SED fitting of the
Herschel Reference Survey

Laure Ciesla, Alessandro Boselli, Médéric Boquien, Véronique Buat,
Luca Cortese, George Bendo, Steve Eales, Matt Smith,
the SAG2 group and the HeViCS team.

From Dust to Galaxies – IAP – June,27th – July,1st 2011

HRS and HeViCS

Herschel Reference Survey and the Herschel Virgo Cluster Survey
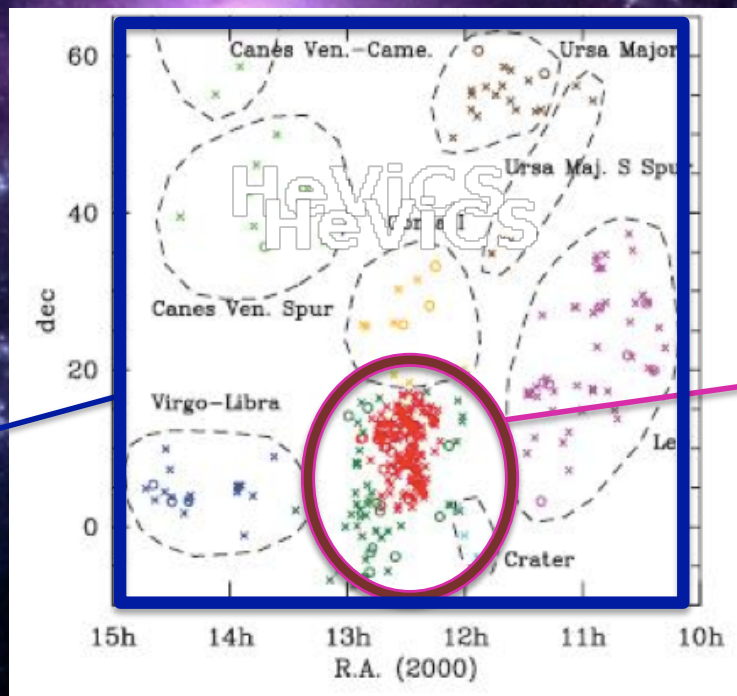
PI: S. Eales, Boselli et al. 2010a

PI: J. Davies, Davies et al. 2010

- dust content vs Hubble type
- role of dust within the ISM
- interplay between dust and stellar populations

Impact of the environment on the dust of the galaxies

$15 < D < 25$ Mpc
$b > 55°$
$A_B < 0.2$
K < 8.7 for E, S0, S0a and
K < 12 for Sa-Im-BCD

Fully sampled of ~60 sq deg using both PACS and SPIRE (100 to 500 microns)
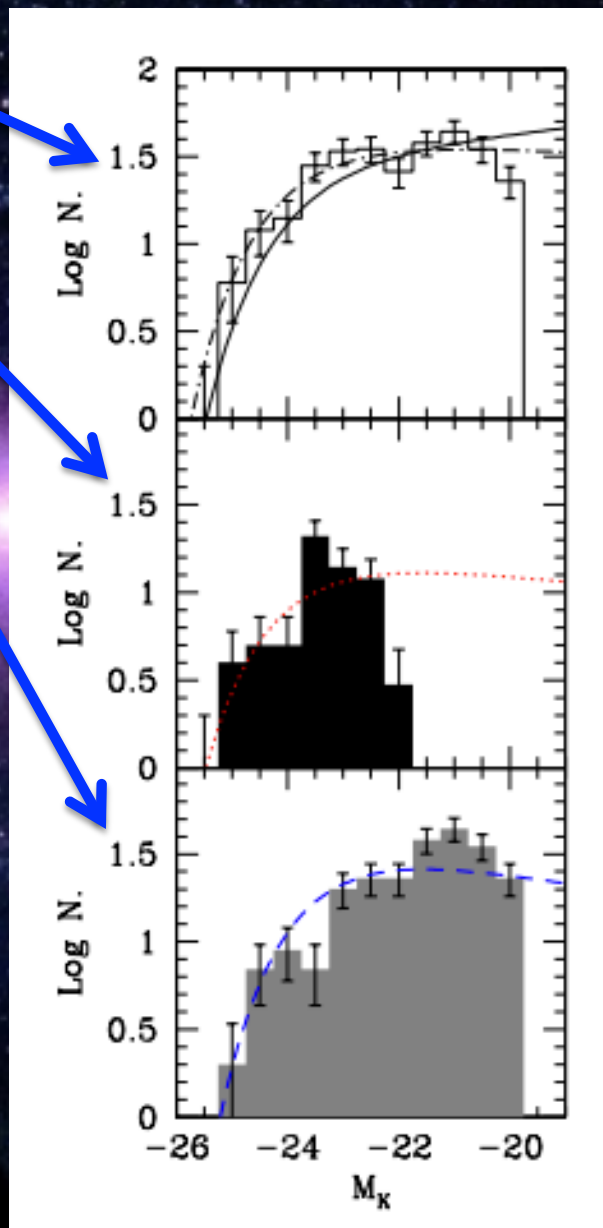
323 galaxies observed at 250, 350, 500 microns
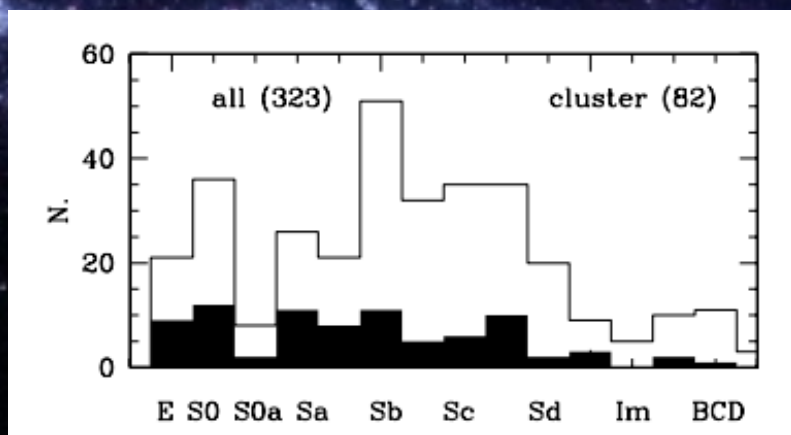
HRS
Herschel Reference Survey

K band luminosity function for **HRS galaxies**.

K band luminosity function for **Early types**.
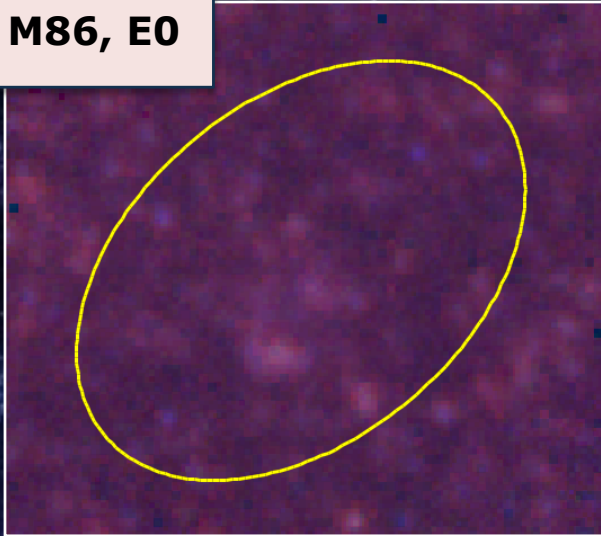
K band luminosity function for **Late types**.

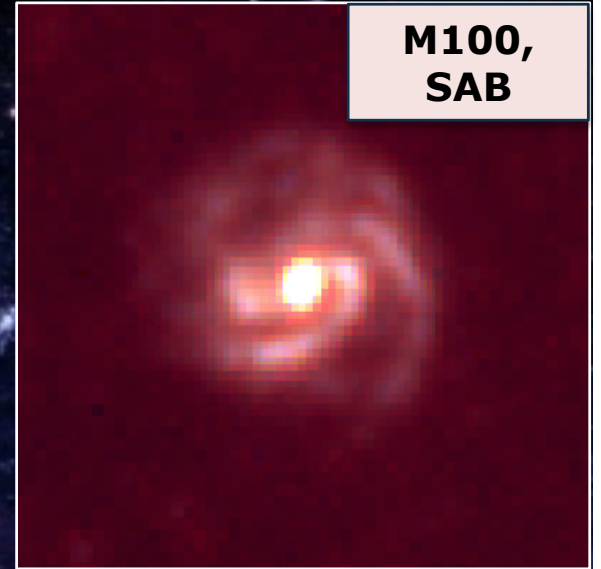Compared to 2MASS
Kochanek et al. 2001
Cole et al. 2001

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HRS
Herschel **R**eference **S**urvey

M86, E0

M100, SAB

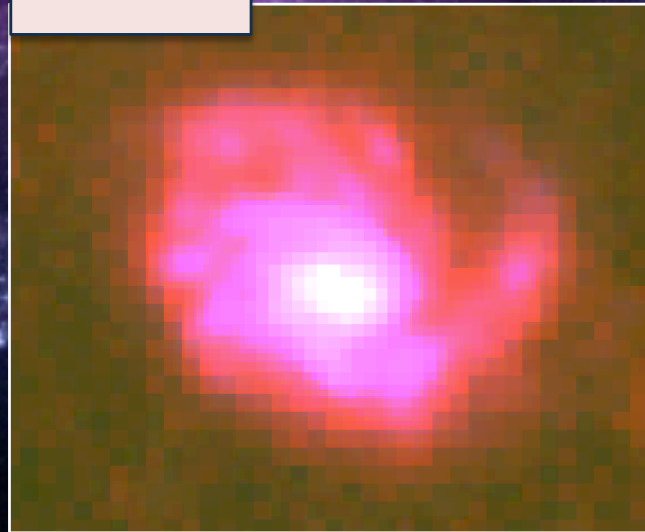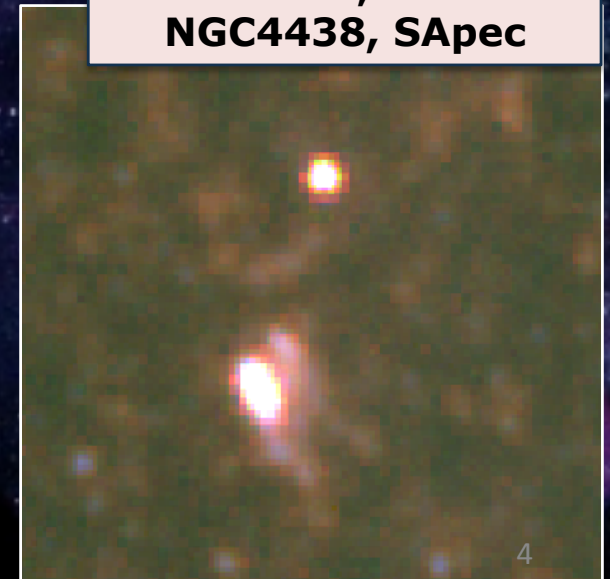Images in SPIRE bands 250, 350 and 500 microns
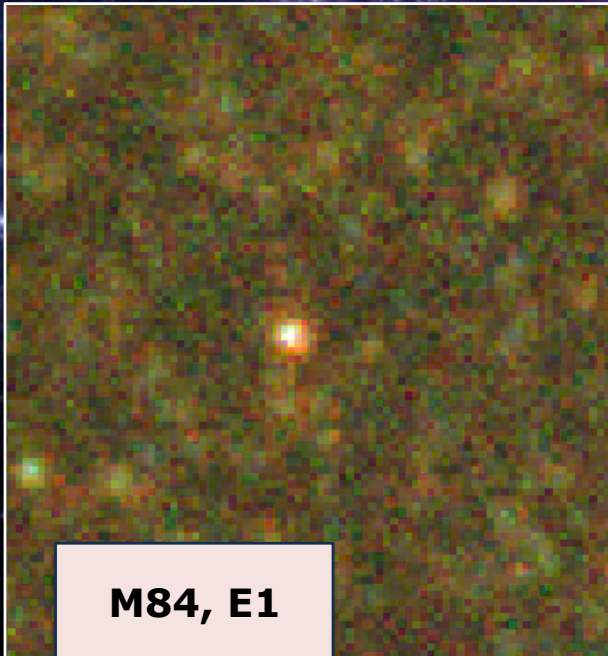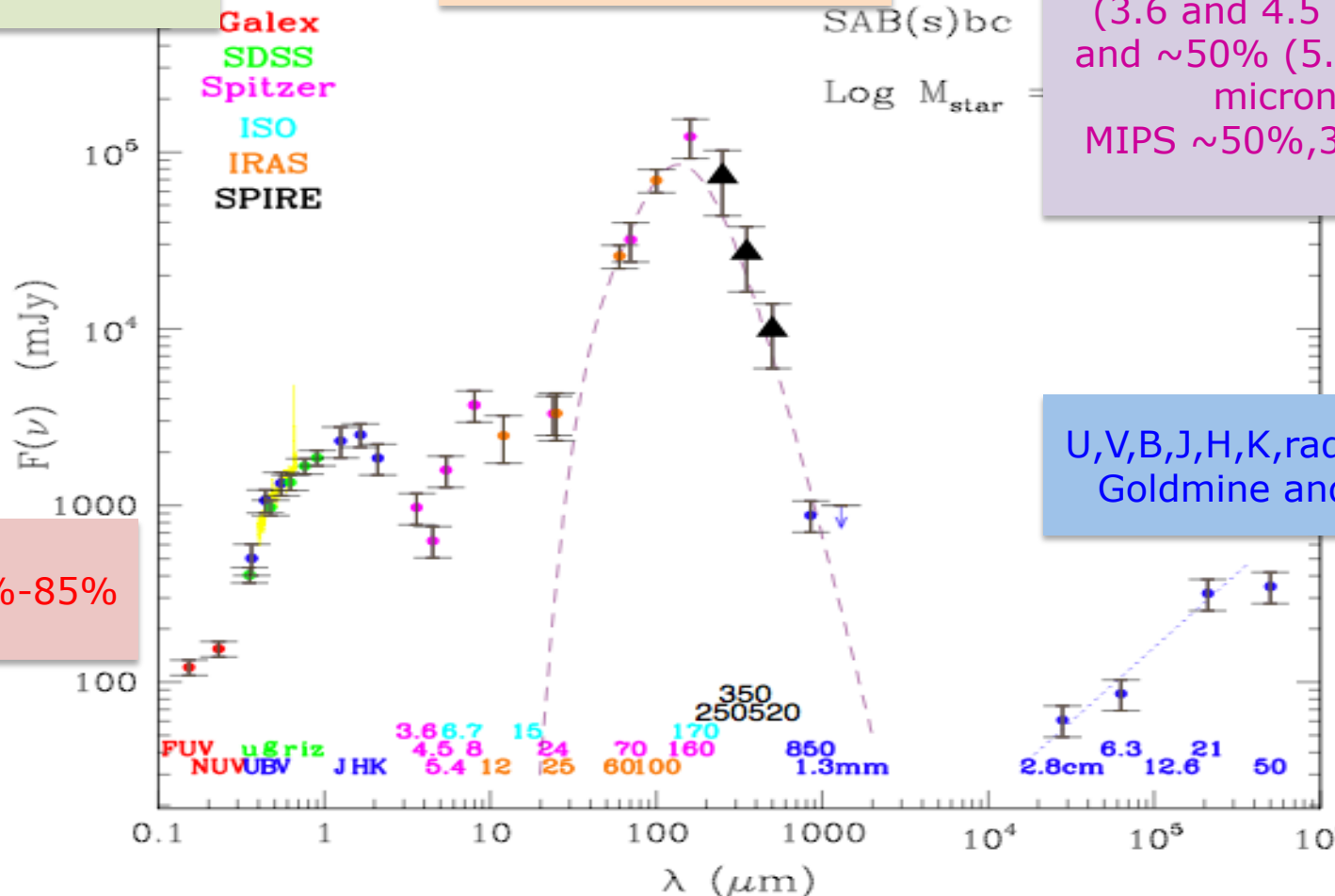
M99, SA

