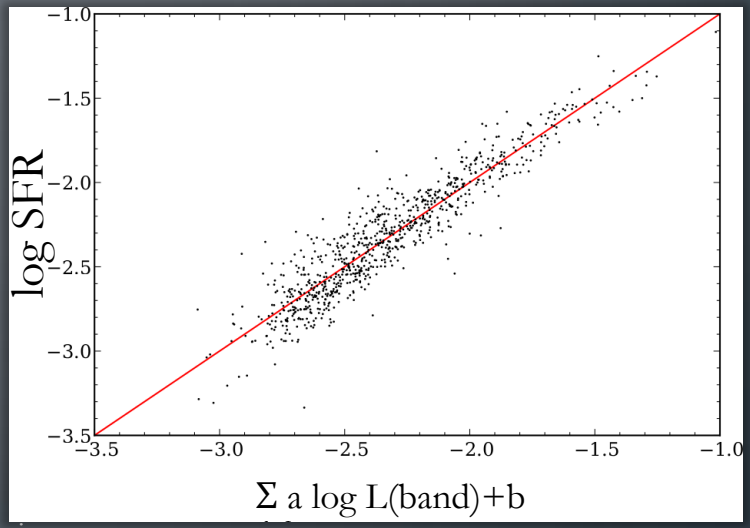


TIR luminosity fitting the IR SED from 8 μm to 500 μm

Bands tracing the warm dust are most important to trace the TIR/SFR

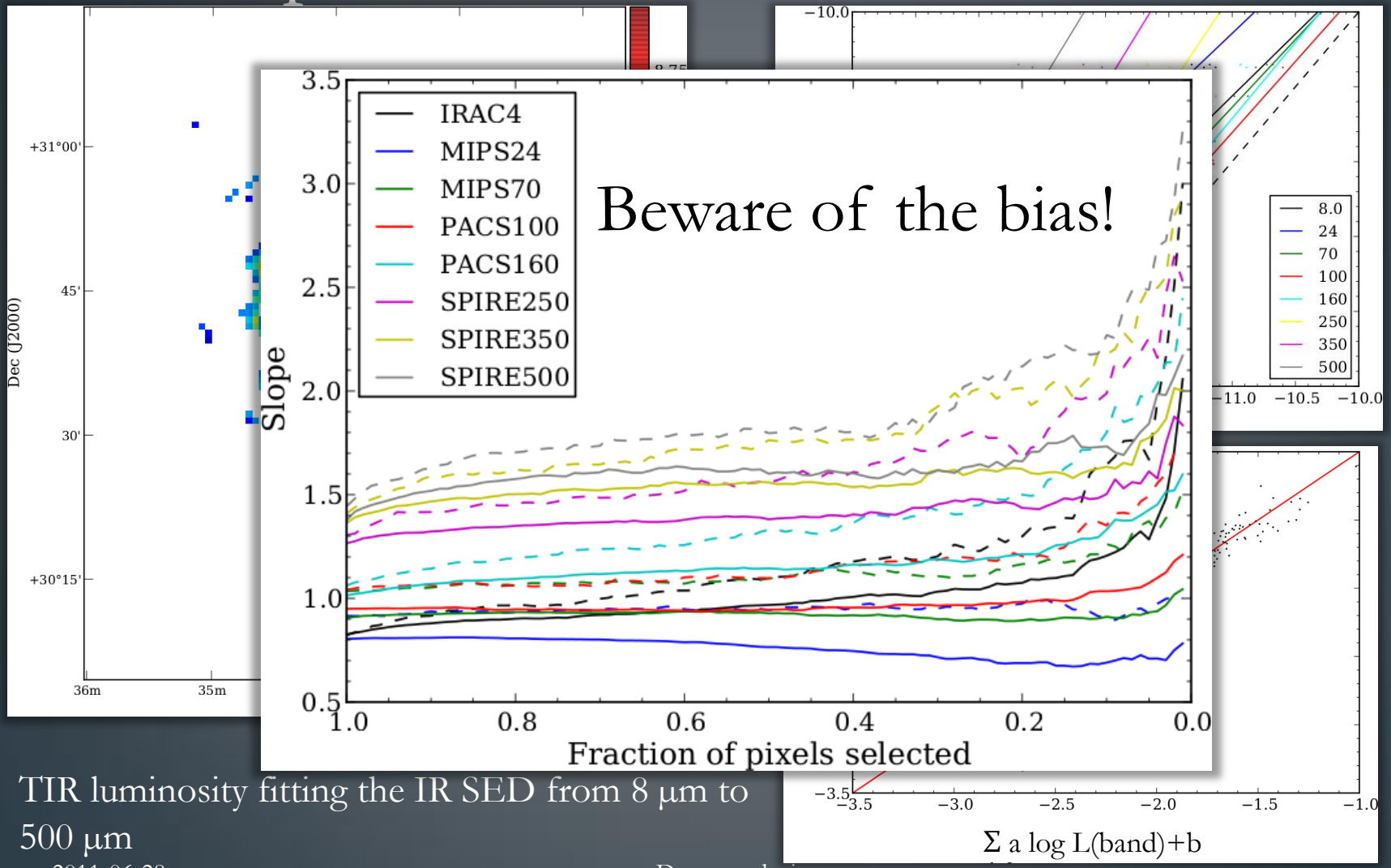






