Dust in galaxies of the Local Universe

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INAF-Osservatorio Astrofisico di Arcetri
and the DustPedia collaboration

DustPedia
www.dustpedia.com

DustPedia - A Definitive Study of Cosmic Dust in the Local Universe

FP7-SPACE proj. 606847

PI: Jon Davies (Cardiff University)

DustPedia

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SPIRE 250μm images

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A legacy database of 875 galaxies

- Observed by *Herschel*
- Large size: $D_{25} > 1'$
- Nearby: $v < 3000$ km/s

(Davies et al. 2017)

SPIRE 250μm images

DustPedia's goals

Davies et al. (2017)

- Measure the UV-mm spectral energy distribution (SEDs) for each galaxy in the sample.

- Use full SED (HerBIE, CIGALE) and radiative transfer (SKIRT) models, to derive stellar, gas and dust properties, star formation rates and histories as a fun ction of morphological type.

- Develop a dust evolution model (THEMIS) consistent with the SEDs of galaxies of different morphological types and determine the primary sources and sinks for cosmic dust.

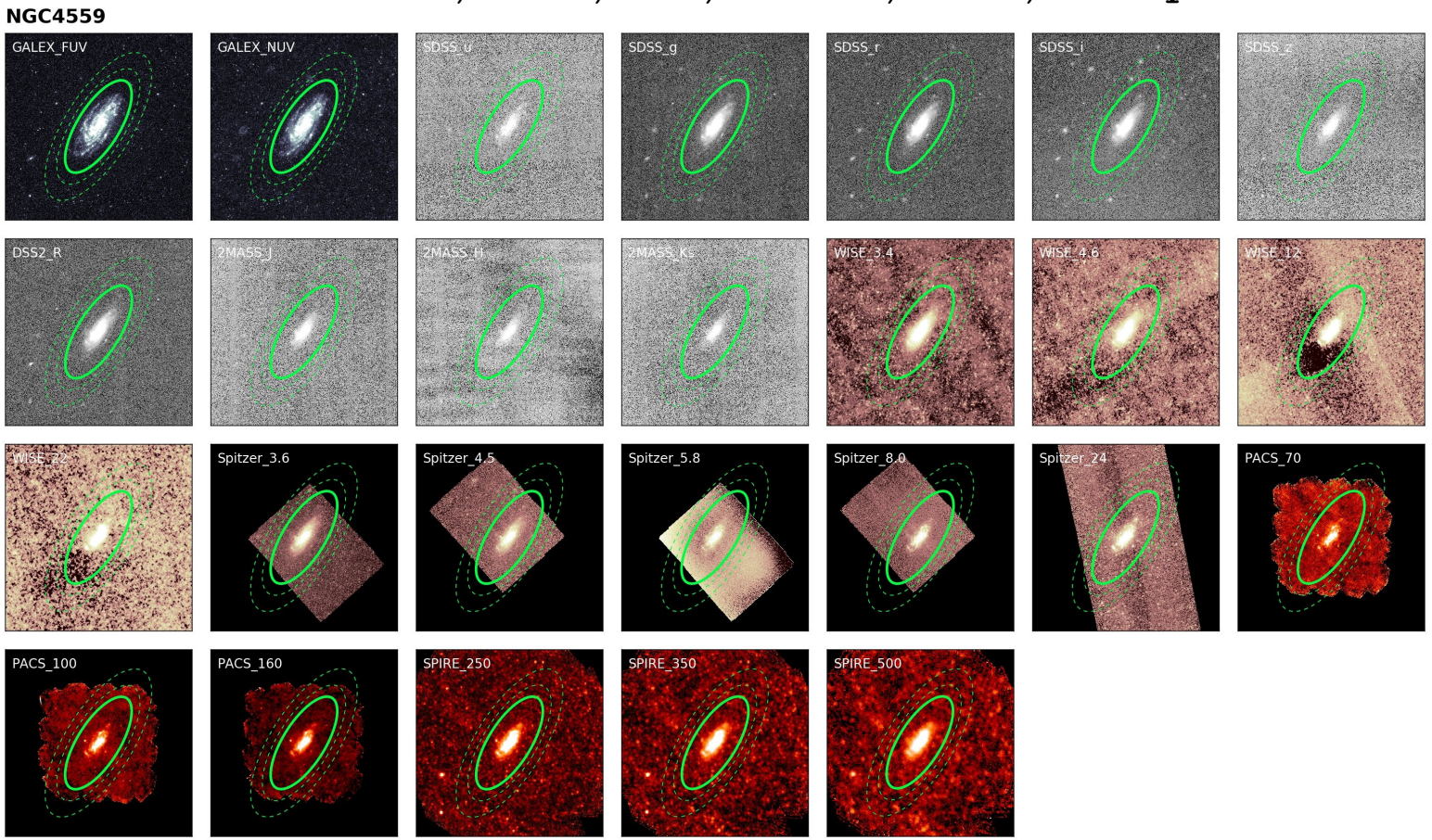
- Compare the evolution of the dust SED and optical/physical properties in the Local Universe with that inferred from cosmological surveys and the cosmic far infrared background.

The DustPedia database

Clark et al. (2017)

publicly available at http://dustpedia.astro.noa.gr/

- Multi-λ imagery and aperture-matched photometry for 875 galaxies.
- Dedicated *Herschel* reductions with PACS and SPIRE; standardized archival observations from GALEX, SDSS, DSS, 2MASS, WISE, and Spitzer.