NGC4435, SB and NGC4438, SApec

M84, E1

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HRS Corollary Data

SDSS ~80%

IRAS ~90%

Spitzer IRAC* ~85%
(3.6 and 4.5 microns)
and ~50% (5.4 and 8.0 microns)
MIPS ~50%,33%,31%

Galex ~70%-85%

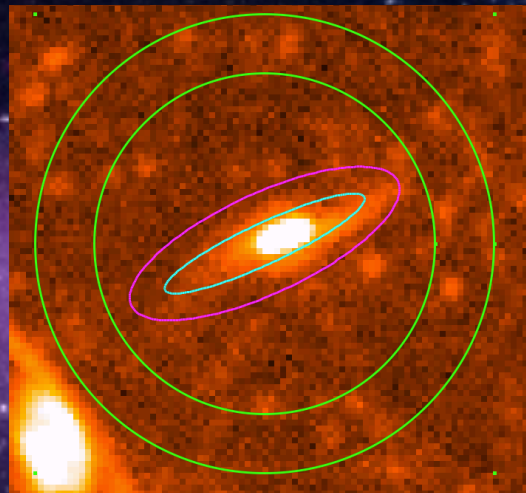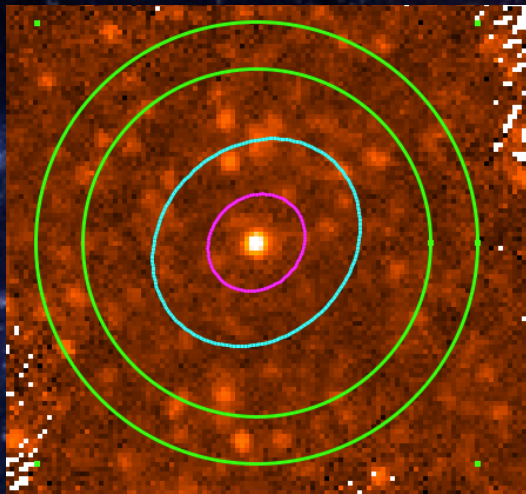U,V,B,J,H,K,radio from Goldmine and NED

M100

Other data are available like metallicity, Halpha (~70%), SFR, birthrate parameter (sSFR)…
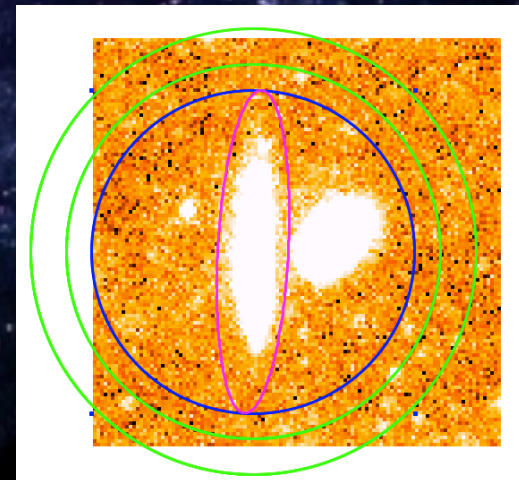
*IRAC photometry in progress

Ciesla et al. (in prep)

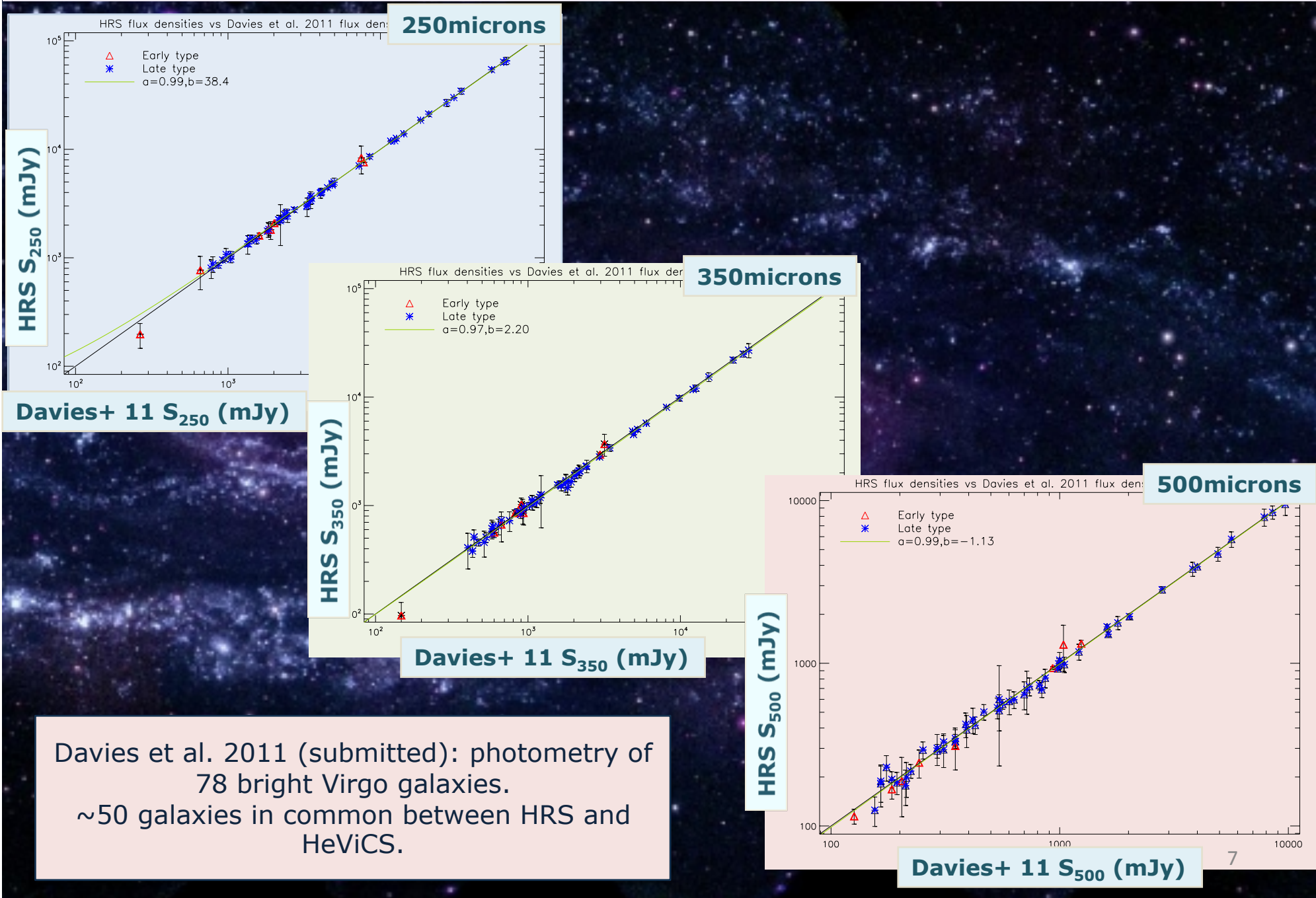Aperture photometry for extended sources (adapted to every galaxy) and PSF fitting on timeline data for point like sources

PSF fitting on timeline data: fitter coded by George Bendo.
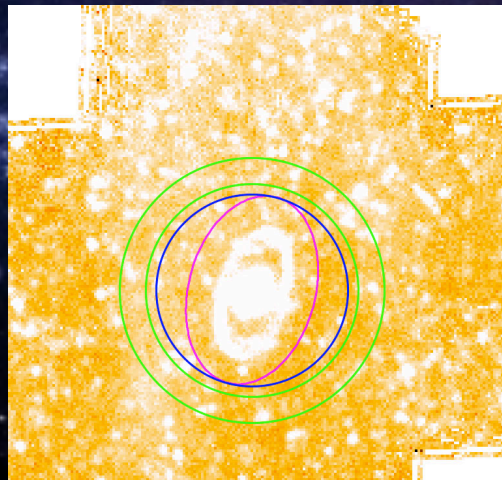
Photometry: comparison with Davies et al. 2011

250microns

HRS flux densities vs Davies et al. 2011 flux densities

- △ Early type
- ✳ Late type
- a=0.99,b=38.4

HRS S_{250} (mJy)

Davies+ 11 S_{250} (mJy)

350microns

HRS flux densities vs Davies et al. 2011 flux densities

- △ Early type
- ✳ Late type
- a=0.97,b=2.20

HRS S_{350} (mJy)

Davies+ 11 S_{350} (mJy)

500microns

HRS flux densities vs Davies et al. 2011 flux densities

- △ Early type
- ✳ Late type
- a=0.99,b=−1.13

HRS S_{500} (mJy)

Davies+ 11 S_{500} (mJy)

Davies et al. 2011 (submitted): photometry of 78 bright Virgo galaxies.
~50 galaxies in common between HRS and HeViCS.

Goals of the SED fitting of the HRS

Test already existing templates and models for the far infrared emission.

Study the dust emission of galaxies spanning a large range in Luminosity, Morphological type, Metallicity, sSFR, Stellar Mass, Dust Mass …

Provide templates for cosmological studies.

Goals of the SED fitting of the HRS

Test already existing templates and models for the far infrared emission.