TIR luminosity fitting the IR SED from 8 μm to 500 μm

Bands tracing the warm dust are most important to trace the TIR/SFR



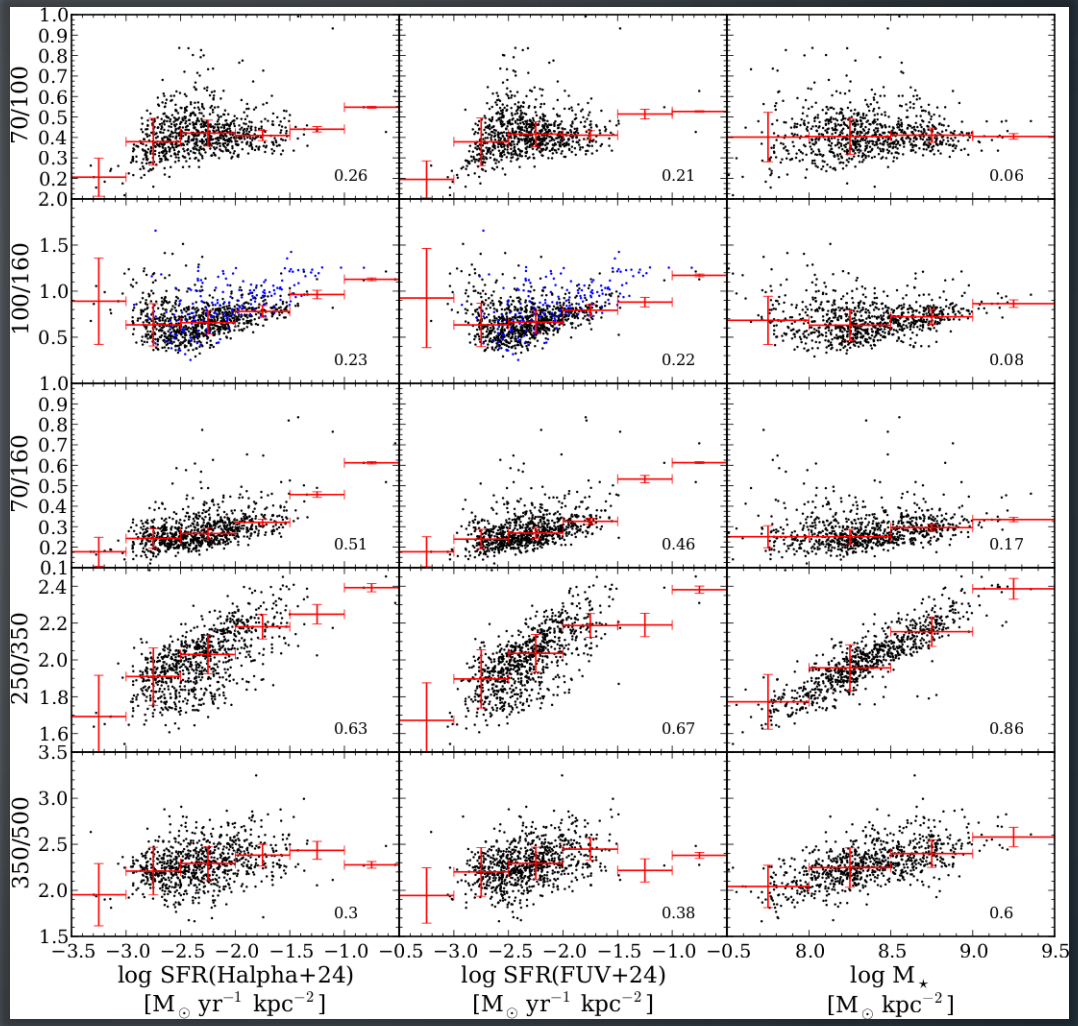
TIR luminosity fitting the IR SED from 8 μm to 500 μm