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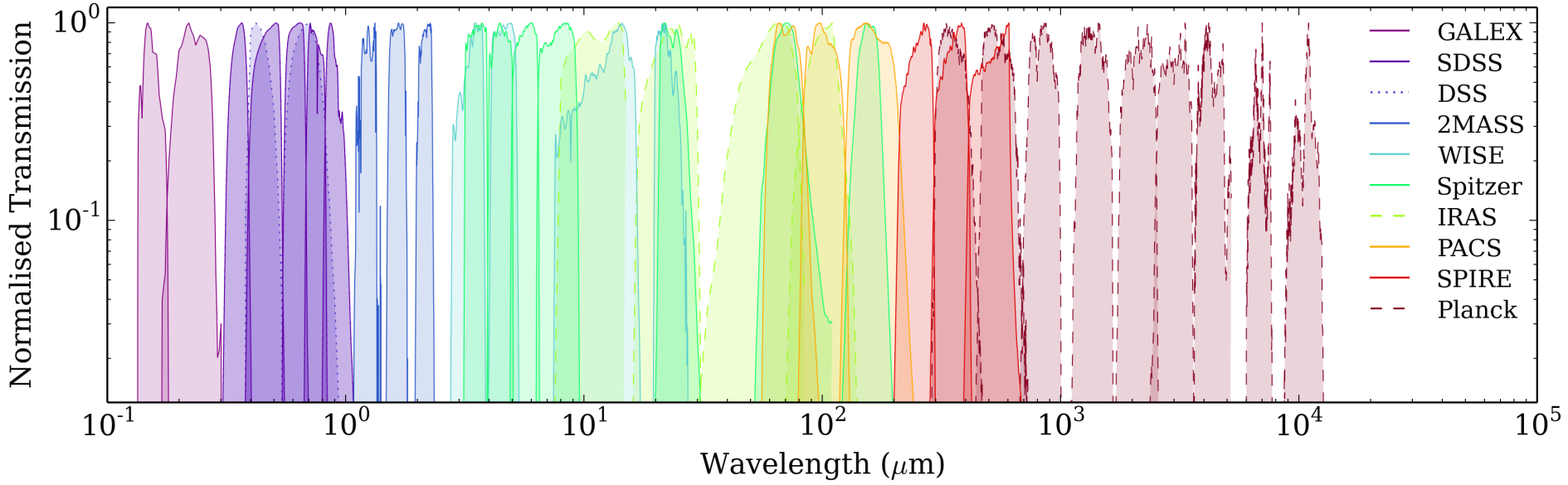
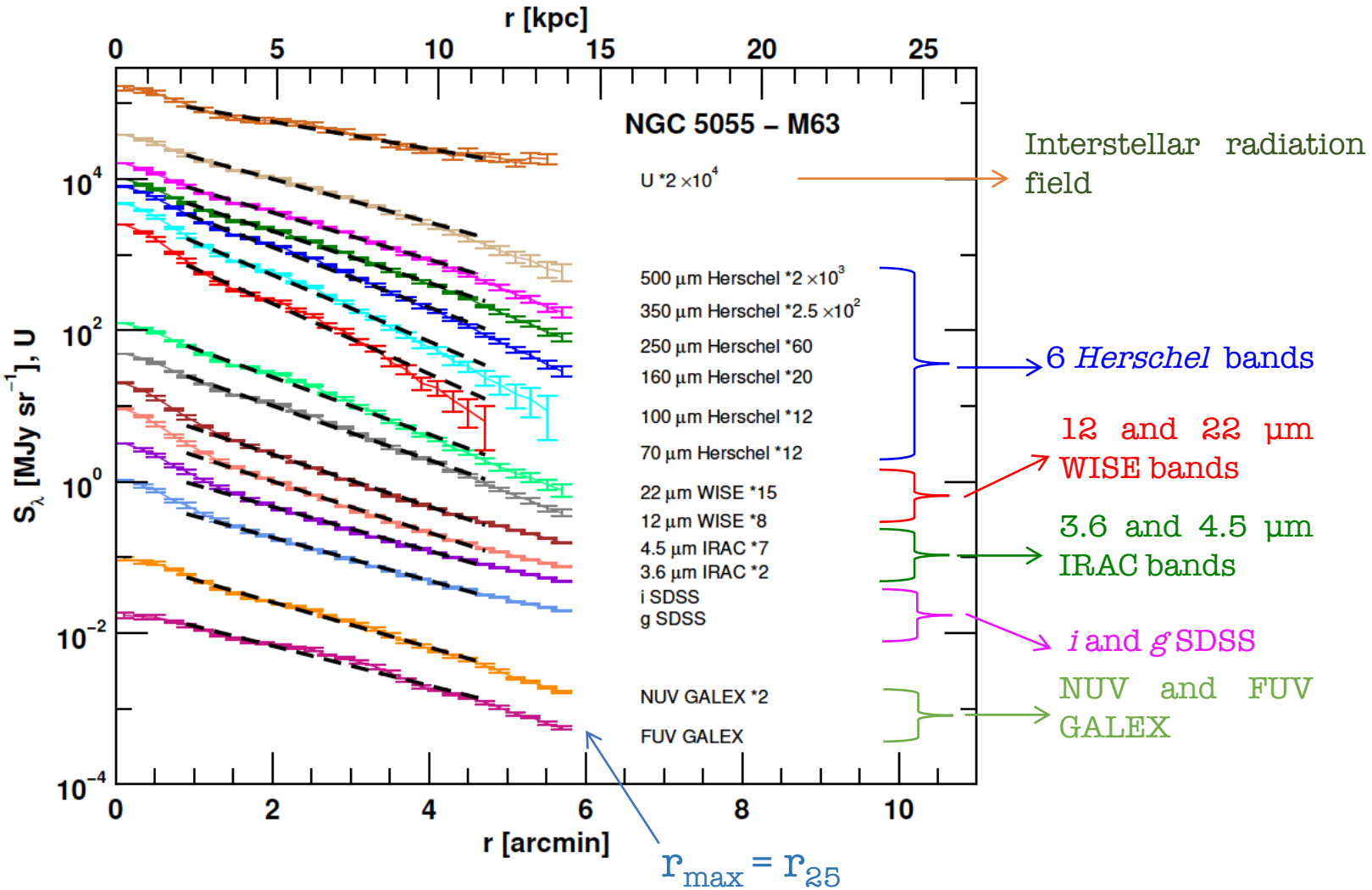
- Dedicated *Herschel* reductions with PACS and SPIRE; standardized archival observations from GALEX, SDSS, DSS, 2MASS, WISE, and Spitzer.
- Ancillary data from IRAS and Planck.
- up to 42 bands/galaxy, 25 bands/galaxy on average (21,857 photometric measurements).



Radial distribution of dust, stars, gas and SFR in DustPedia face-on galaxies (Casasola et al. 2017)

- ✓ 18 face-on ($(d/D)_{submm}$>0.4) and large (D_{submm}>9') galaxies
- ✓ Exponential fits to UV/Optical/NIR/submm surface brightness and to dust, stellar, gas and SFR surface density