Study the dust emission of galaxies spanning a large range in Luminosity, Morphological type, Metallicity, sSFR, Stellar Mass, Dust Mass …

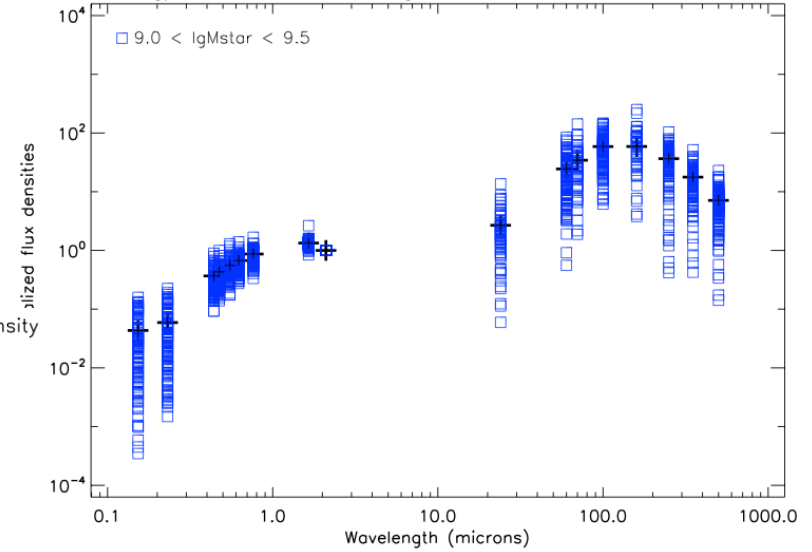Provide templates for cosmological studies.

HRS SEDs and mean SEDs

Spectral Energy Distribution of HRS galaxies normalized to K band flux density
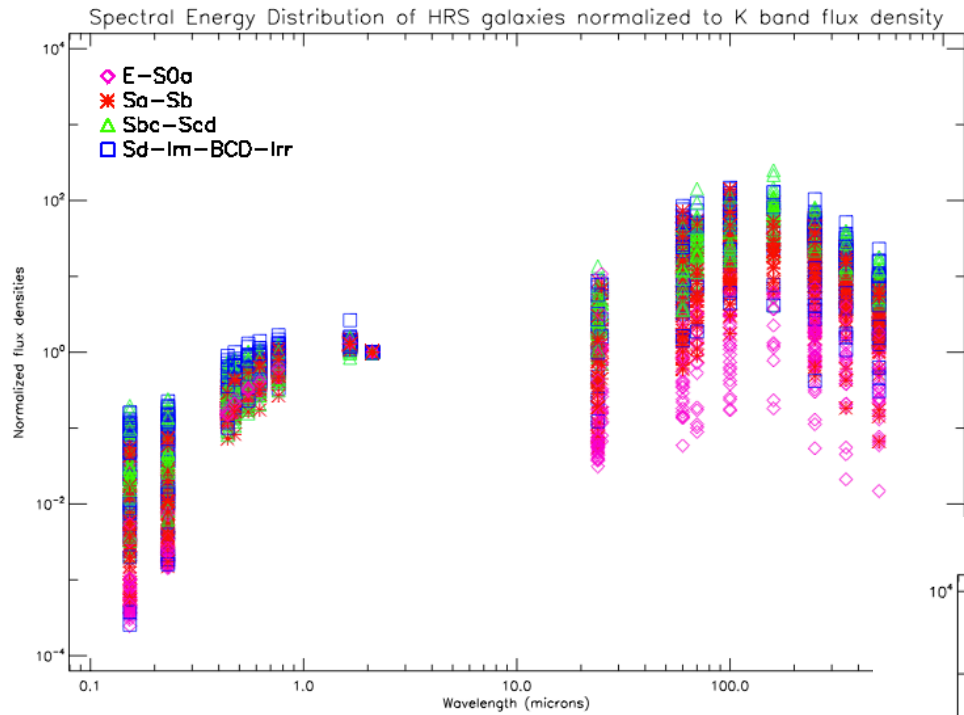
Production of mean SEDs using different parameters:
Morphological Type, Stellar Mass
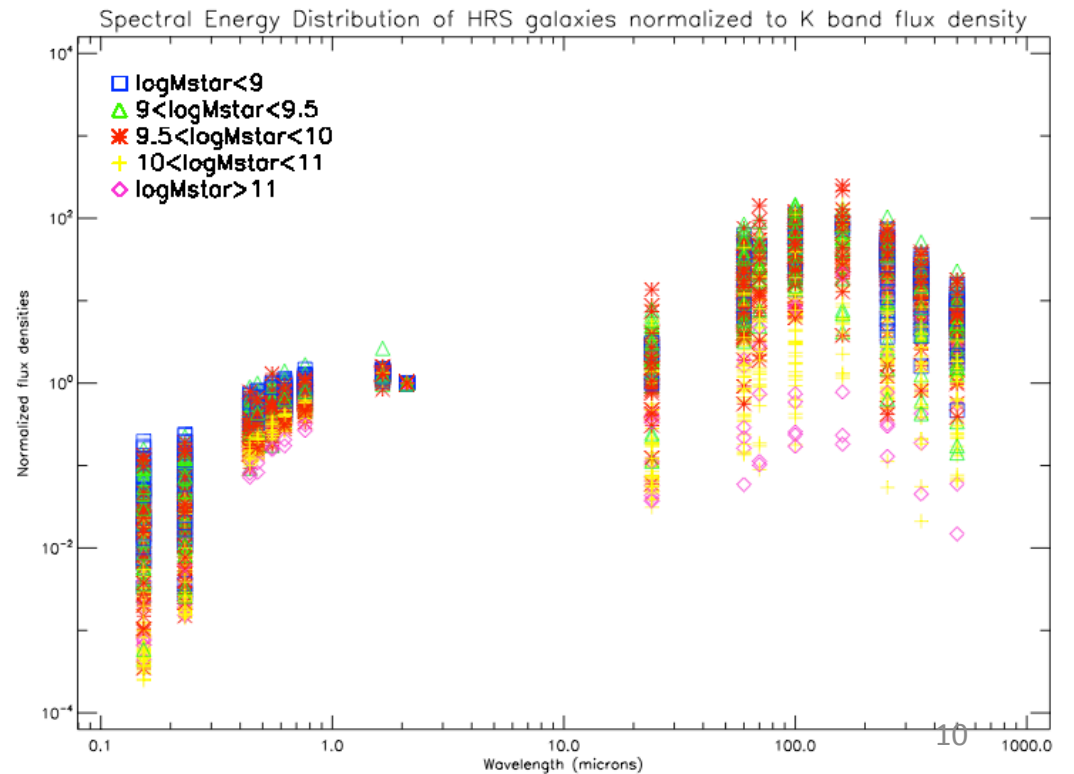
Normalized to the K band
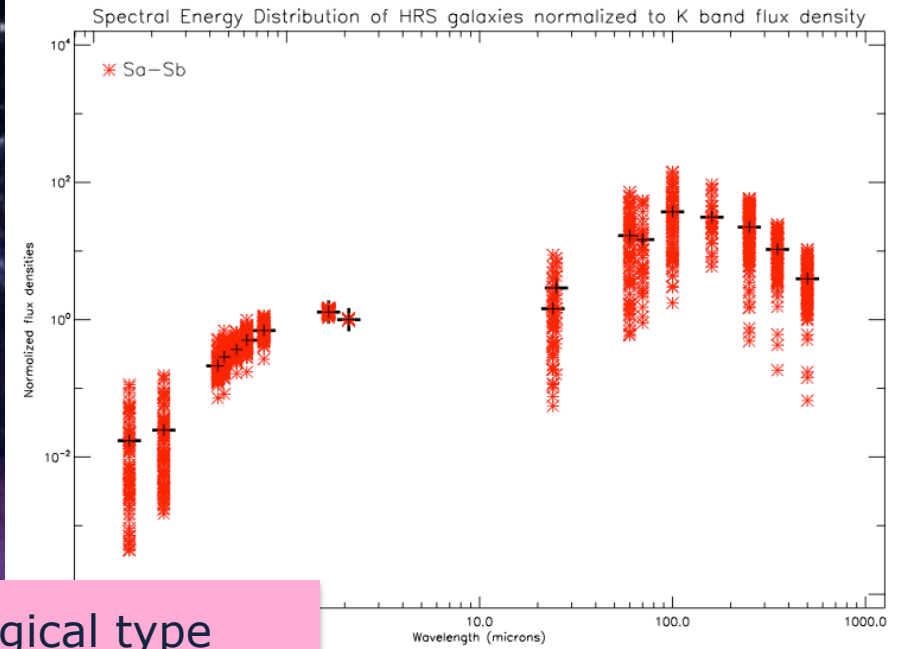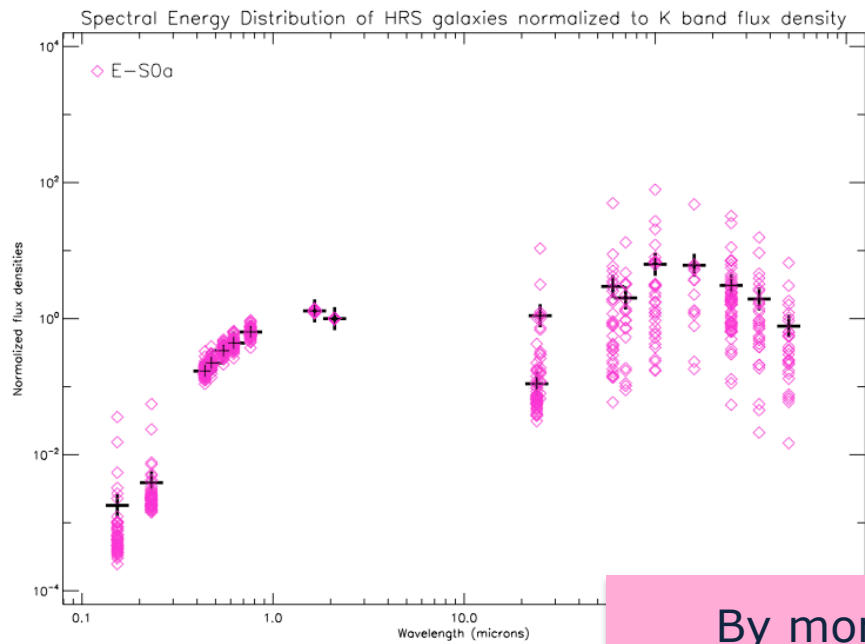
By morphological type
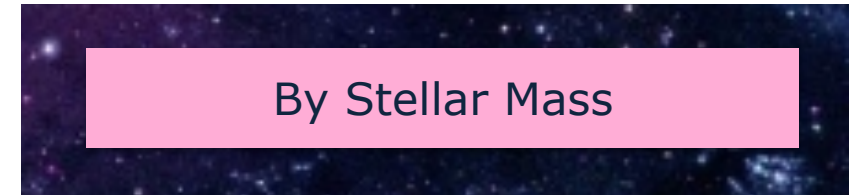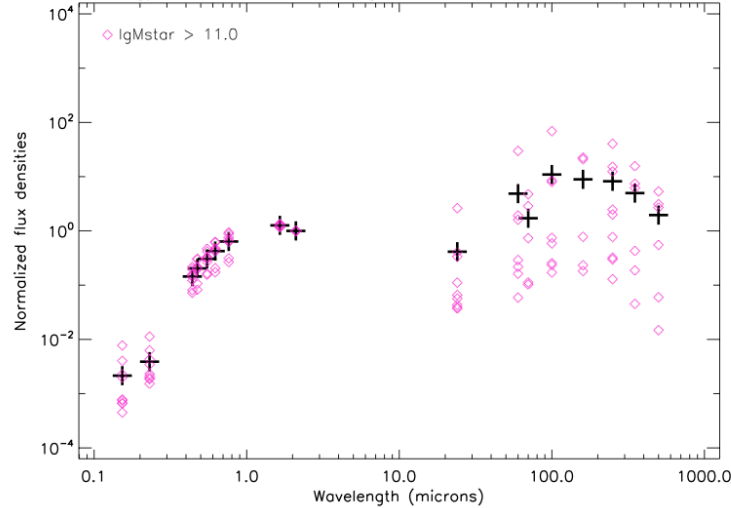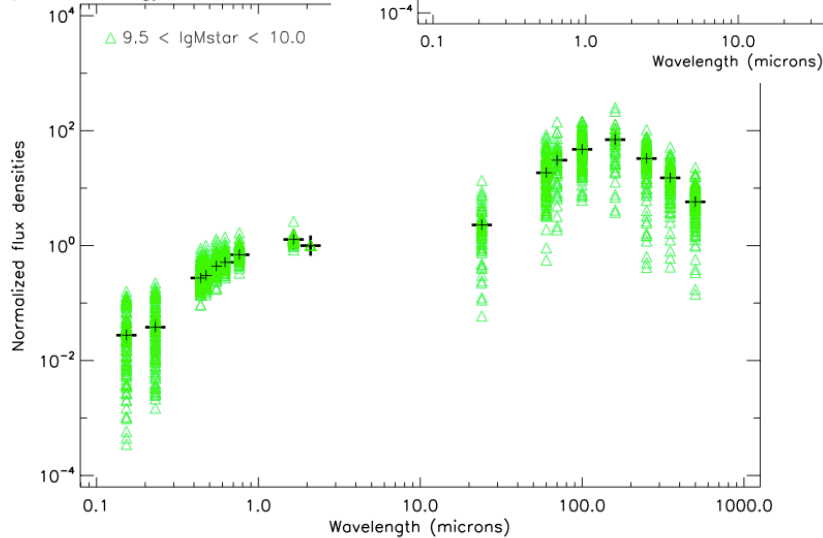
HRS SEDs and mean SEDs

