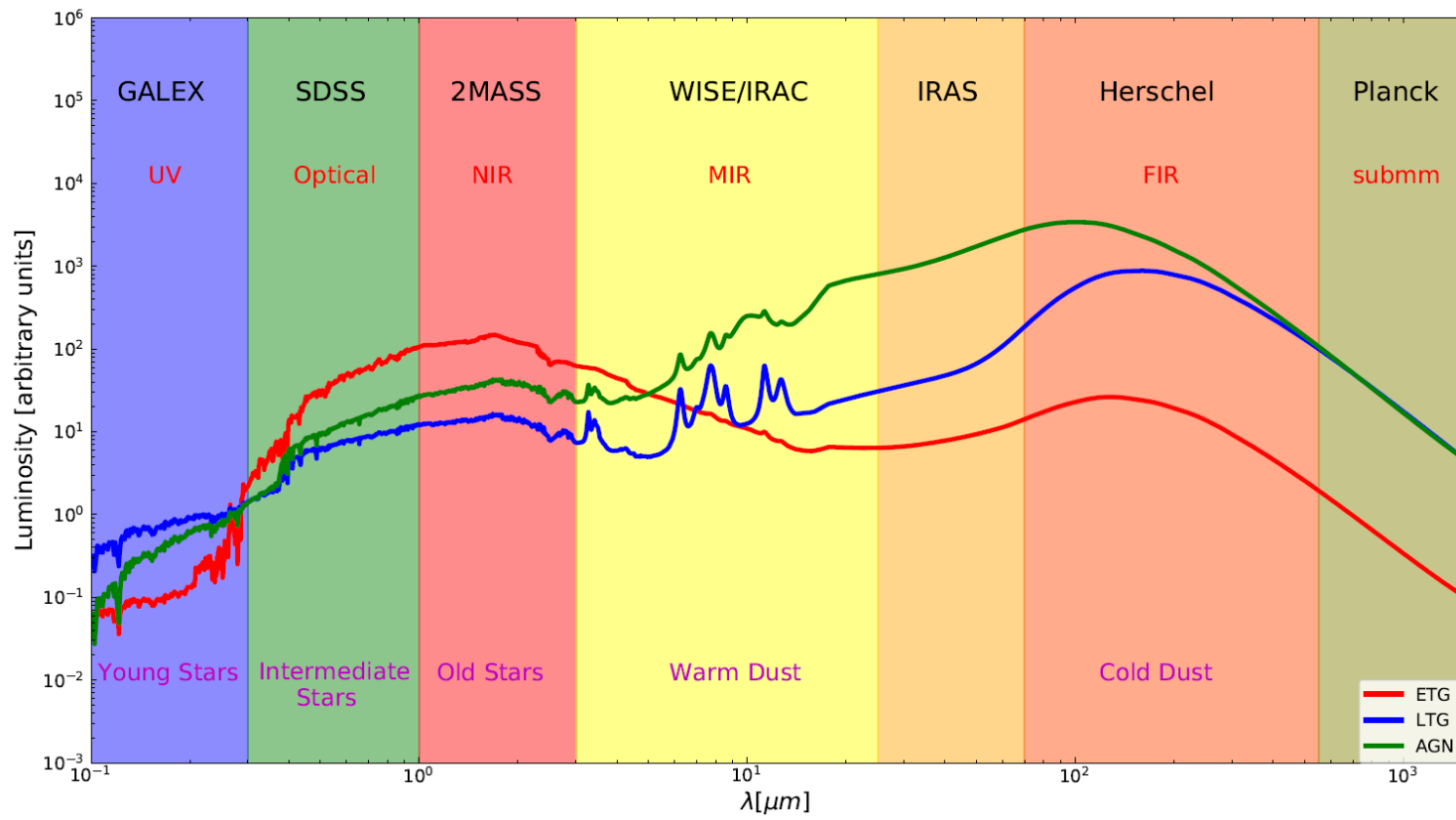Angelos Nersesian

Modelling the cold dust in nearby spirals galaxies with radiative transfer

A galaxy's SED

Dust Heating

Questions
- Where and how much is dust heated in galaxies?
- What is the role of each stellar population?
- What is the relation to the 3D structure of the galaxy?

With our method we can ...
- Take into account the effect of non-local heating.
- Create a self-consistent 3D model of the radiation field.

How?
- 3D Monte Carlo dust continuum radiative transfer.
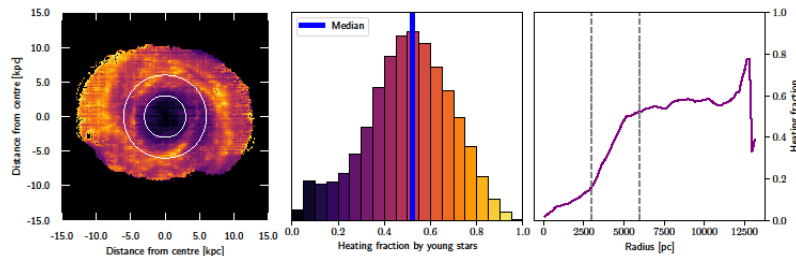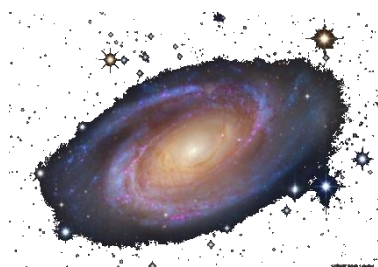
skirt.ugent.be