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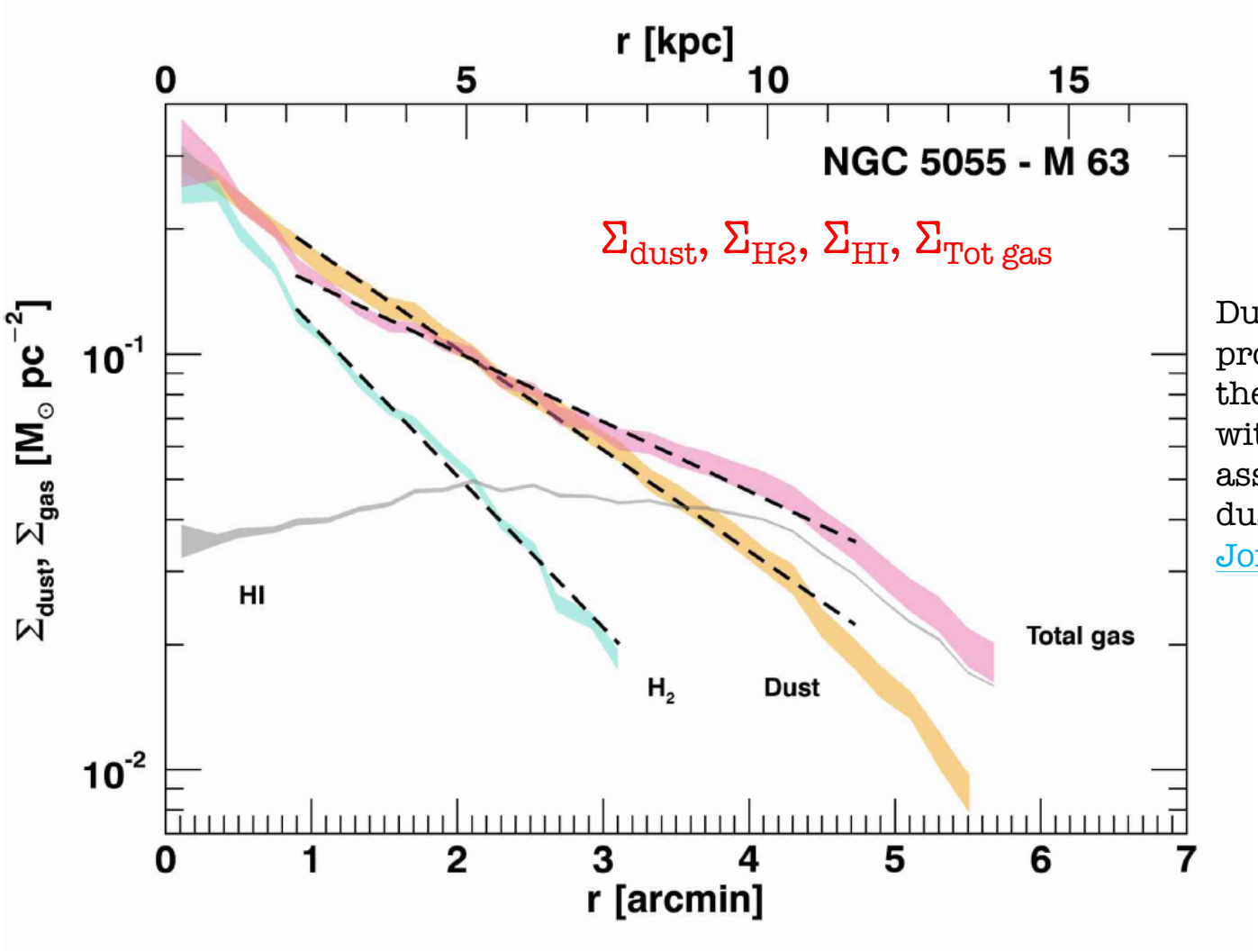
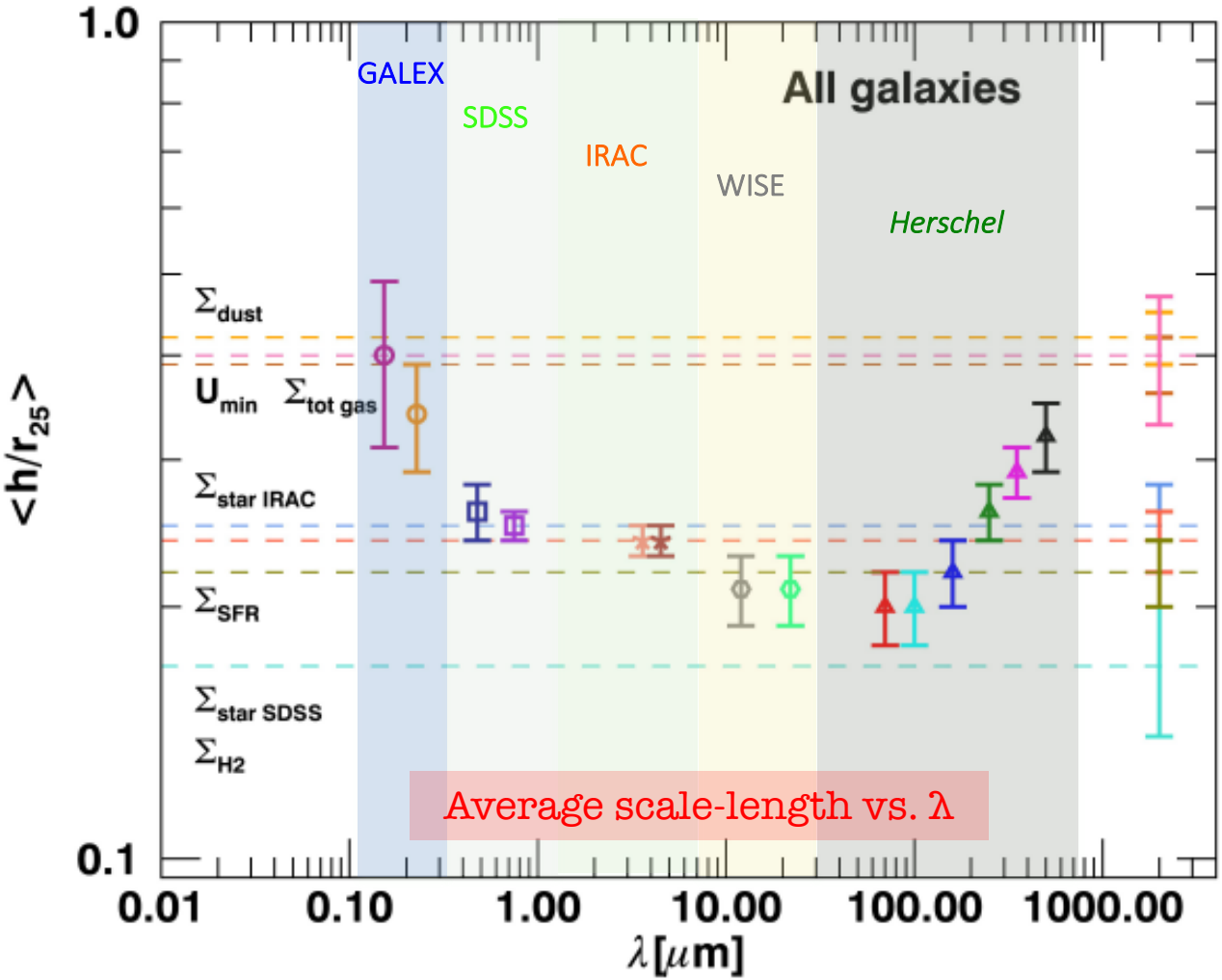


Dust surface density profile derived by fitting the SED at each position within a galaxy and assuming the THEMIS dust model (Jones+13, Jones+17)

Radial distribution of dust, stars, gas and SFR in DustPedia face-on galaxies (Casasola et al. 2017)

$\langle h_{dust} \rangle$ = 1.8 $\langle h_{star} \rangle$. Direct confirmation of radiative transfer studies (Xilouris+99, Bianchi+07, De Geyter+14). Longer grain lifetime at larger radii (e.g., Sauvage+05)?

$\langle h_{dust} \rangle$ = 2.3 $\langle h_{H2} \rangle$. No simple scaling of dust, atomic and molecular gas profiles. Different dust properties?



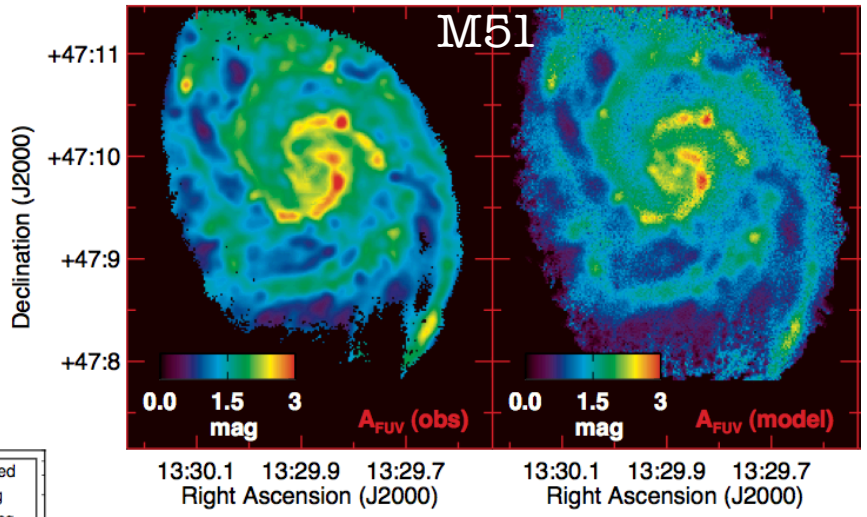
2-D Sersic profile fits to all DustPedia WISE 3.4μm and Herschel maps (Mosenkov+,in prep.)

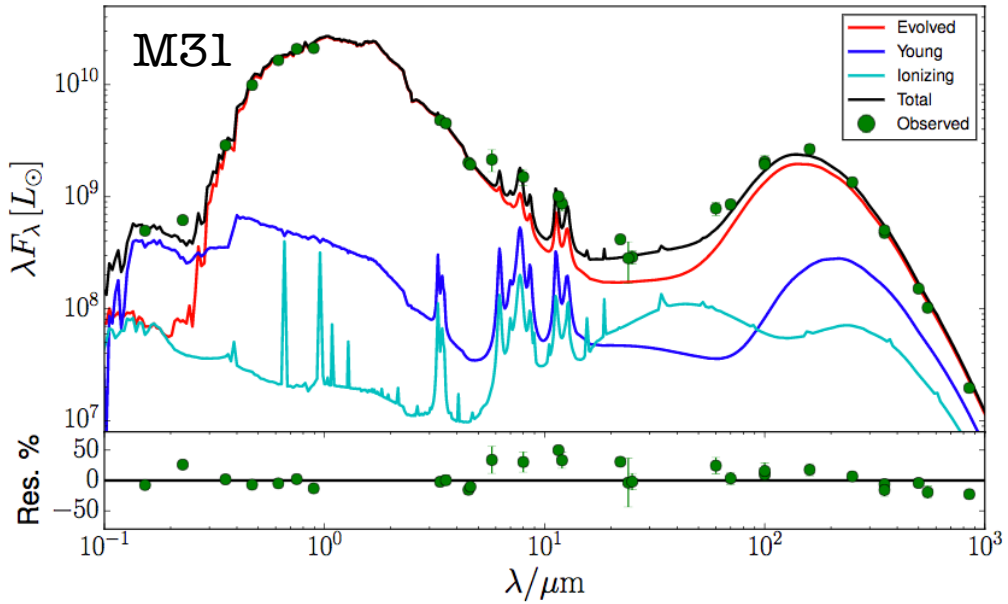
Radiative Transfer and SFR estimates

http://www.skirt.ugent.be

SKIRT (Baes+ 11, Camps+16) radiative transfer models of face on galaxies (M51, De Looze+14; M31, Viaene+17)

- Stellar templates from observations
- Vertical geometry from edge-on fits
- As much dust as needed, scaled on A_V from TIR/UV (Cortese+08)





M51: heating by young stars dominates the FIR SED

M31: old stars (mainly from the bulge) dominates.