Spectral Energy Distribution of HRS galaxies normalized to K band flux density

lgMstar<9

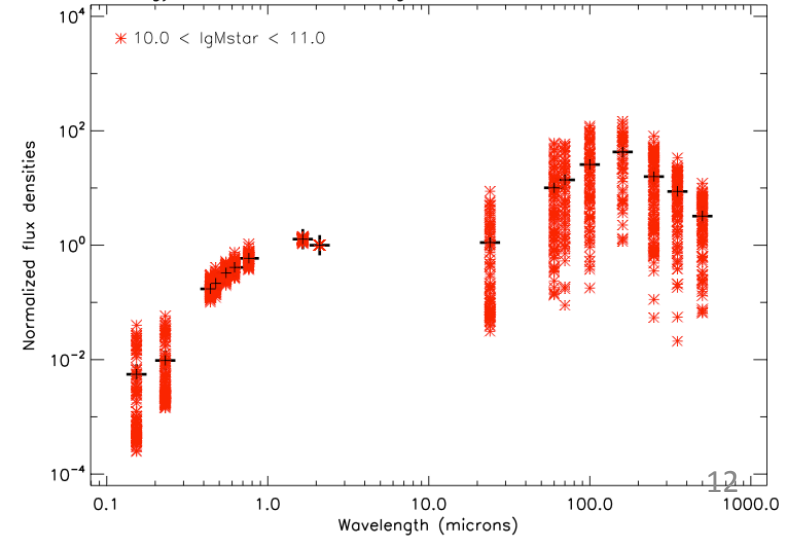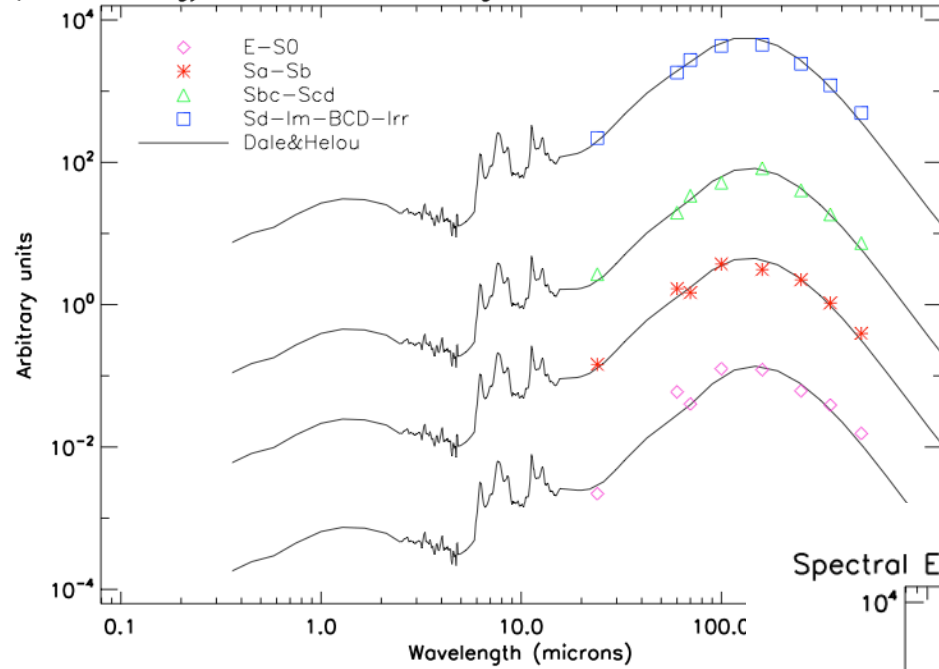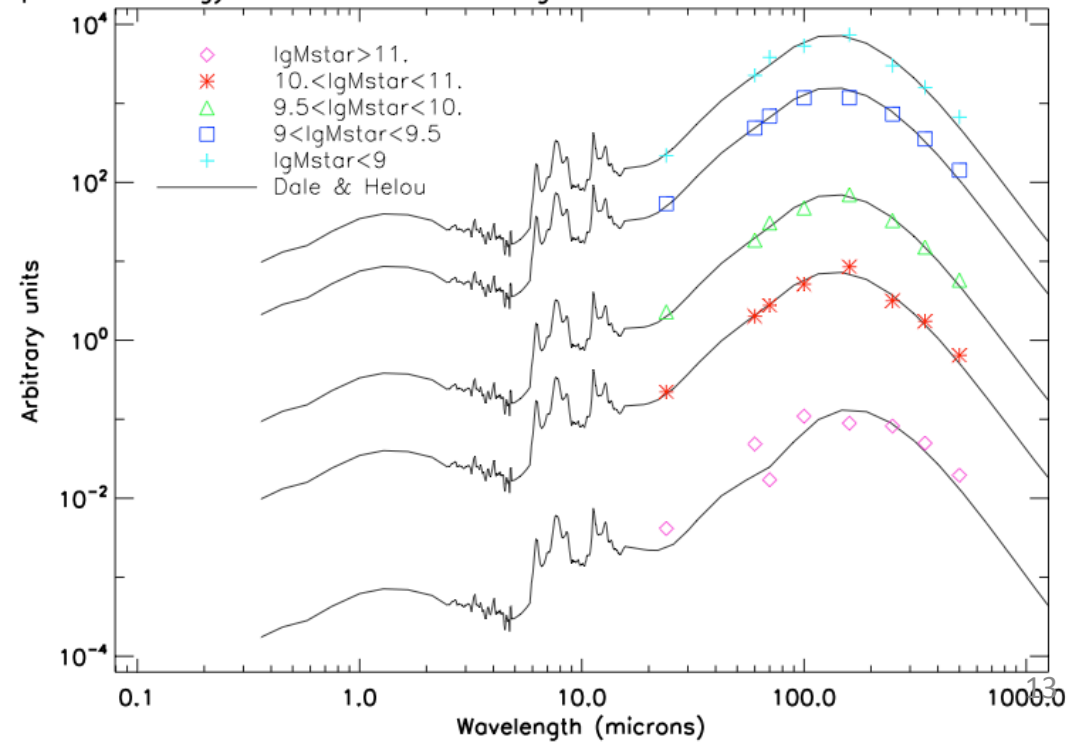Spectral Energy Distribution of HRS galaxies normalized to K band flux density
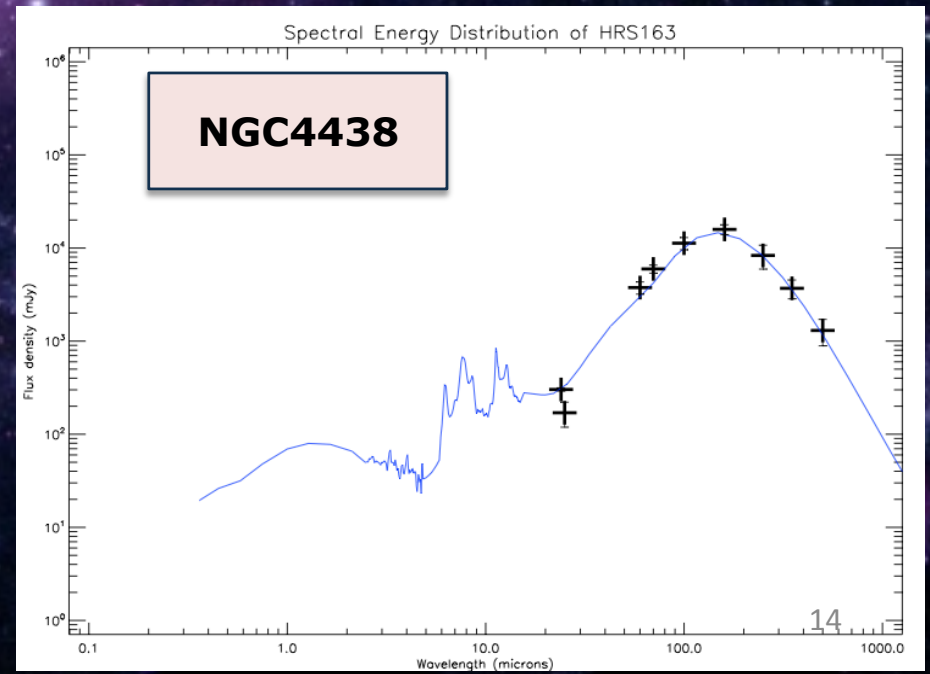
9.0 < lgMstar < 9.5
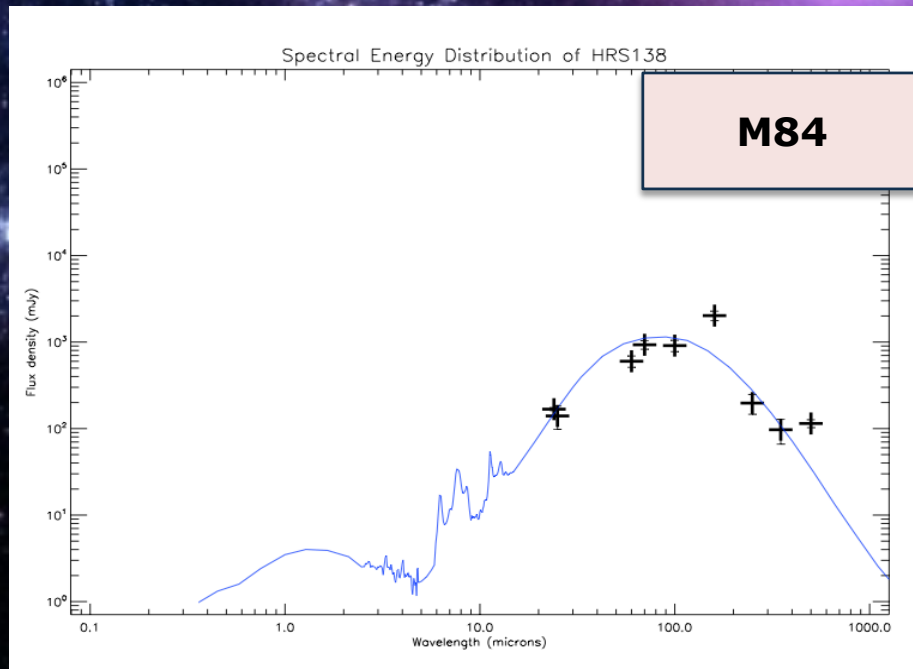
Spectral Energy Distribution of HRS galaxies normalized to K band flux density