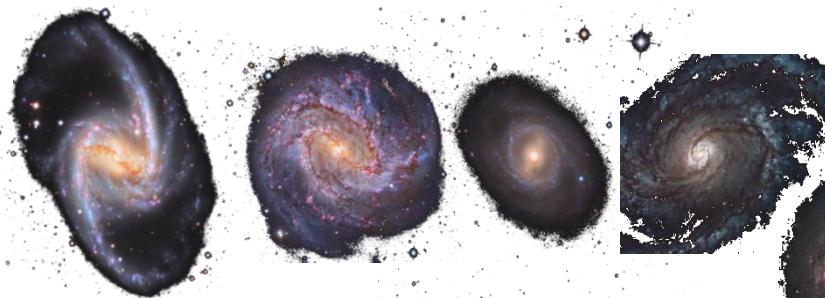Radiative transfer models

Radiative transfer (RT) in nearby galaxies

DustPedia

(II) Verstocken et al. 2020

(III) Nersesian et al. 2020a

(IV) Viaene et al. 2020

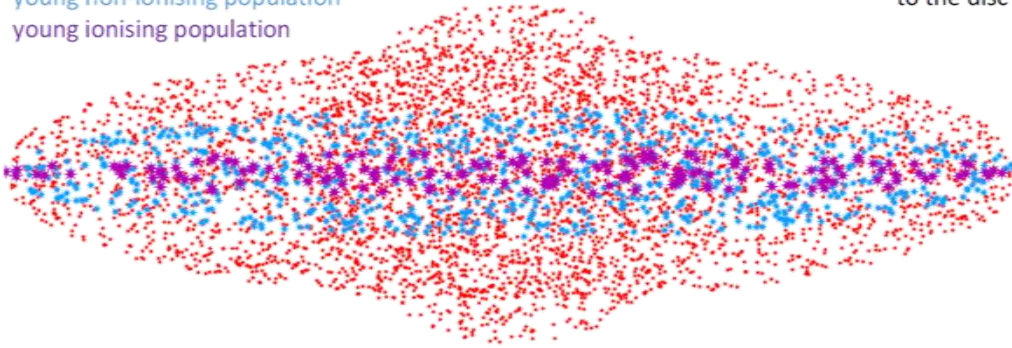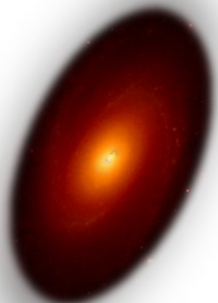**(V) Nersesian** et al. 2020b

old population
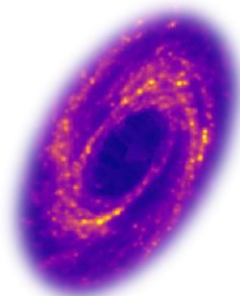young non-ionising population
young ionising population

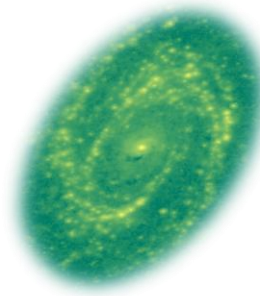2D cut perpendicular
to the disc

Verstocken et al. 2020

1. 2D → 3D;
2. Distribution constraints:
   - Young ionising stars
   - Young non-ionising stars
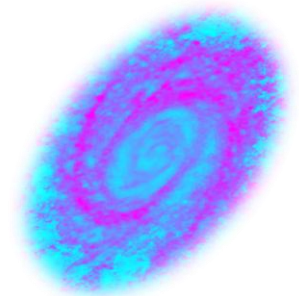   - Old stars
   - Dust
3. Radiative transfer solution.

Old stellar disc + bulge
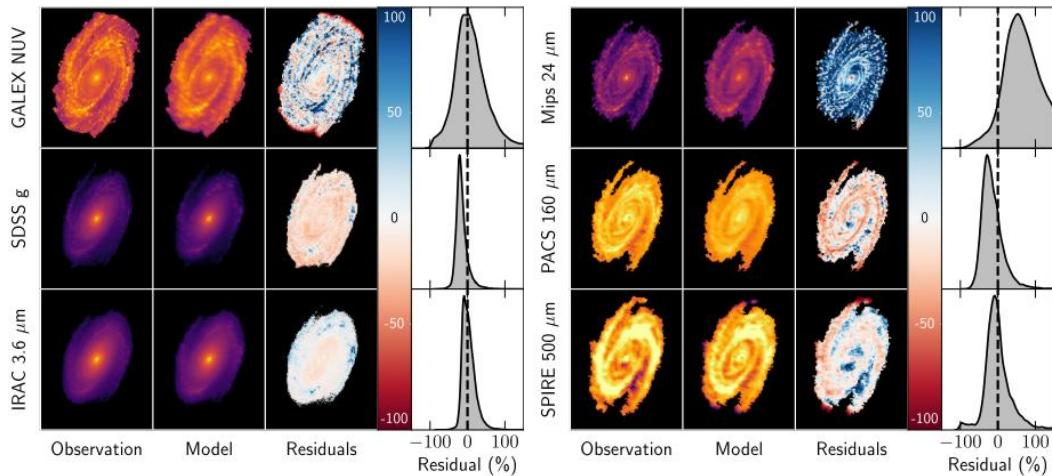
**Young non-ionising
stellar disc**