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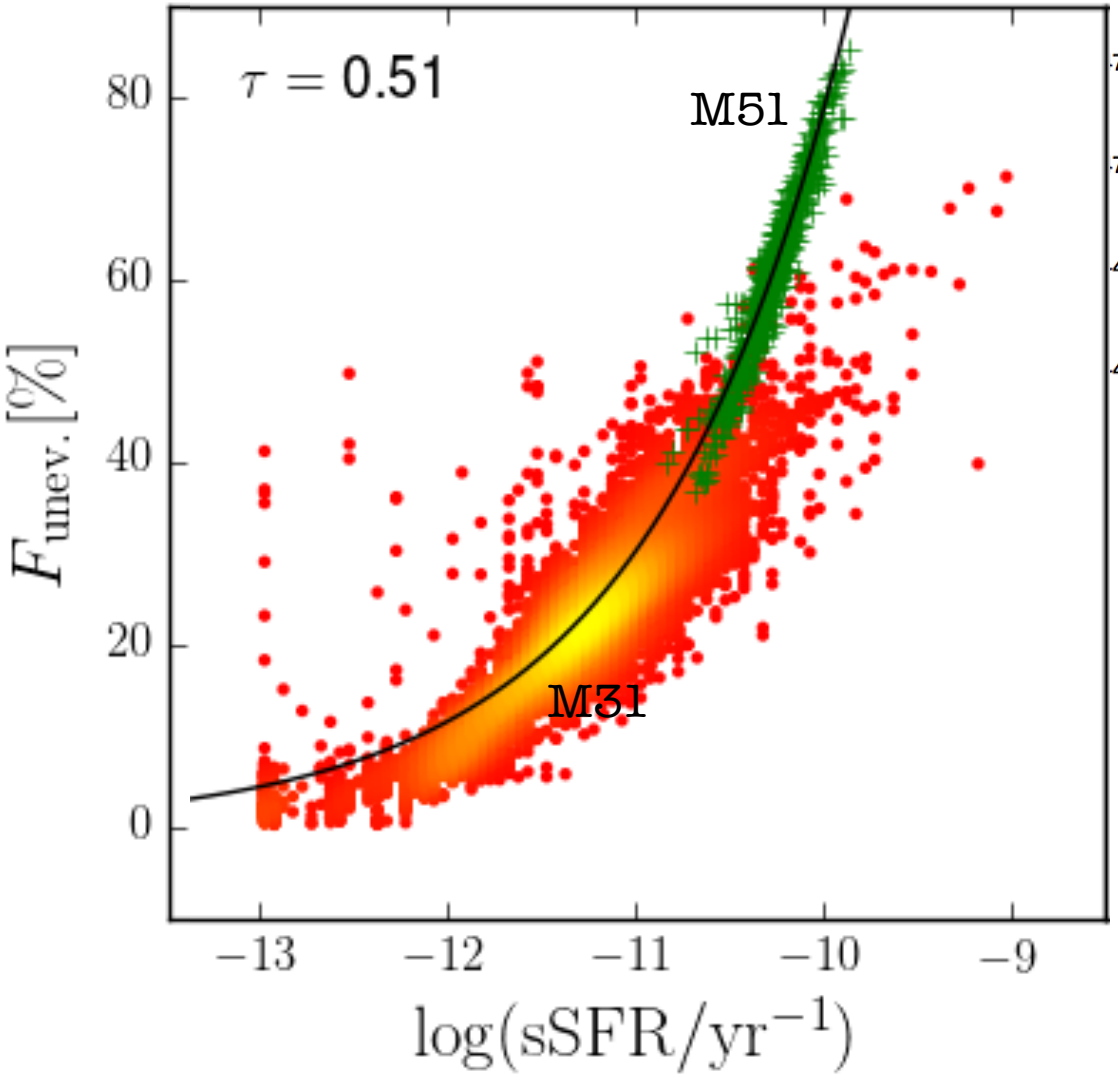
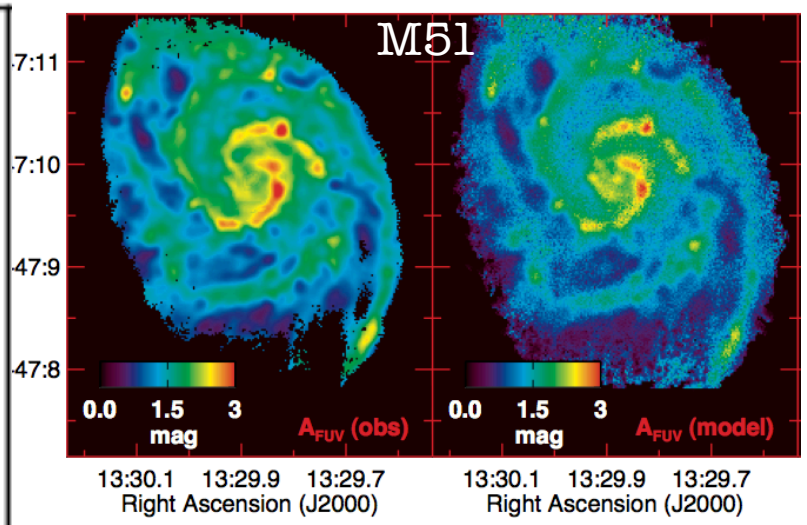




M51: heating by young stars dominates the FIR SED

M31: old stars (mainly from the bulge) dominates.

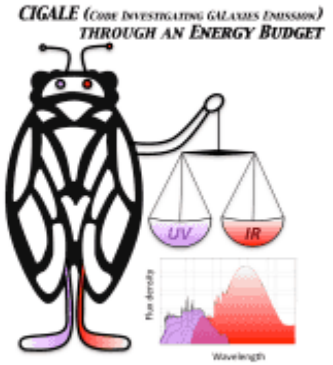
But a similar dependence on sSFR

Work on M81 (Verstocken+, in prep.) and other DustPedia galaxies in progress

Global SED modelling and dust properties

Inclusion of THEMIS dust emission templates into the CIGALE SED fitting tool (Nersesian+, in prep.)