lgMstar > 11.0

By Stellar Mass

Spectral Energy Distribution of

9.5 < lgMstar < 10.0

Spectral Energy Distribution of HRS galaxies normalized to K band flux density
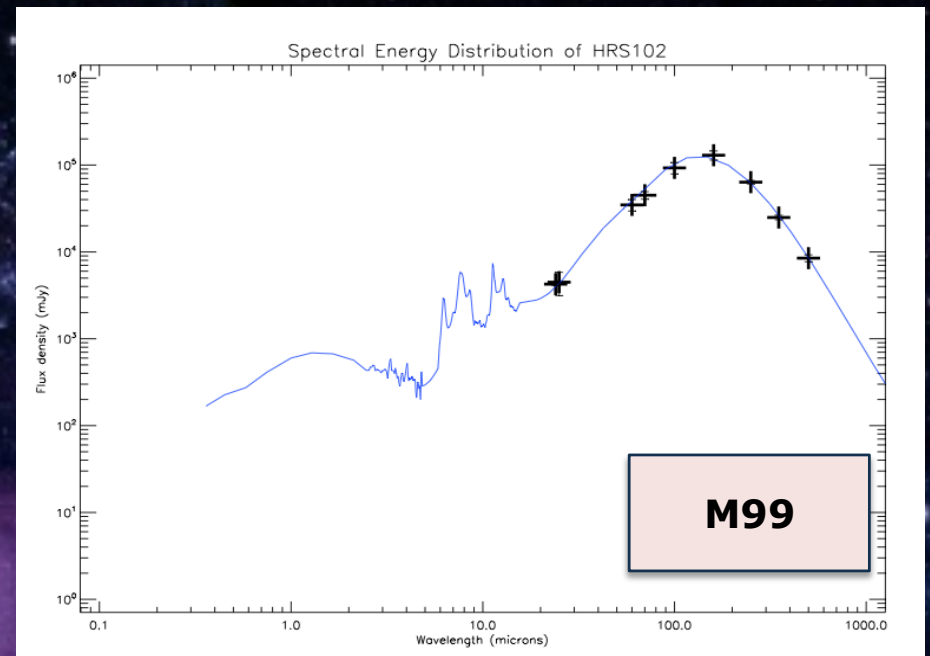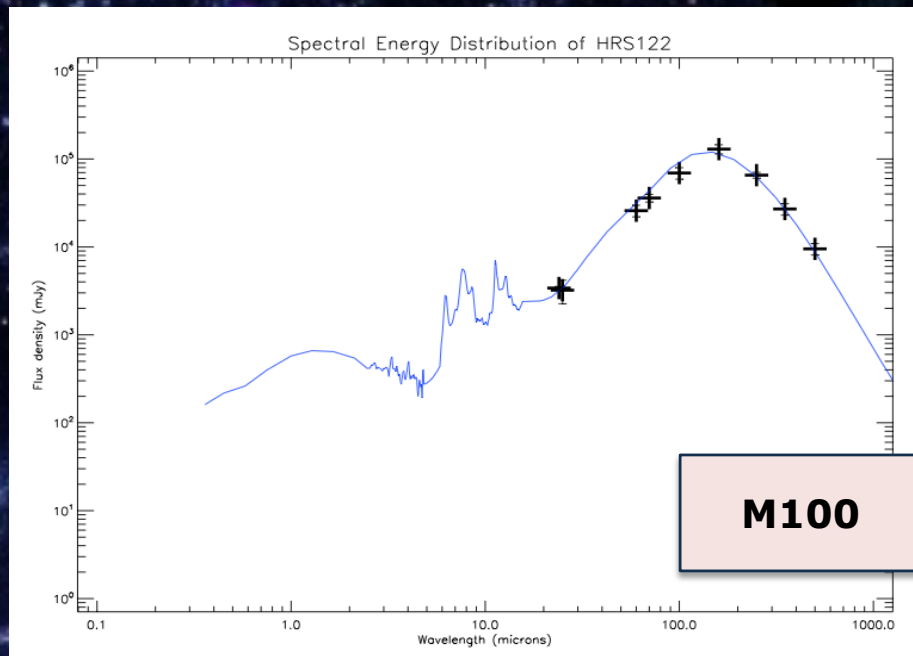
10.0 < lgMstar < 11.0

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Dale & Helou 2002
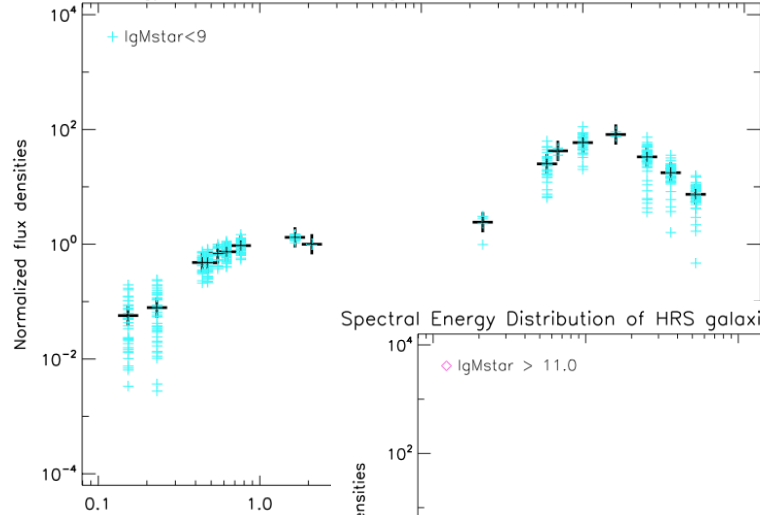
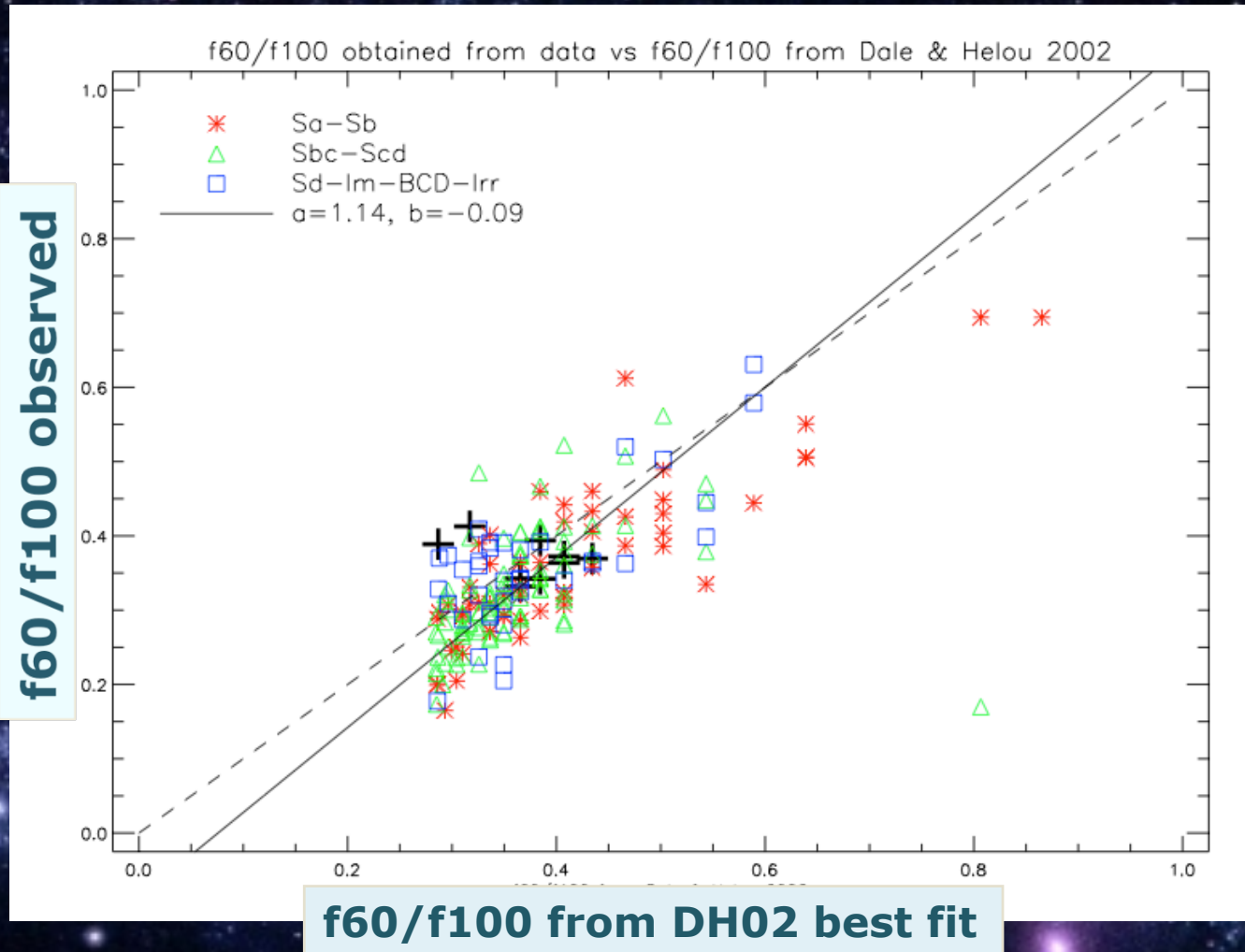Spectral Energy Distribution of HRS galaxies normalized to K band flux density