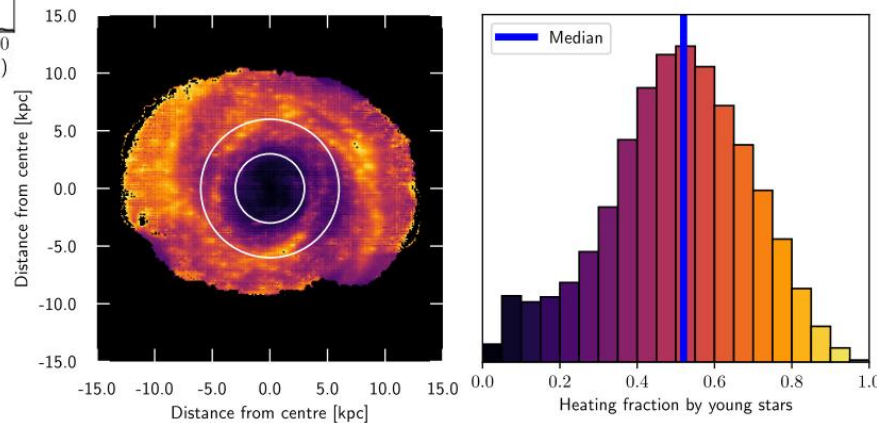**Young ionising
stellar disc**

Dust disc

The role of Old SP in dust heating

Median Values

f_{young} = 50.2%

f_{old} = 49.8%

Verstocken et al. 2020

The role of galactic bars in SFR

NGC1365

f_{young} = 68%

f_{old} = 32%

M95

f_{young} = 47%

f_{old} = 53%
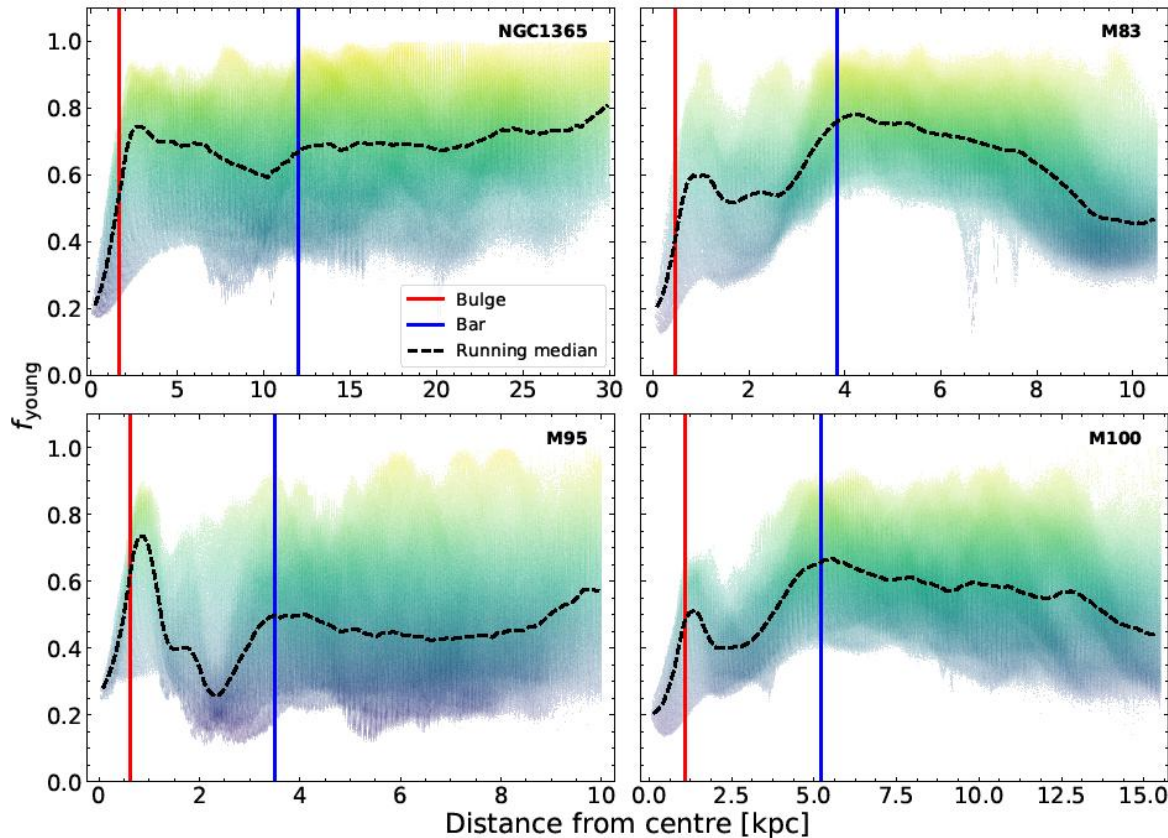
M83

f_{young} = 64%

f_{old} = 36%

M100

f_{young} = 57%

f_{old} = 43%

Nersesian et al. 2020a

The role of AGN heating
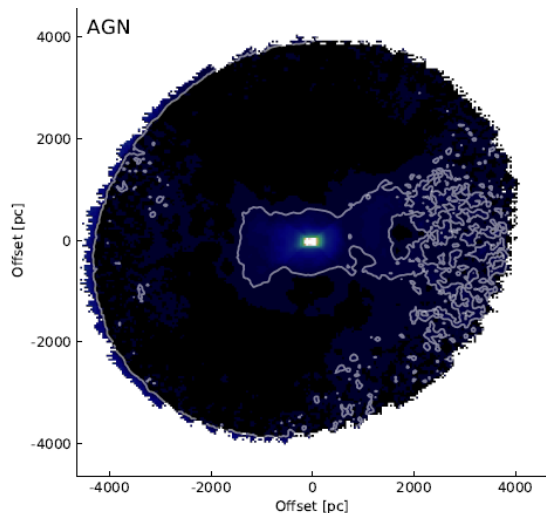
Median Values

f_{young} = 83%

f_{AGN} = 80% (inner 100 pc)