THEMIS, an interstellar dust model based on optical properties measurements in the lab, including hydrogenated amorphous carbon (Jones+13, 17)



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Code Investigating GALaxy Emission
https://cigale.lam.fr/

THEMIS
The Heterogeneous dust Evolution Model for Interstellar Solids

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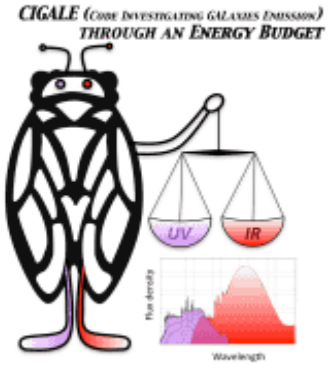

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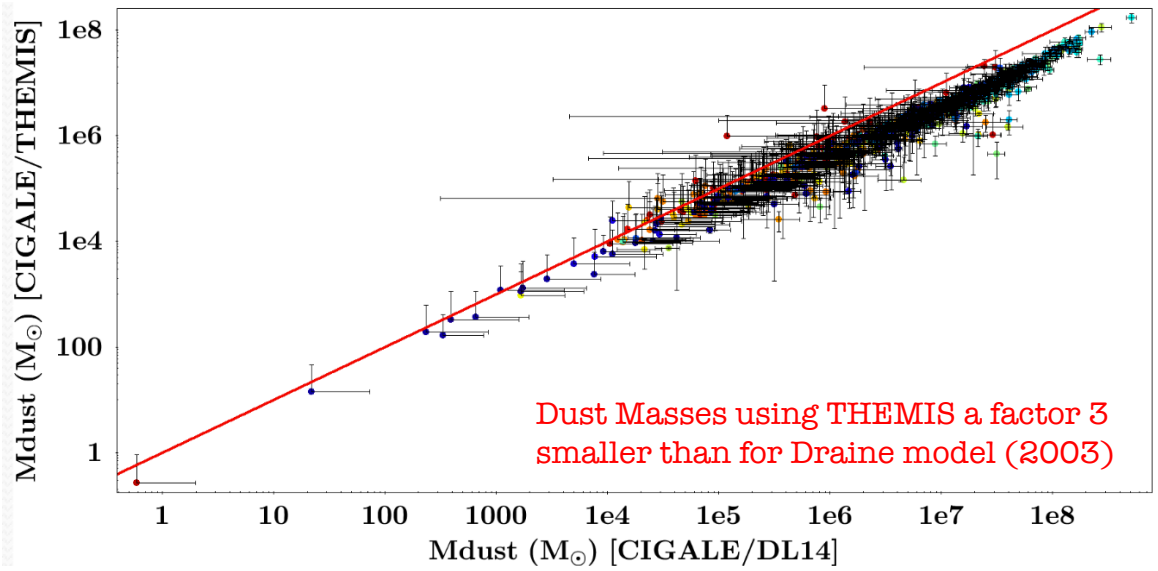
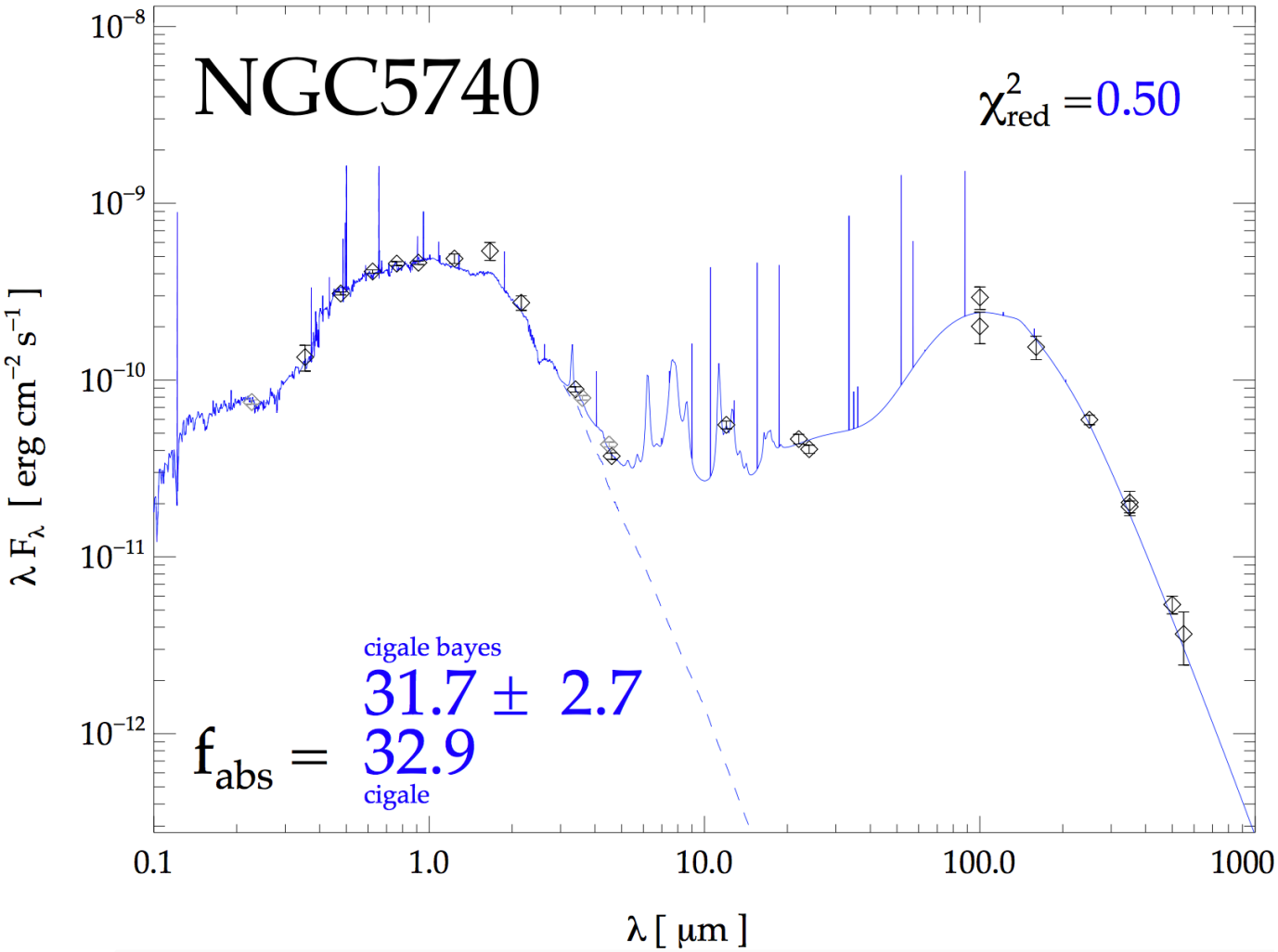


A study of Dust, Star and Gas scaling laws is forthcoming (Nersesian+, Casasola+, in prep.)

The fraction of luminosity absorbed by dust

On average, 30% of the bolometric luminosity is absorbed and re-emitted by dust grains (Soifer+91; Xu+95; Popescu+02, Skibba+11, Davies+12, Viaene+16)