Young and old stellar populations

- SFR estimators trace young stars

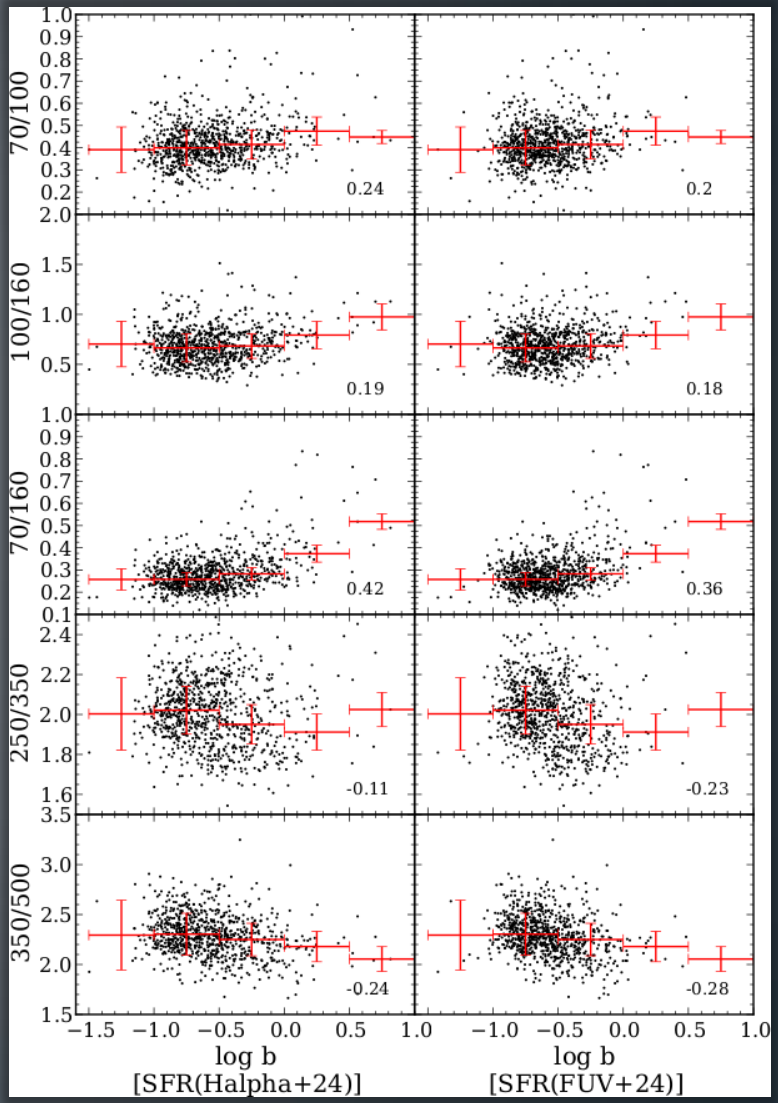
- Near-IR traces the stellar mass

- What drives the dust colours?