Viaene et al. 2020

The M51 system

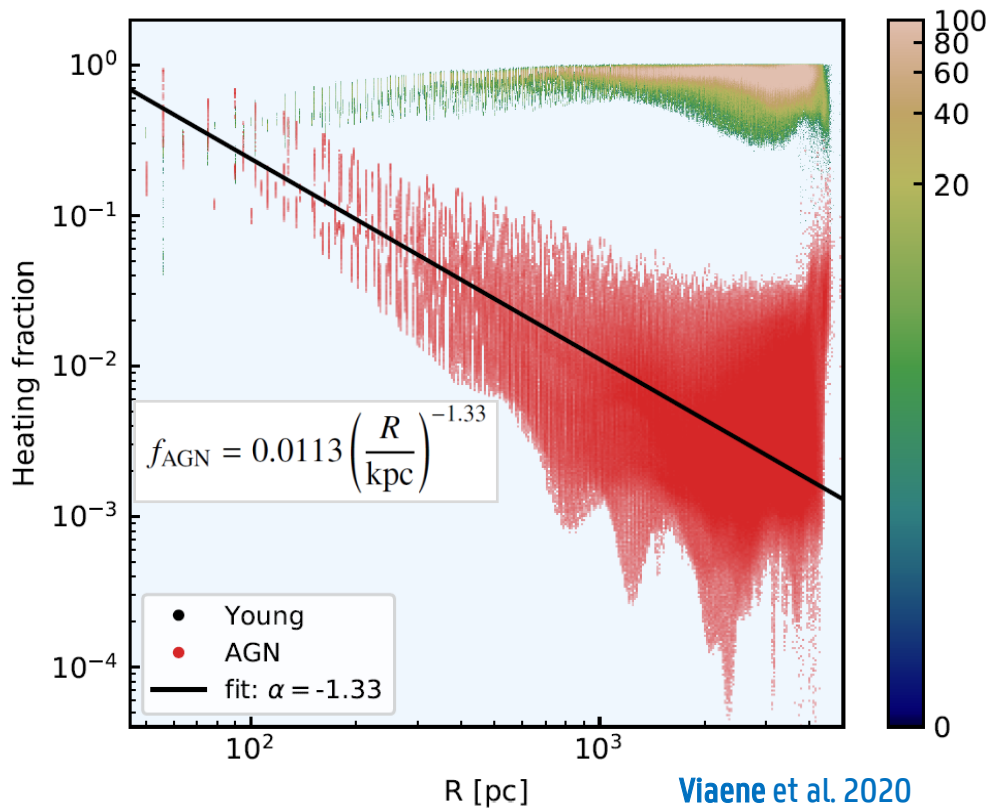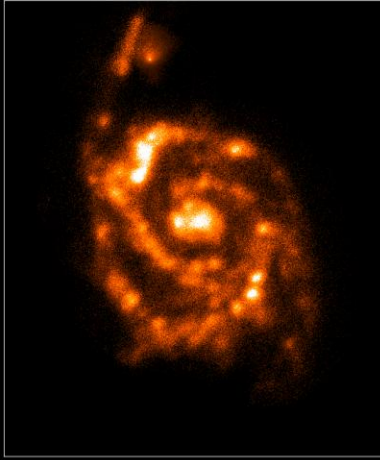GALEX FUV, GALEX NUV, SDSS u, SDSS g, SDSS r, KPNO Hα, SDSS i, SDSS z, 2MASS J, 2MASS H, 2MASS Ks, WISE W1, IRAC I1, IRAC I2, WISE W2, IRAC I3, IRAC I4, WISE W3, WISE W4, MIPS 24μm, MIPS 70μm, PACS blue, MIPS 160μm, PACS red, SPIRE PSW, SPIRE PMW, SPIRE PLW

Old stellar bulge (M51a), Old stellar disc (M51a), Young non-ionising stellar disc (M51a), Young ionising stellar disc (M51a)

M51 interacting system

u
g
r
i
z

Old stellar bulge (M51b)

Old stellar disc (M51b)

Dust disc (M51)

Nersesian et al. 2020b

Earth view

Spectral Energy Distribution
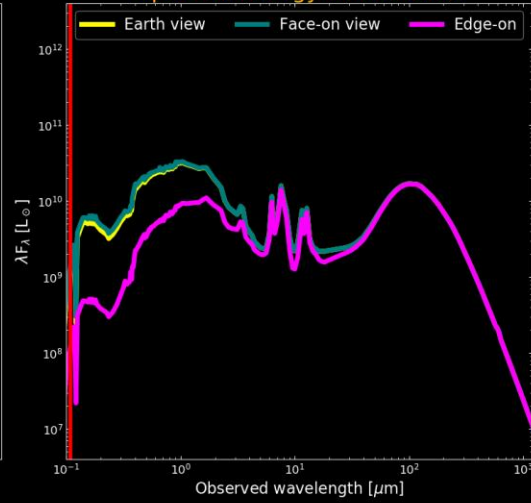
Face-on view