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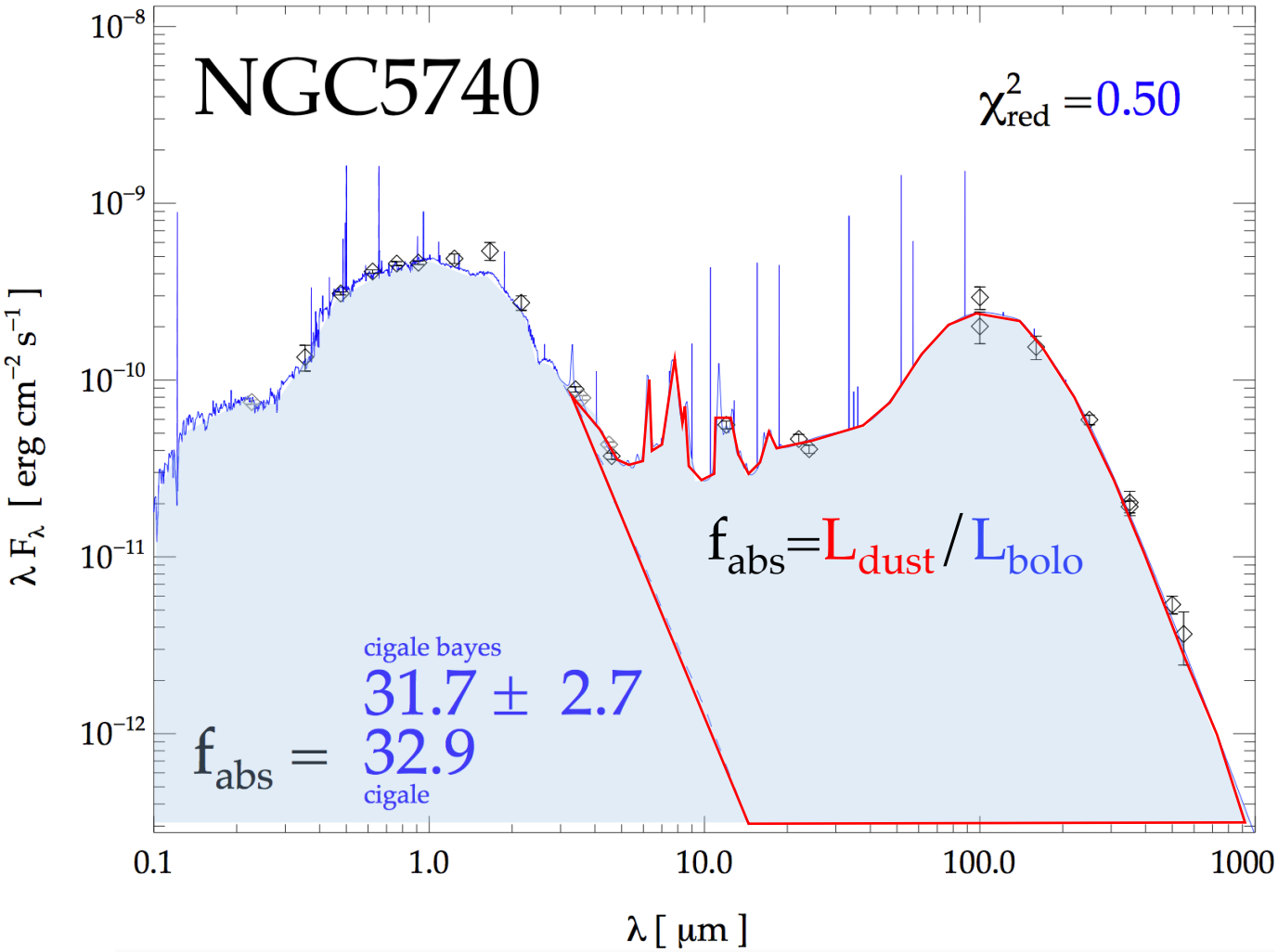


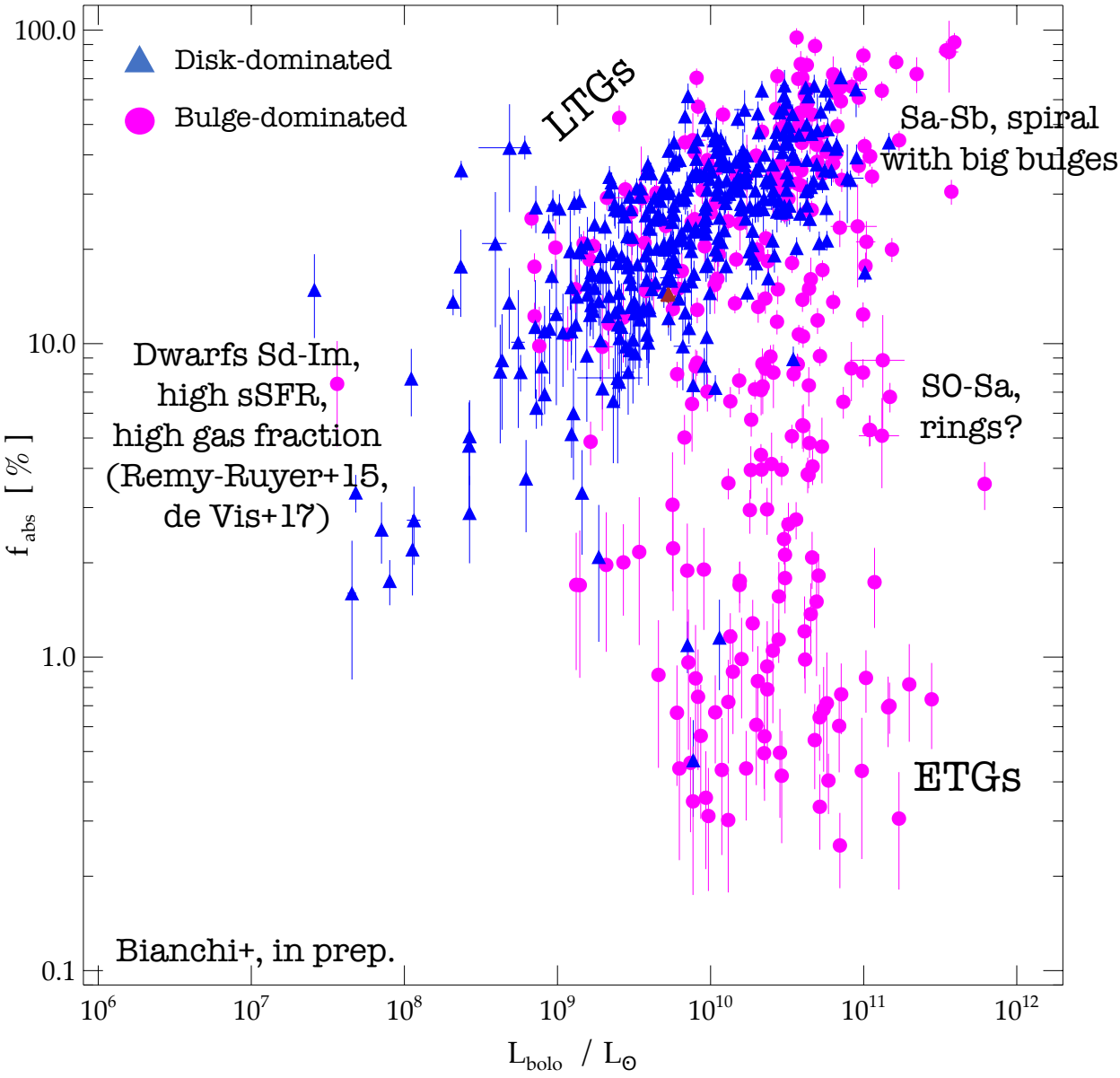
The fraction of luminosity absorbed by dust

2-D Sersic profile fits at 3.4 μm (Mosenkov+, in prep.)

f_{abs}=25%, but large scatter and dependence on L_{bolo}

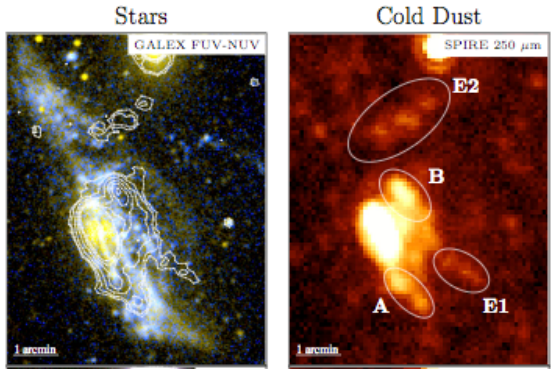
Dependence on stellar & dust mass build-up, and on the geometry evolution

Cosmic Background f_{abs}=50% (Franceschini & Rodighiero+17)

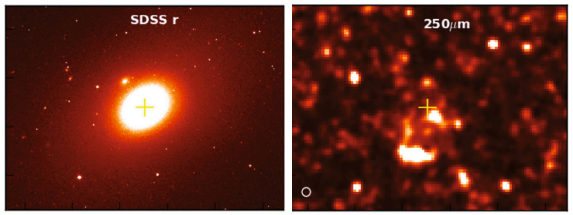


Dust Evolution and Environment

Dust is removed from galaxies in clusters by ram-pressure stripping and tidal interaction. Any effect on global galactic properties? Davies+, in prep.