Effect of the radiation hardness on dust colours

- Hardness is measured by the birthrate parameter
  - b=SFR/<SFR>
  - SFR measured from Hα+24 μm (Hα+FUV)
  - <SFR> measured from the 3.6 μm
- Boselli et al. (2010) have found correlations
  - 60/100 (350/500) increases (decreases) with b
  - Just a few galaxies

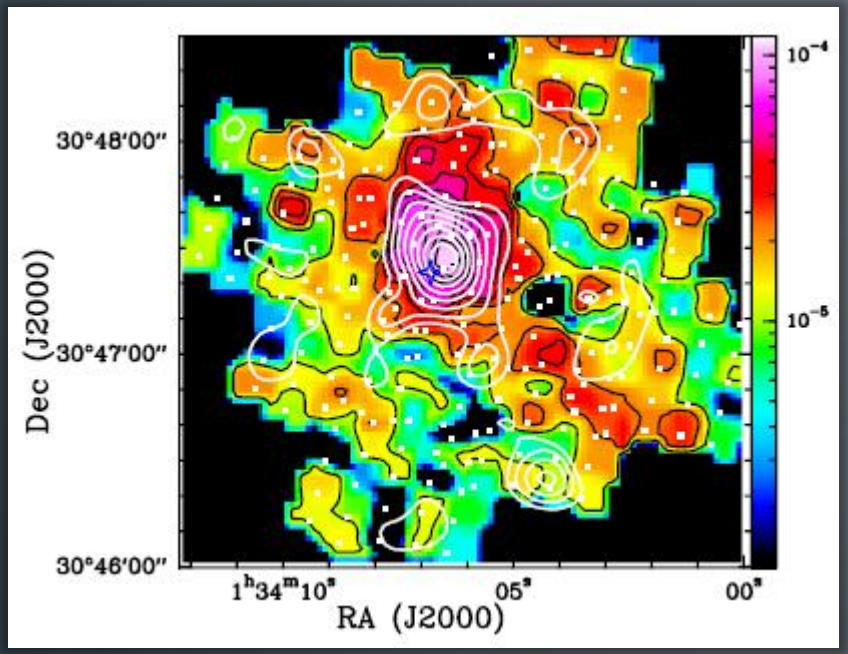


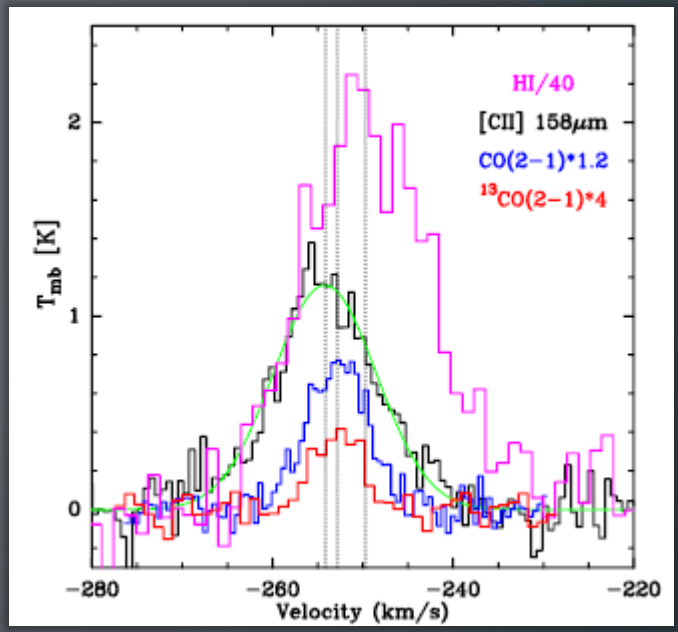
Take home messages

- Relations available to determine the TIR/SFR in a resolved fashion in nearby galaxies
  - See also Boquien et al. (2010a,b), Verley et al. (2010)
- The colours are driven by the radiation field intensity
  - The warm dust colour is driven by SF at high SFR
    - Other processes are also in play at low SFR
  - The cold dust colour is driven by the old stellar population

An extra word on HERM33ES

- Mostly a spectral mapping proposal
- Mookerjea et al. (2011, in press)





[CII]@158 μm but also [OI]@63 μm, [NII]@122 μm, [NIII]@57 μm