Edge-on

Nersesian et al. 2020b
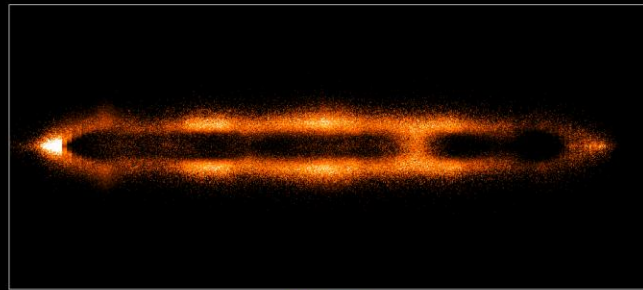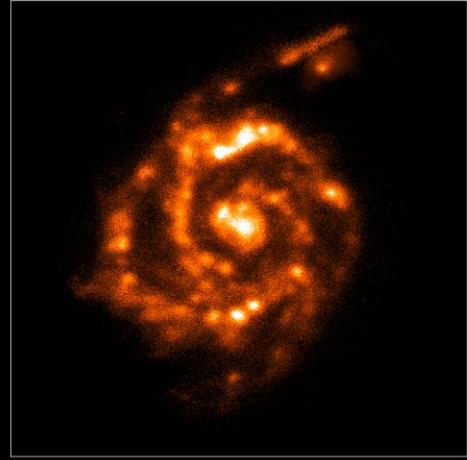
RT modelling: The M51 system

Nersesian et al. 2020b
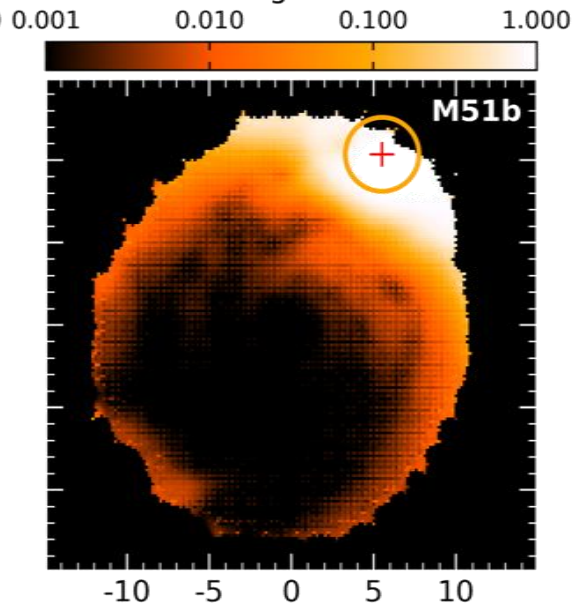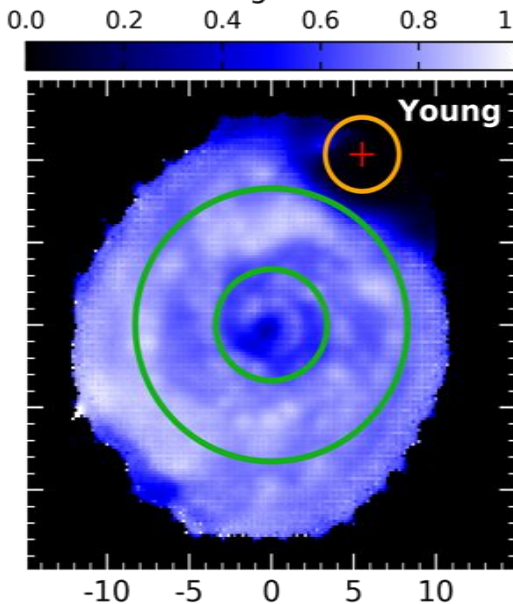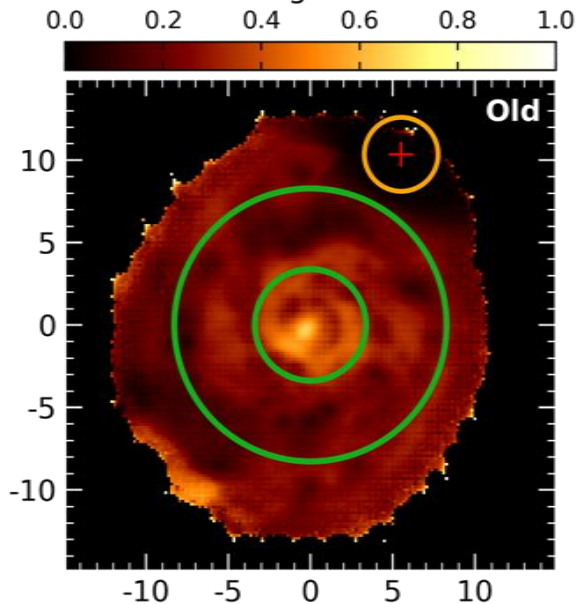
Method Limitations & Solutions

- The insensitivity of the DustPedia data set to cold dust.

- The spatial resolution of the interstellar dust component.