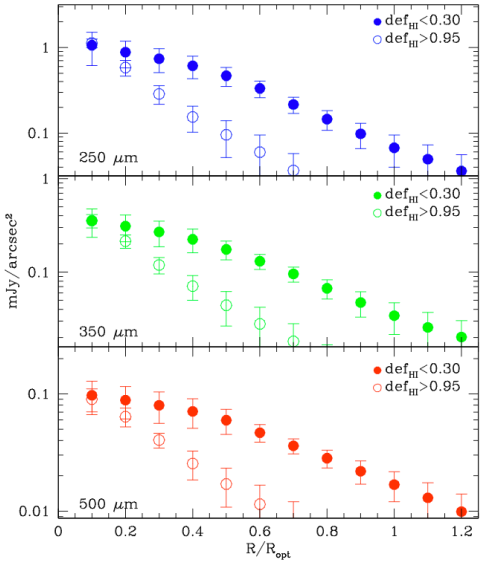


NGC4438 (Cortese+10b)



M86 (Gomez+10)

Cortese+10a



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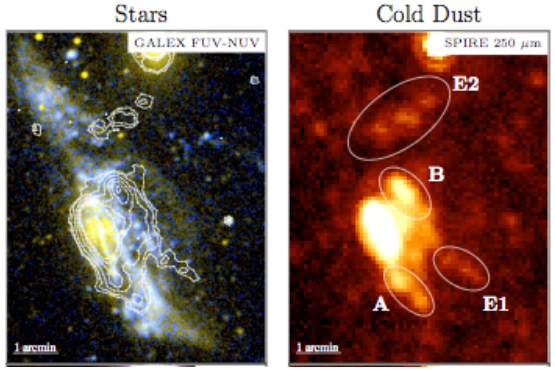

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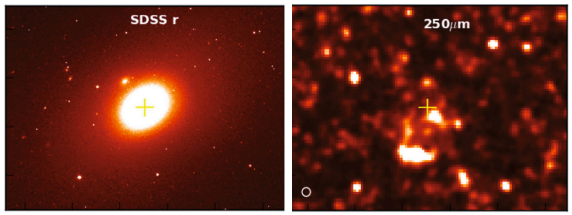

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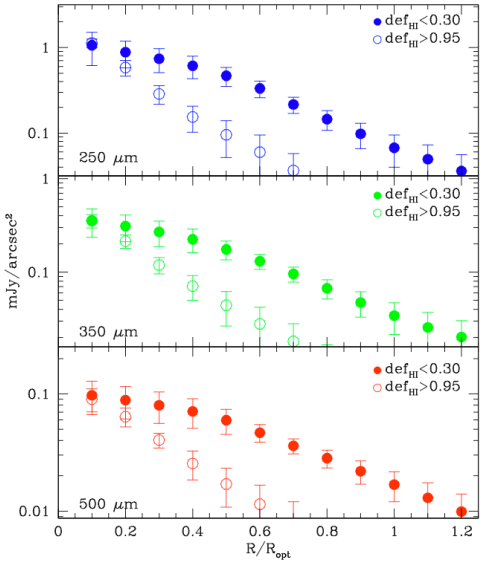
Dust in ETGs is not correlated to the stellar component, external origin? Dust in DustPedia ETGs (Cassarà, Xilouris+, in prep.)

The evolution of dust grains in the hot ISM of ETGs (De Vis+, in prep.)

Cortese+10a



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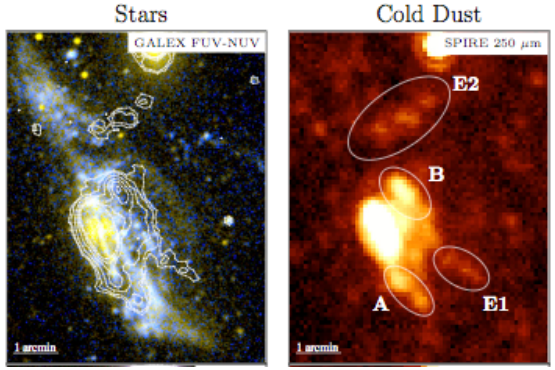

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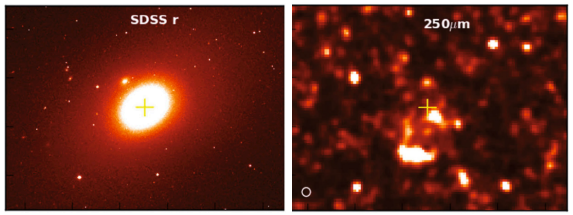

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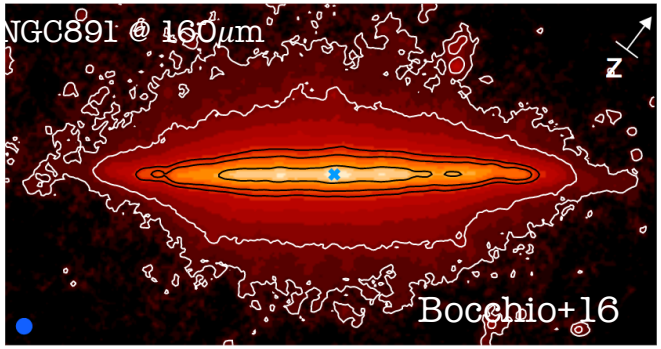

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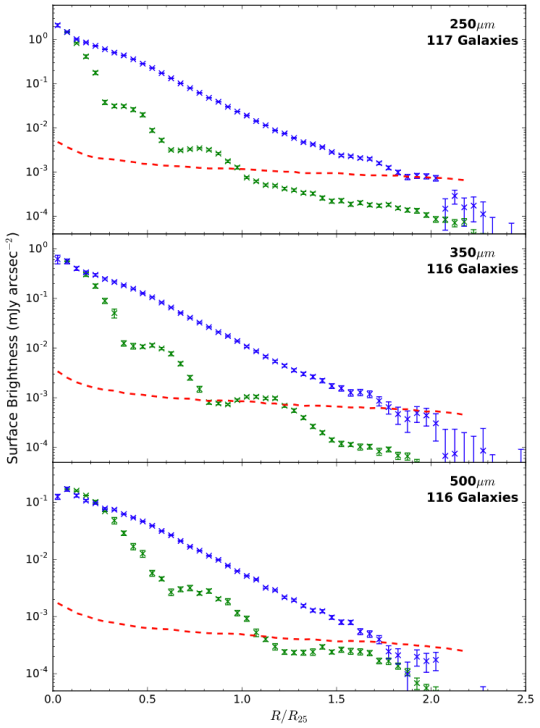

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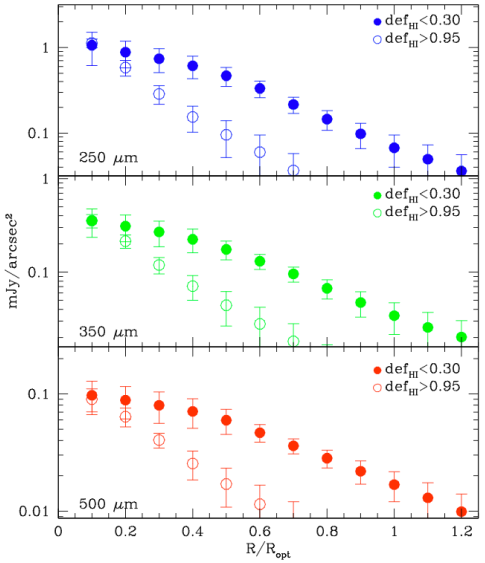

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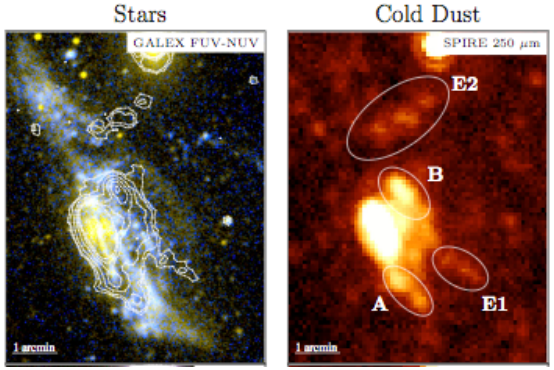