Spectral Energy Distribution of HRS galaxies normalized to K band flux density
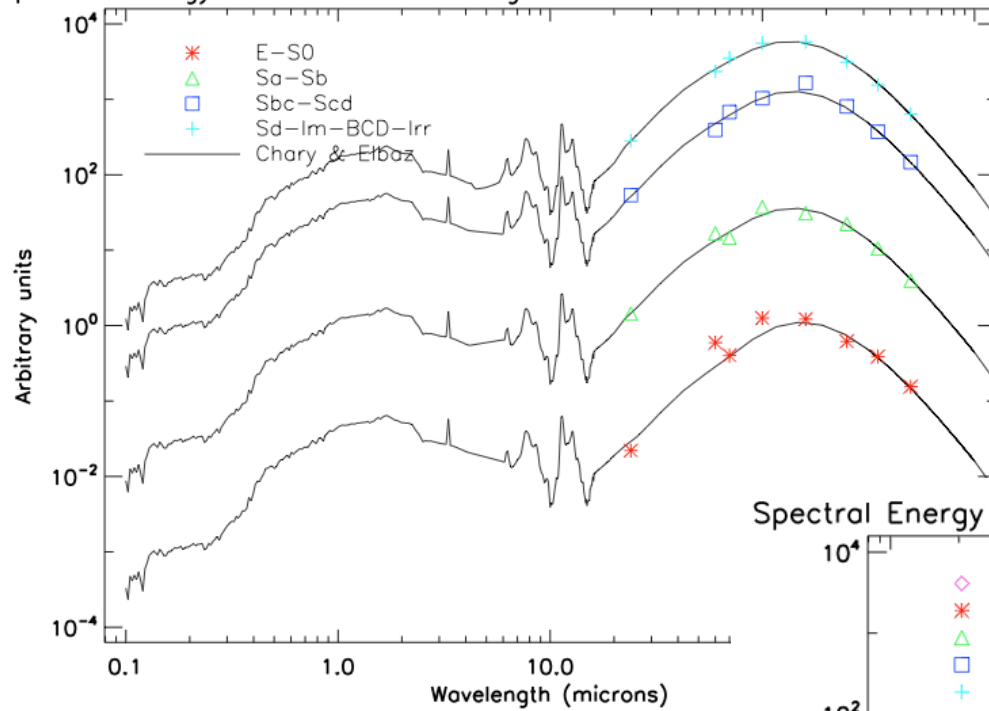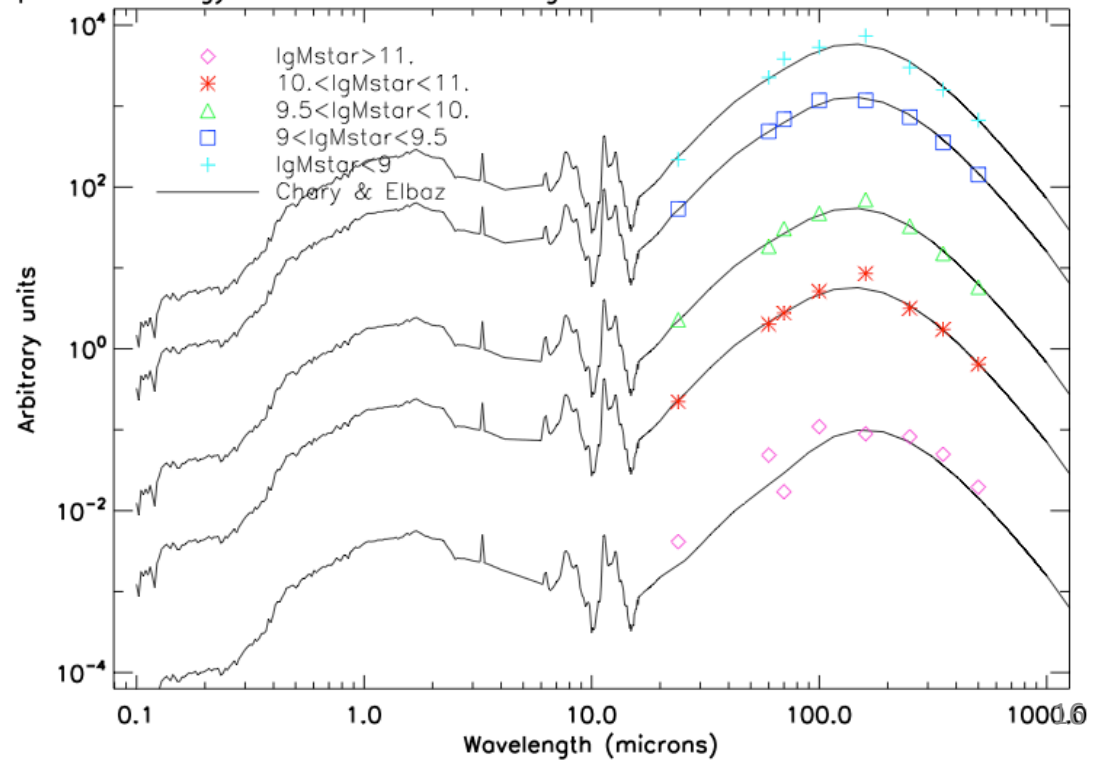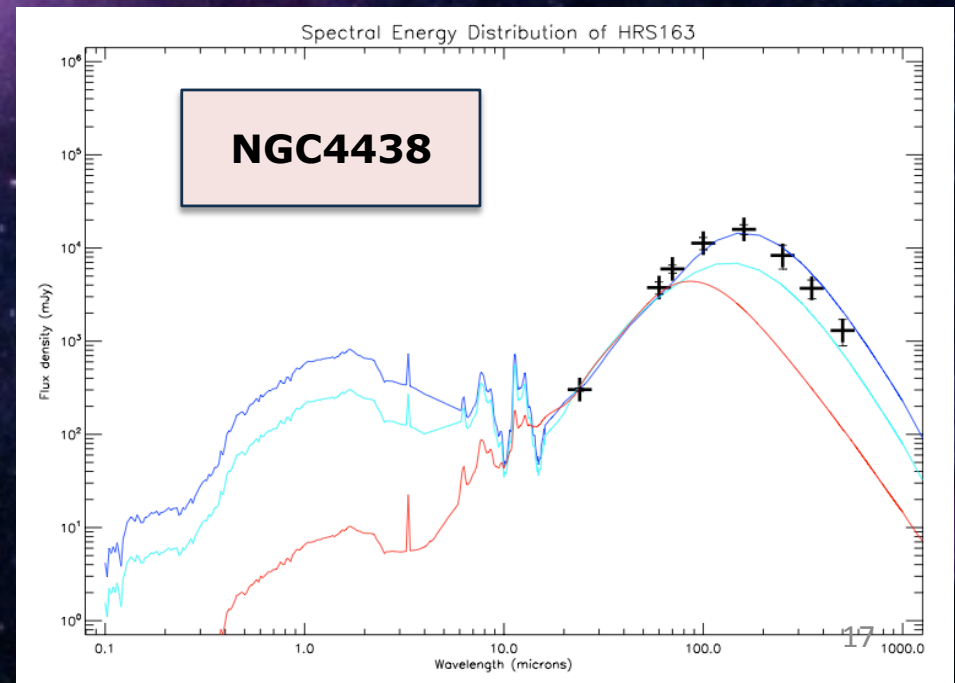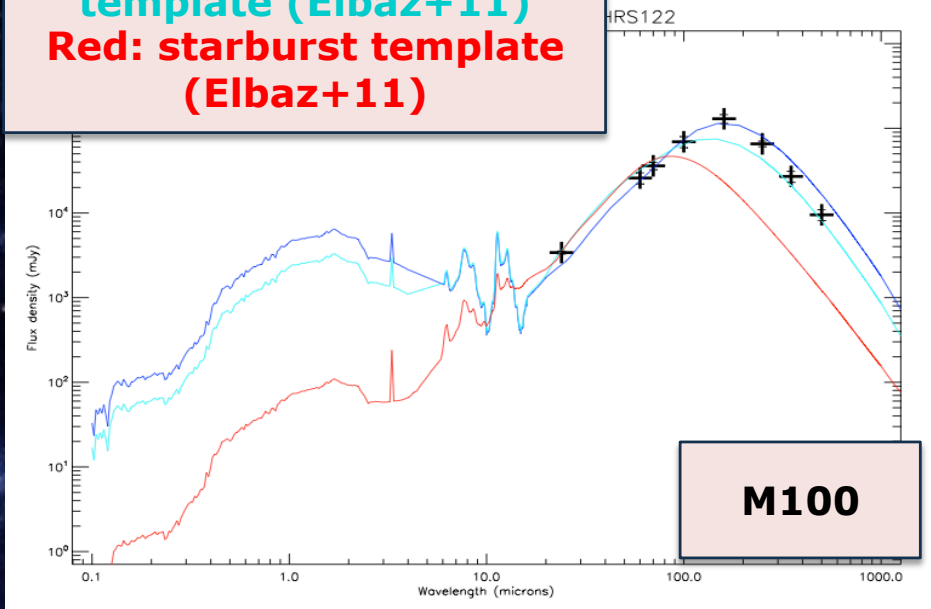
Dale & Helou 2002

Spectral Energy Distribution of HRS122 — M100

Spectral Energy Distribution of HRS102 — M99

Spectral Energy Distribution of HRS138 — M84

Spectral Energy Distribution of HRS163 — NGC4438

Dale & Helou 2002

f60/f100 obtained from data vs f60/f100 from Dale & Helou 2002

Legend:
- Sa−Sb
- Sbc−Scd
- Sd−Im−BCD−Irr
- a=1.14, b=−0.09

f60/f100 observed

f60/f100 from DH02 best fit

Chary & Elbaz 2001

Chary & Elbaz 2001

Purple: best fit
Cyan: main sequence template (Elbaz+11)
Red: starburst template (Elbaz+11)

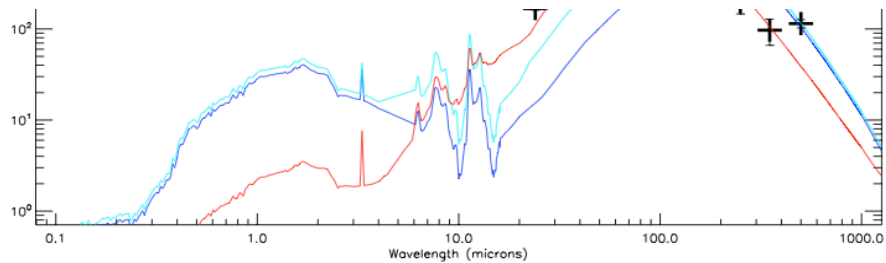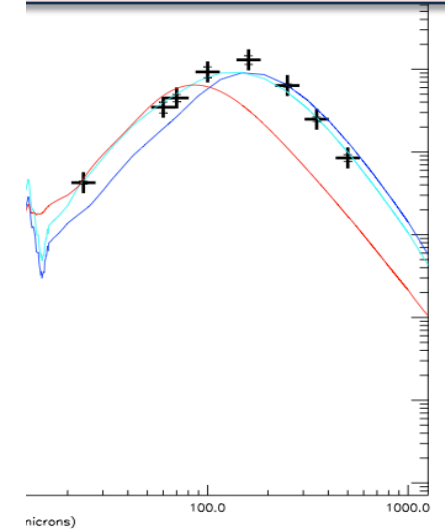**Cyan: $4 \times 10^9 L_{sol}$**
Red: $6 \times 10^{11} L_{sol}$
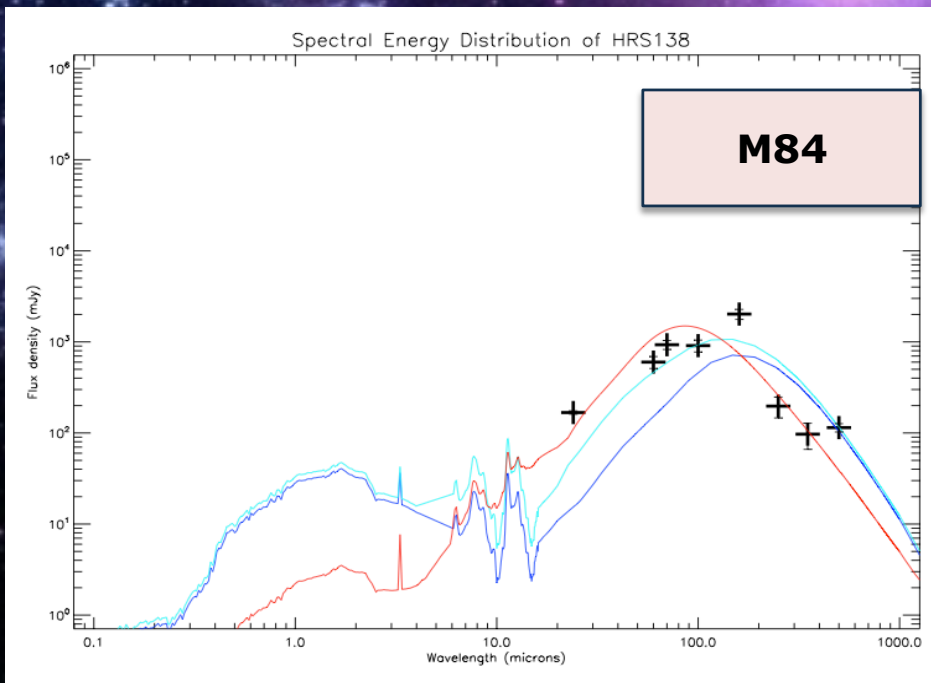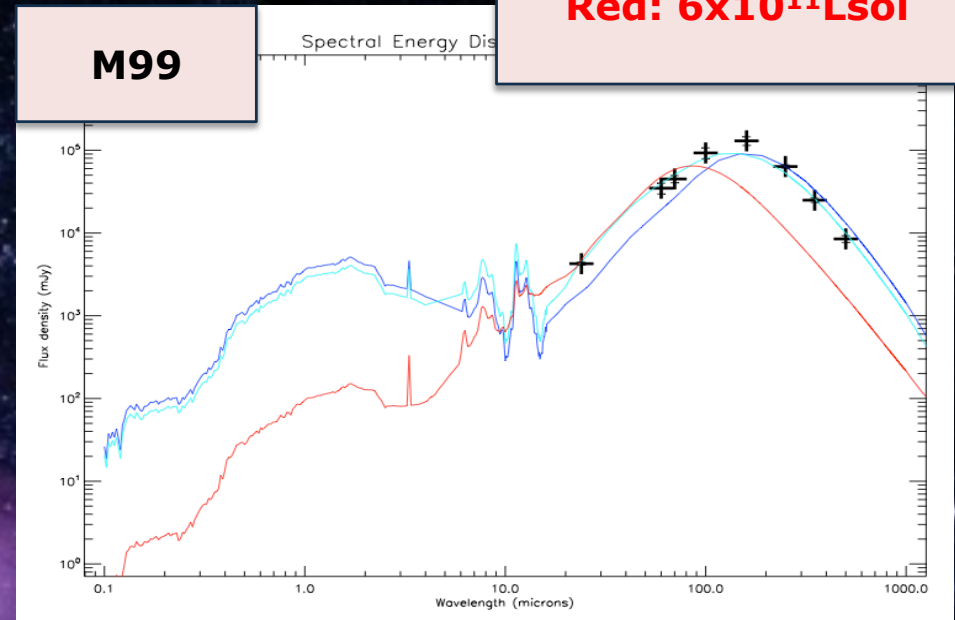
M99

M100

M84

NGC4438

MEAN SED

Purple: best fit
Cyan: main sequence

Cyan: 4x10^{9}Lsol
Red: 6x10^{11}Lsol

Sa-Sb

Spectral Energy Distribution of HRS2

...ution of HRS163

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Purple: best fit
Cyan: main sequence