Whitworth et al. 2019

- New observational data on nearby galaxies in the submm/mm (NIKA2).
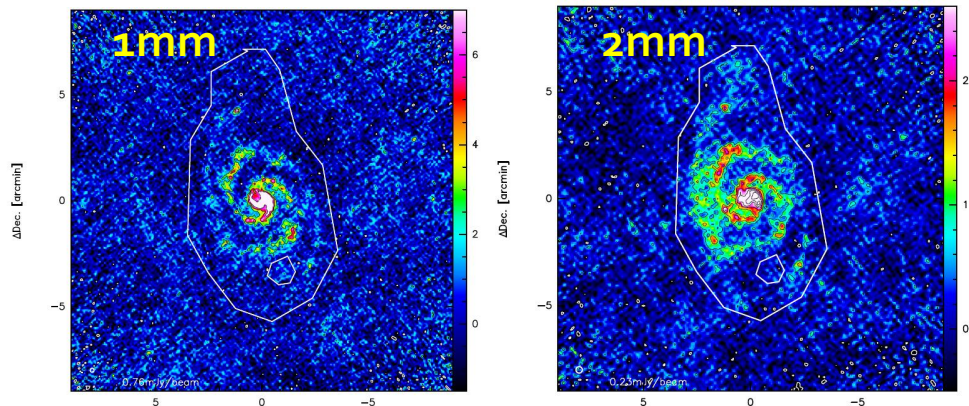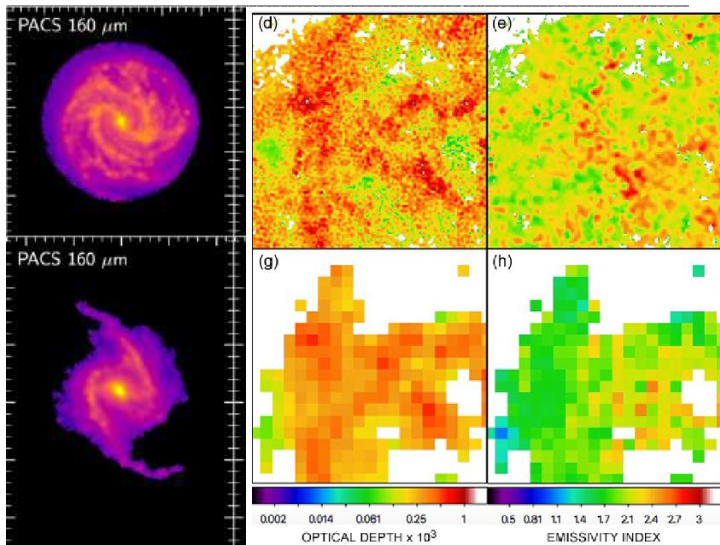
- A radically new method to generate dust density maps for nearby galaxies (PPMAP).

Marsh et al. 2017

NIKA2   IMEGIN   iram
Institut de
Radioastronomie
Millimétrique
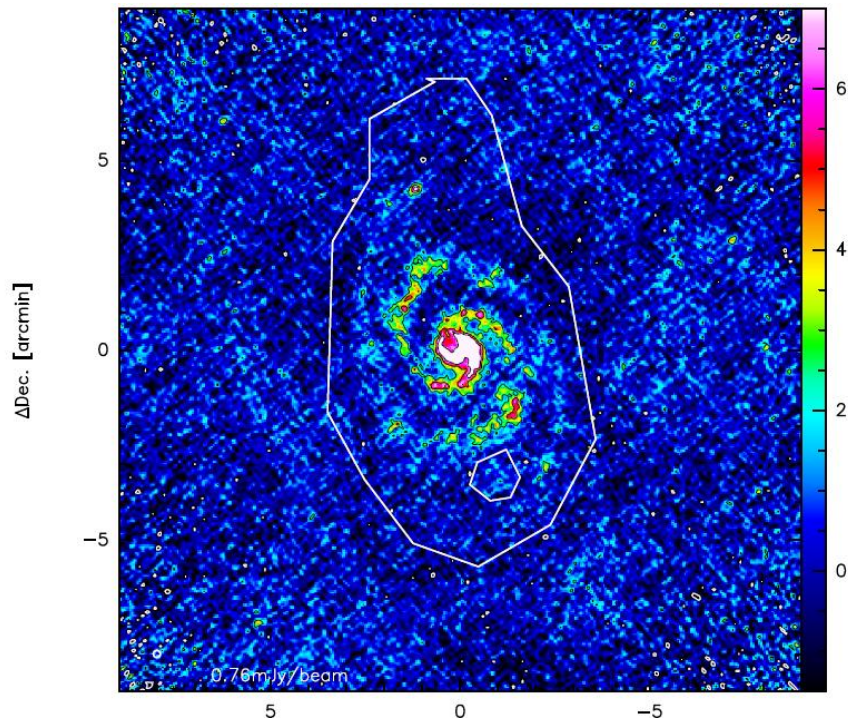
1mm NIKA2 maps of M51 at 11" resolution
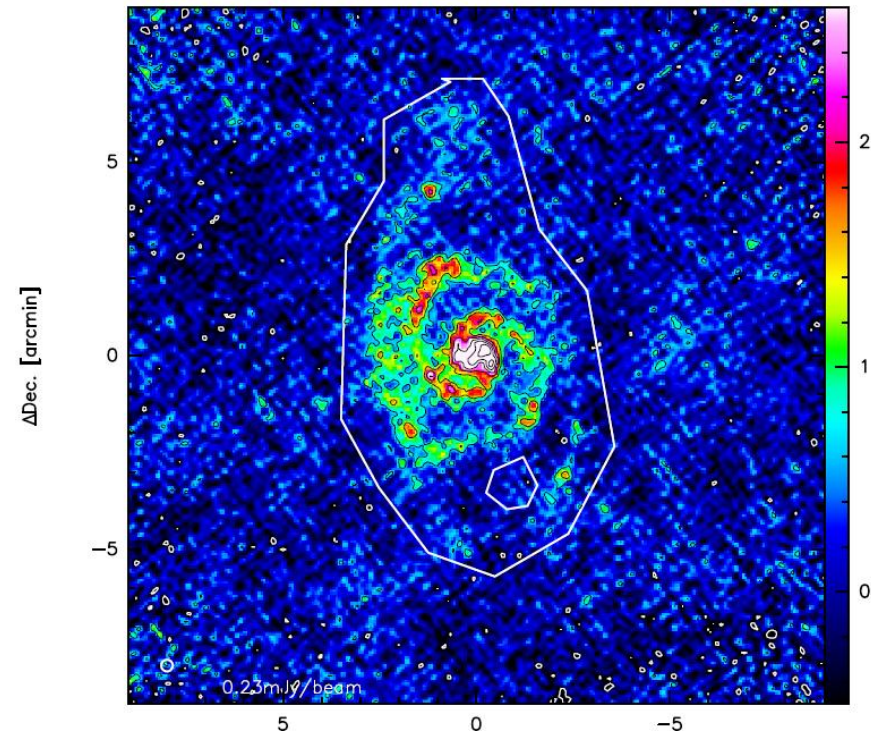
2mm NIKA2 maps of M51 at 18" resolution