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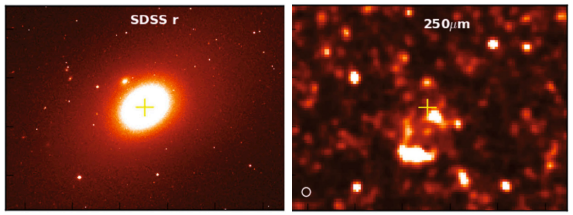

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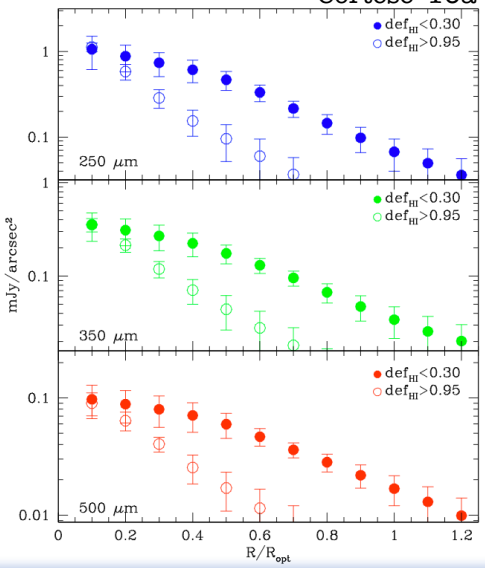

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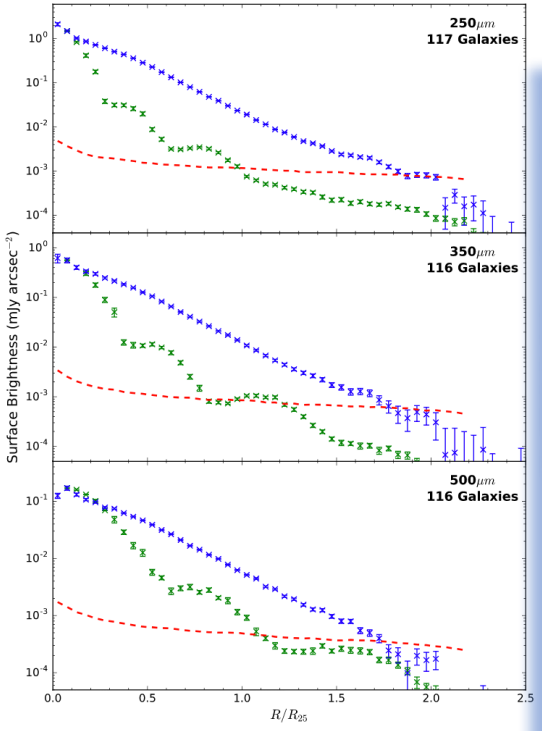

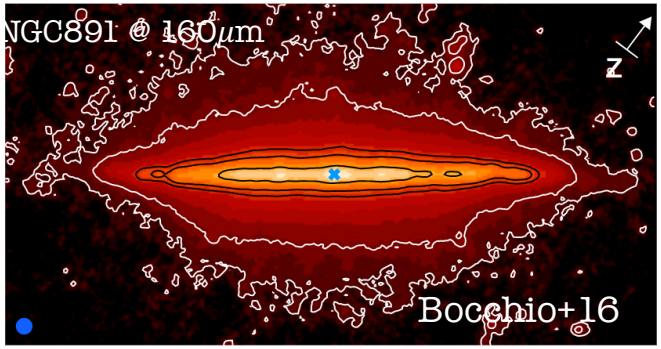

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Model results available soon, plus ancillaries (gas masses, metallicities, etc.), by the end of DustPedia (April 18)

Stay Tuned!

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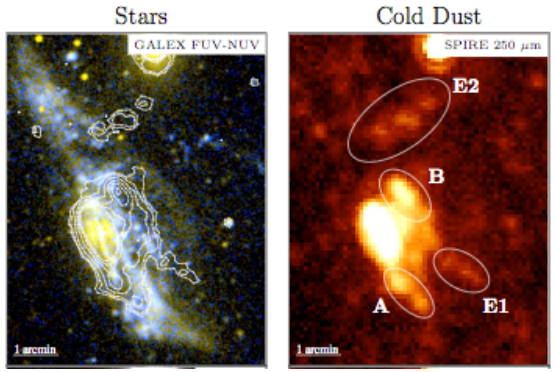

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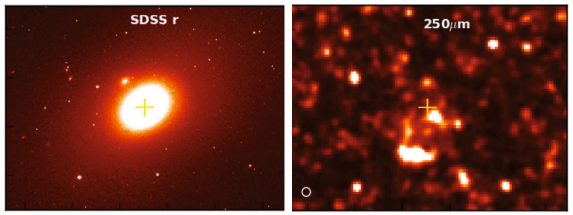

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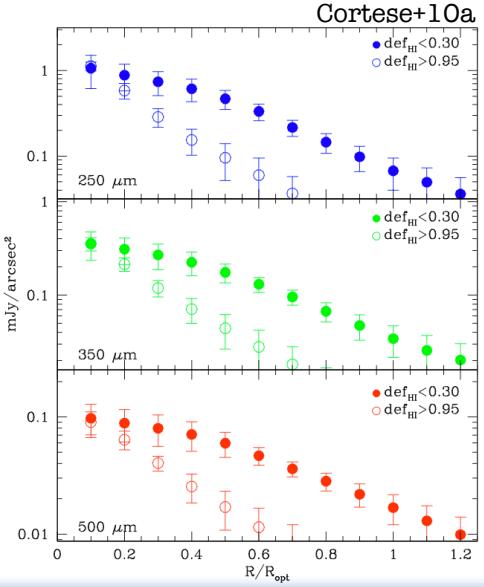

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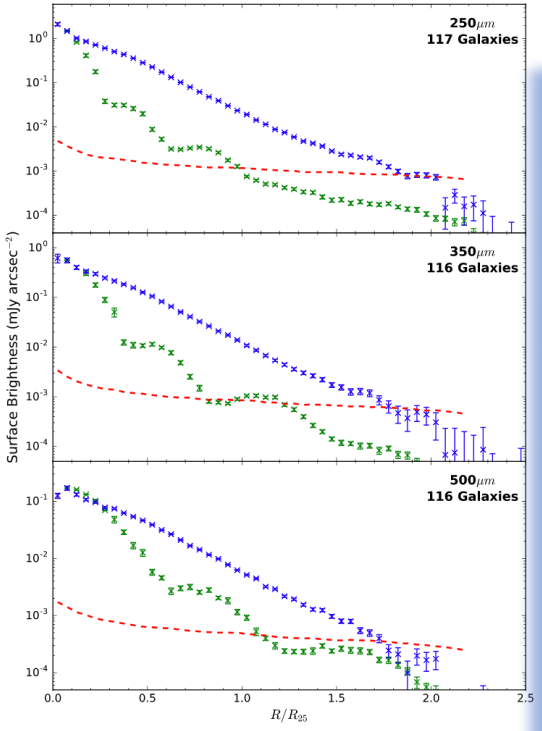

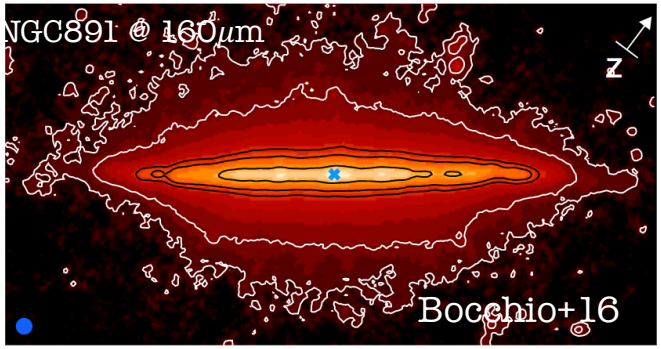

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