NGC0891 at 1.15 mm
11.1"
~0.5kpc

NGC0891 at 2 mm
17.7"
~0.8kpc

IMEGIN

NGC4536 | M100 | M104 | NGC3521
NGC4559 | M74 | NGC3184 | NGC3938
NGC7331 | NGC4631 | NGC4725 | M94

NGC6946 1 mm

NGC6946 2 mm
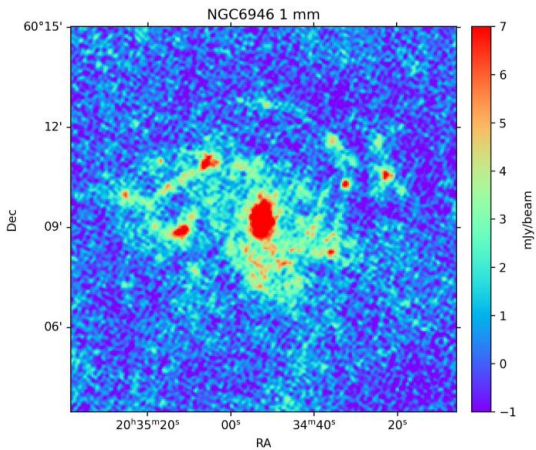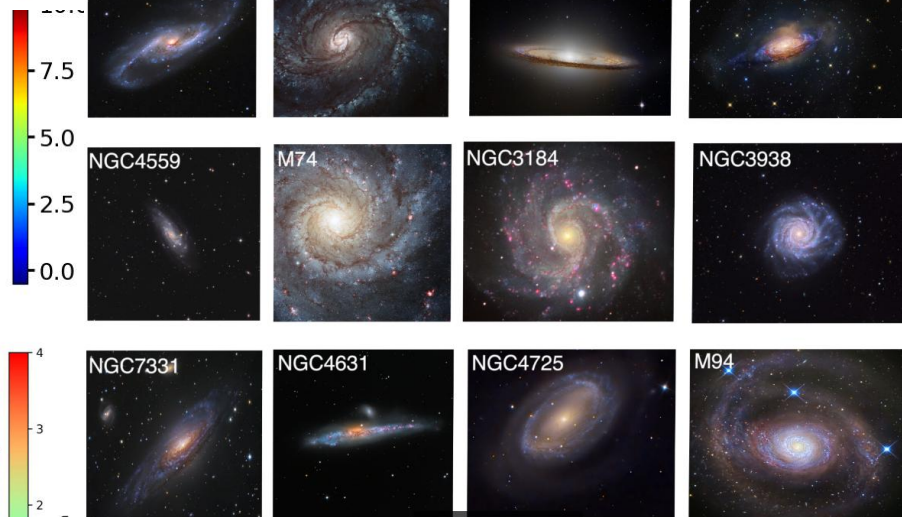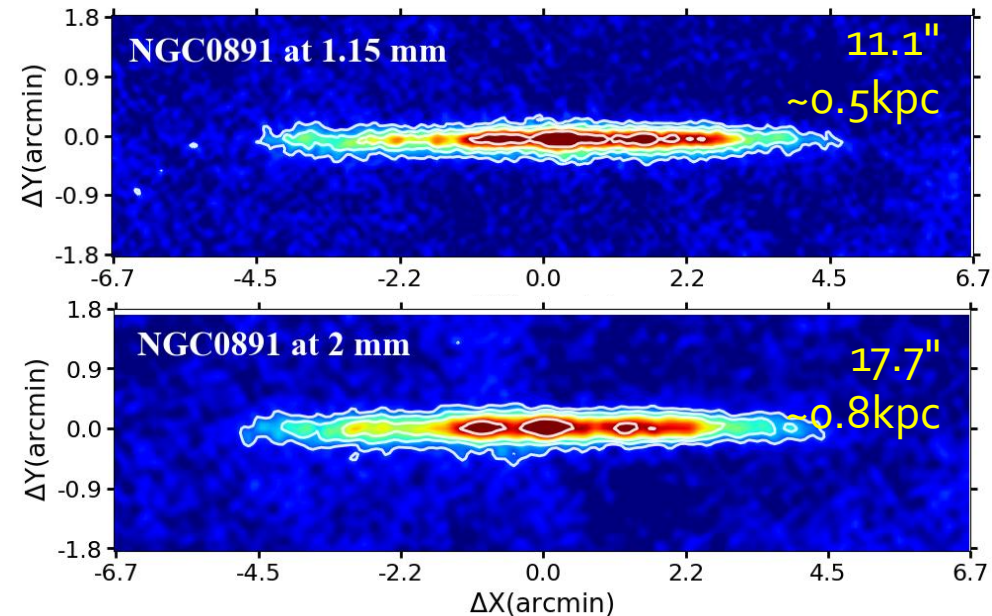
Advantages of the NIKA2 data

Increased spatial resolution at the submm/mm regime allowing for the detection of the very cold dust (T < 15 K), where most of the dust mass is.
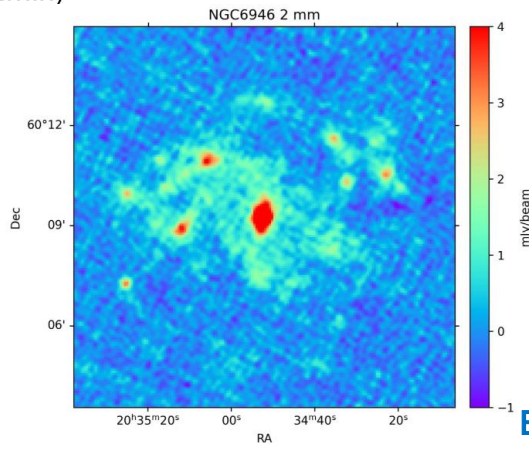
Incorporation of two new physical processes in the **SKIRT** framework:
synchrotron emission + **free-free emission**

Questions need answering

❖ Do we find evidence for a spatial variation of the dust properties between & within galaxies?

❖ How important is the contribution of cold dust in nearby galaxies?

❖ What is the contribution of different stellar populations to the heating of the dust?

❖ Can we put constraints on the dust grain alignment & shape distribution in galaxies?

The sSFR-f$_{young}$ relation
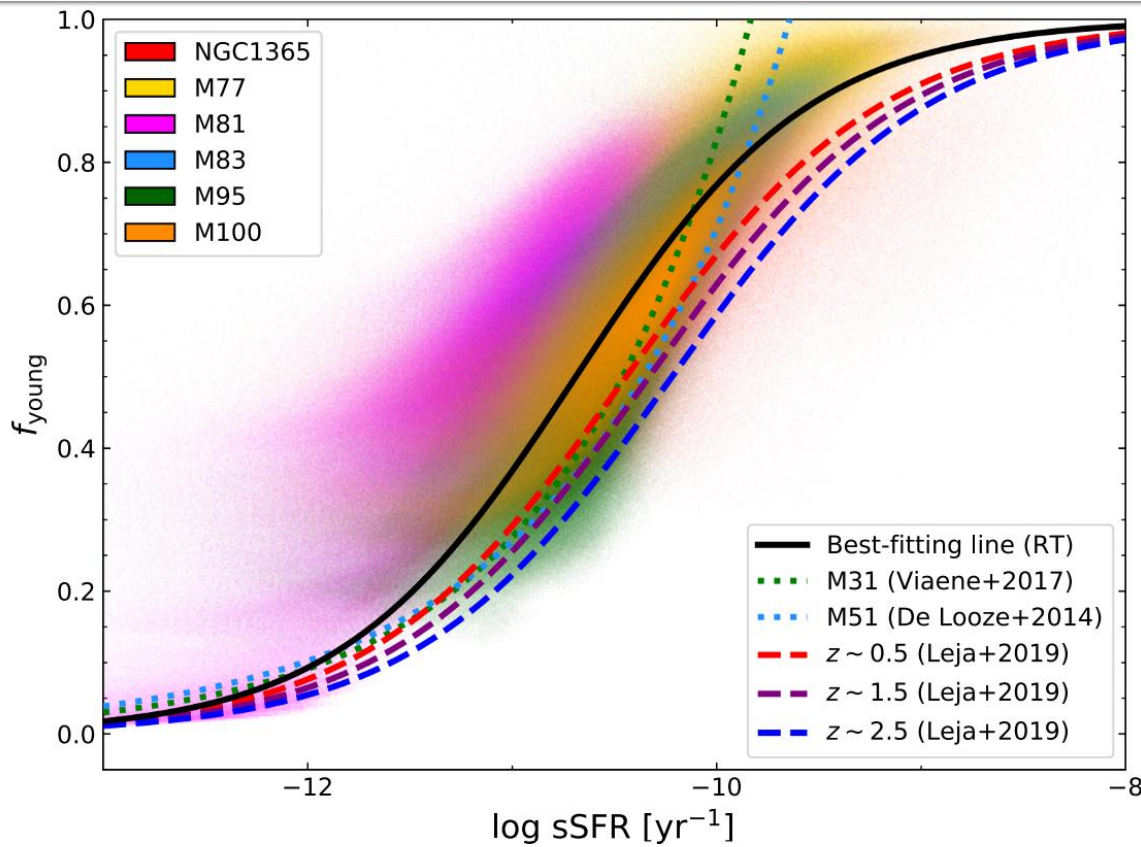
Summary

We have constructed a framework to construct 3D models for nearby galaxies to investigate the dust heating mechanisms.

- ✓ The integrated SEDs of all galaxies are fitted well.
- ✓ Our model is able to reproduce the observed morphologies reasonably well.
- ✓ Our study reveals the importance of old stars, AGN, and merging events to the dust emission at FIR/submm bands.

Limitations of the method

- x The insensitivity of the DustPedia data set to cold dust.
- x The spatial resolution of the interstellar dust component.

Solutions

- ✓ New hi-res observational data on nearby galaxies in the submm/mm (NIKA2).
- ✓ A radically new method to generate dust density maps for nearby galaxies (PPMAP).