Ch... baz 2001

MEAN SED

Cyan: 4×10^9 Lsol
Red: 6×10^{11} Lsol

Sa-Sb

Sbc-Scd

Spectral Energy Distribution of HRS2

Spectral Energy Distribution of HRS3

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Ch... MEAN SED baz 2001

Purple: best fit
Cyan: main sequence

Cyan: 4x10^{9}Lsol
Red: 6x10^{11}Lsol

Sa-Sb

Sd-Im-BCD-Irr

Spectral Energy Distribution of HRS2

Spectral Energy Distribution of HRS4

of HRS3

Draine & Li 2007

model=LMC2_05 Umin=2.50 gamma=0.01 Mdust=8.67255960036

M100

model=MW3.1_60 Umin=3.00 gamma=0.01 Mdust=8.0525885495

M99

model=MW3.1_00 Umin=2.00 gamma=0.2 Mdust=5.85875850514

M84

model=MW3.1_00 Umin=1.50 gamma=0.01 Mdust=7.31067543567

NGC4438
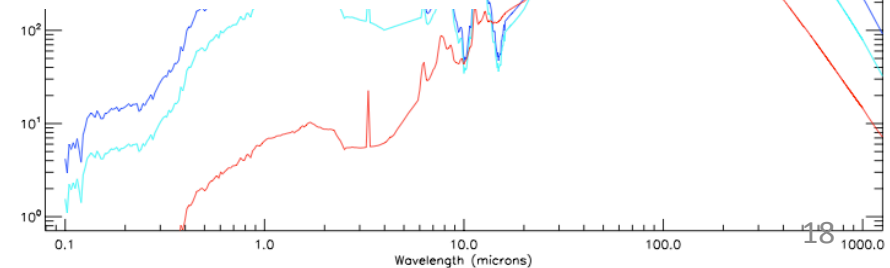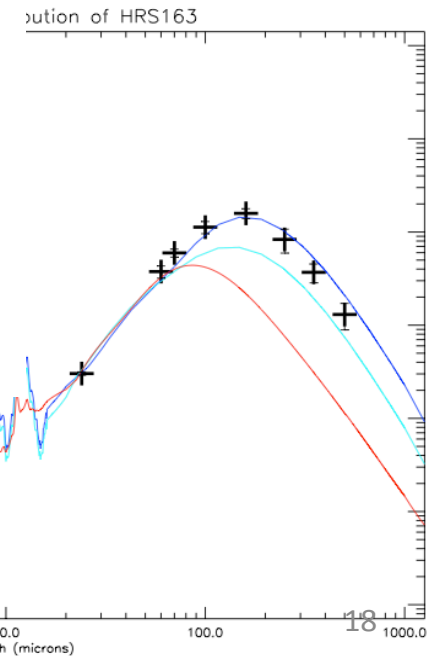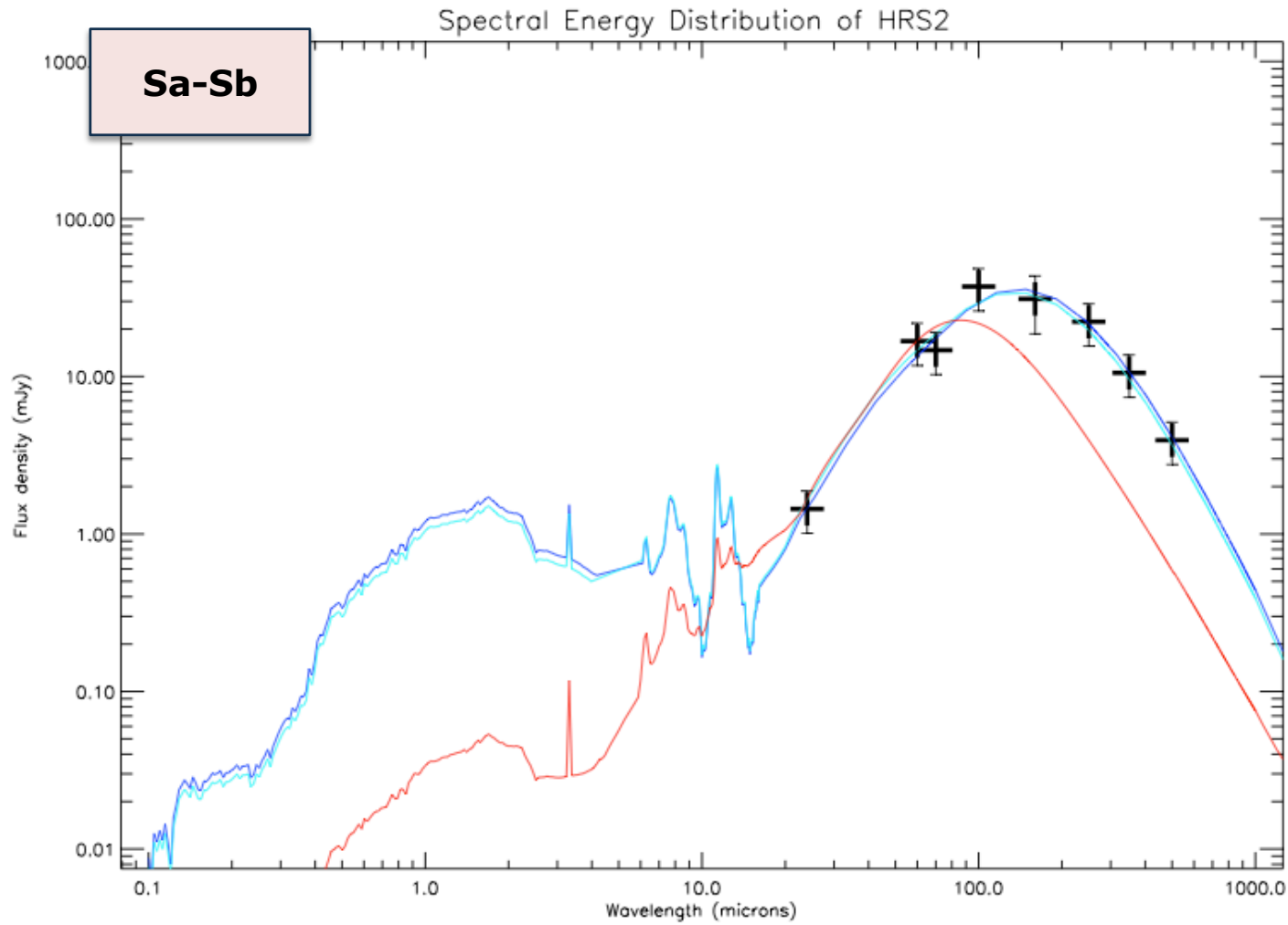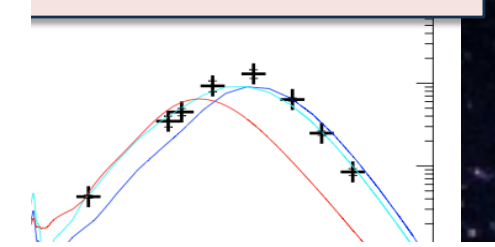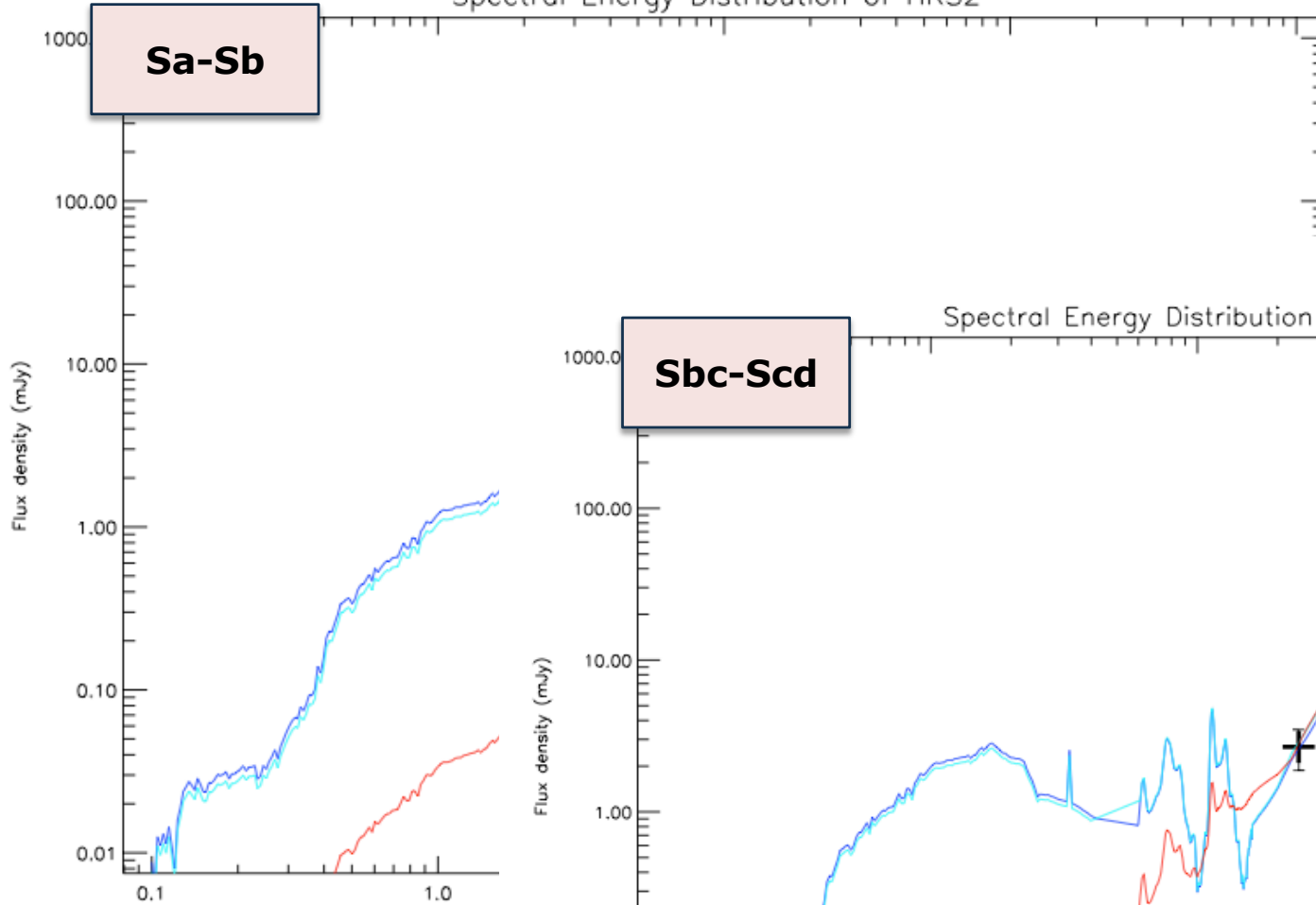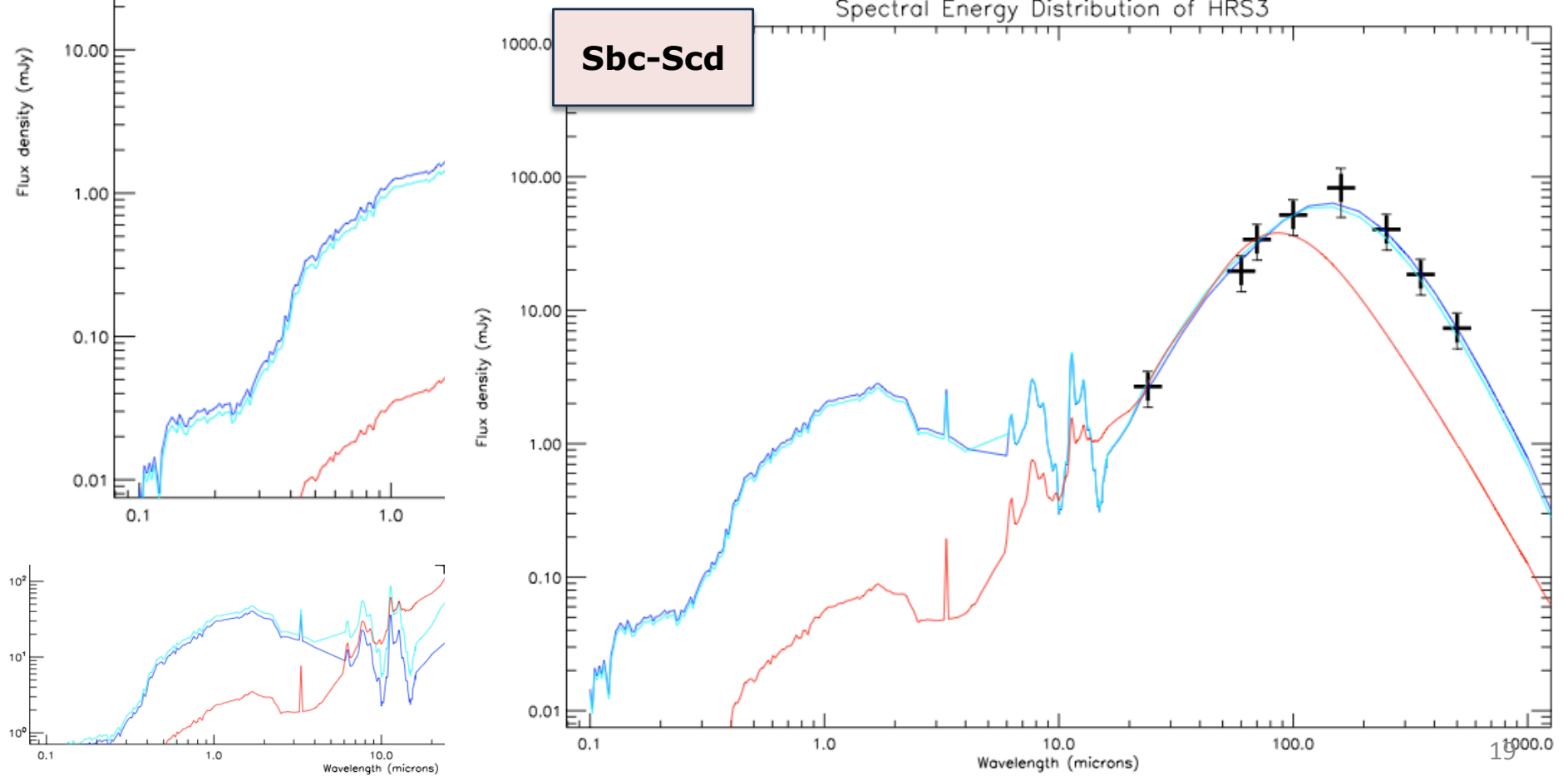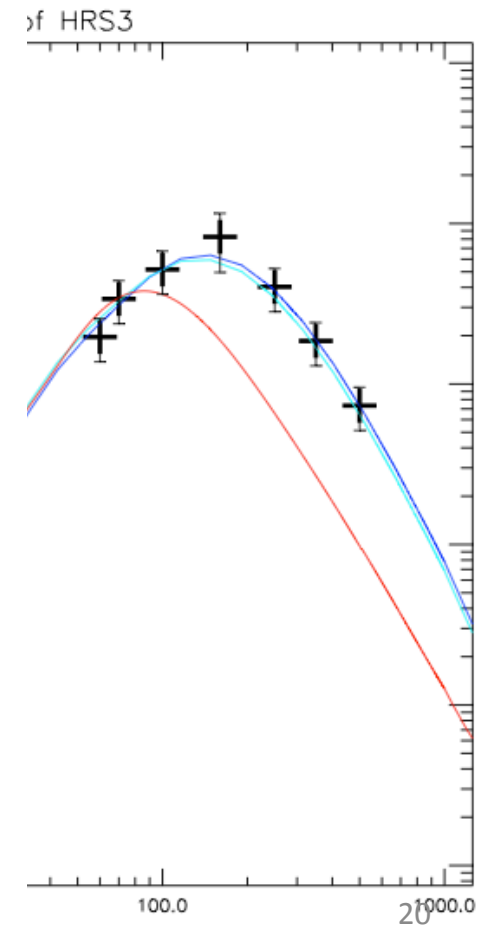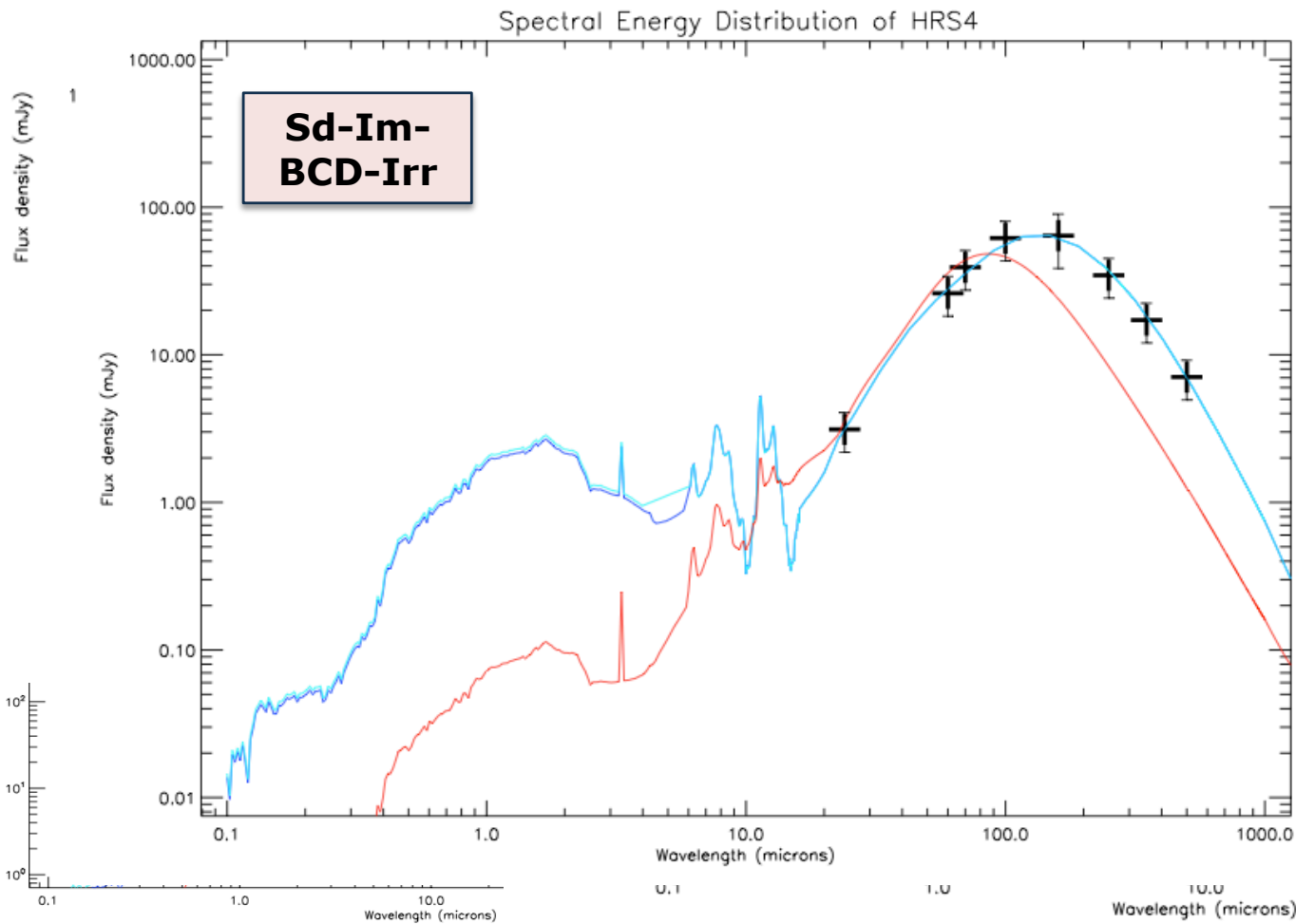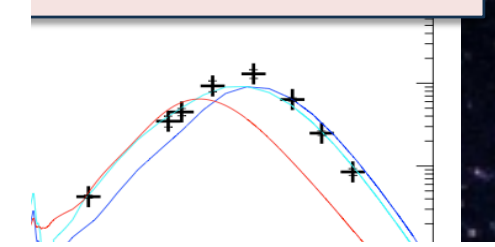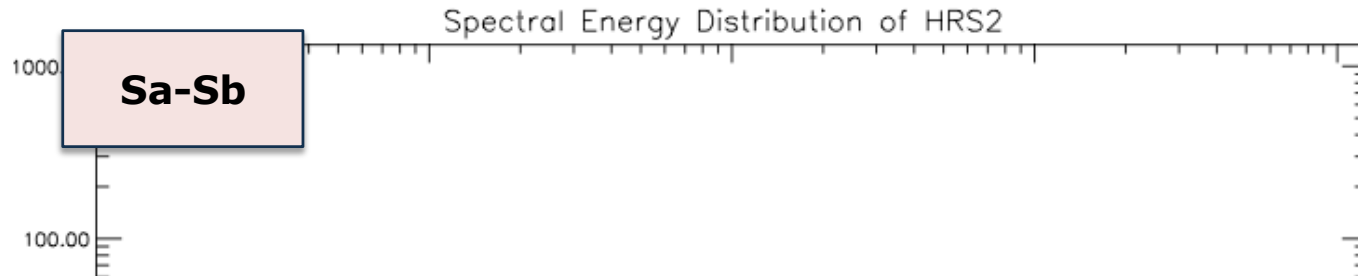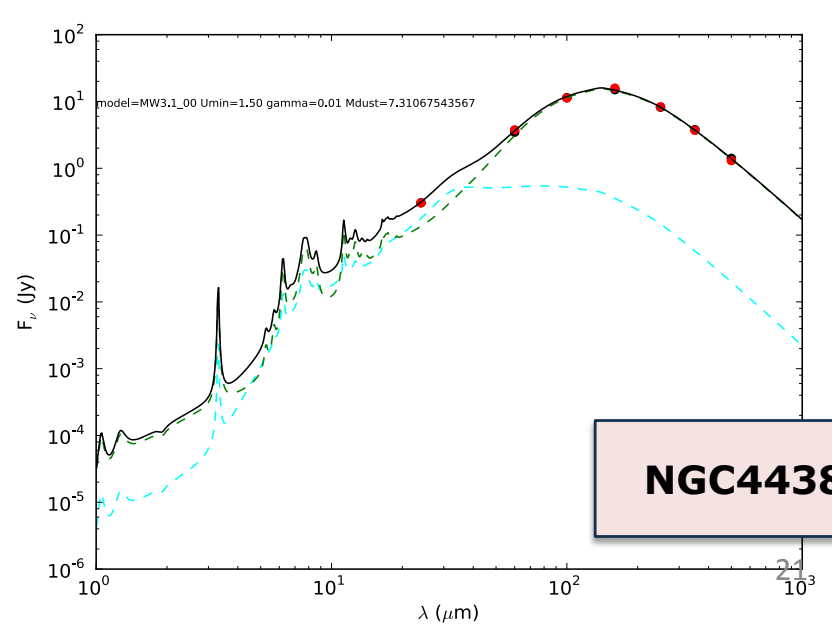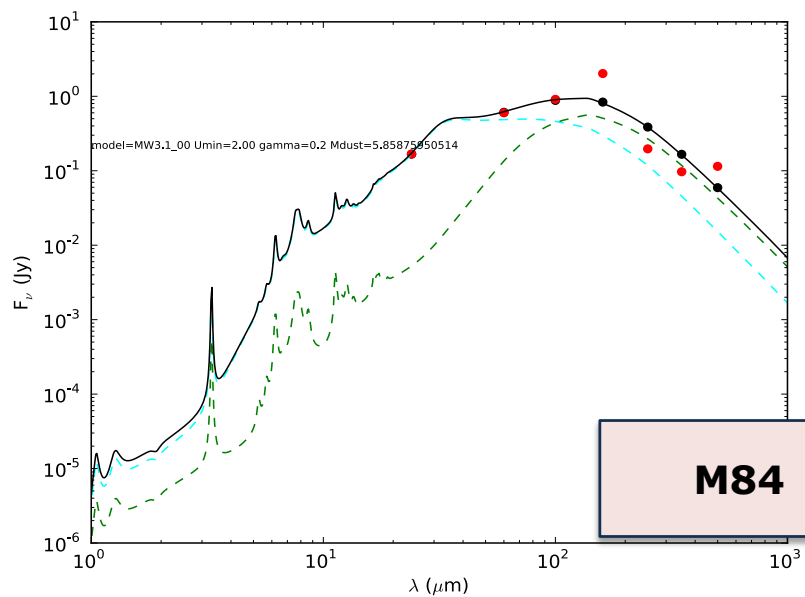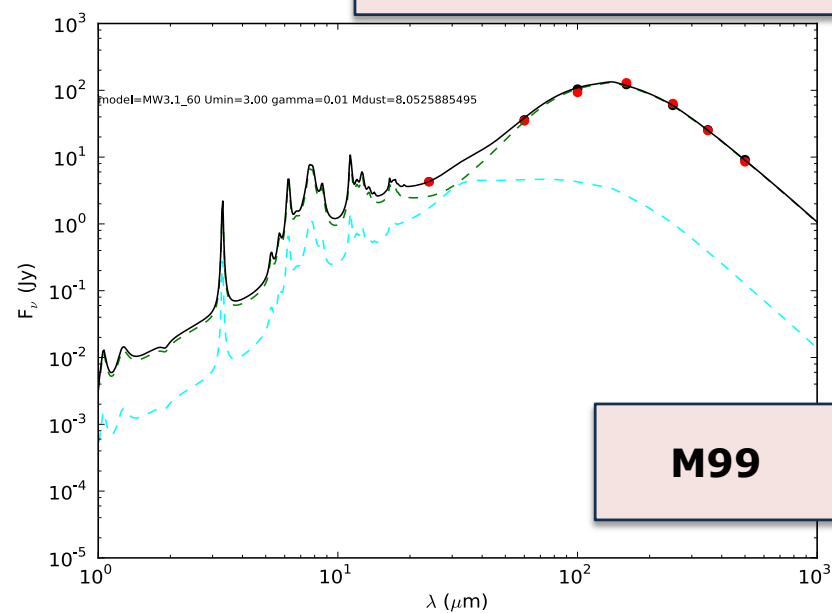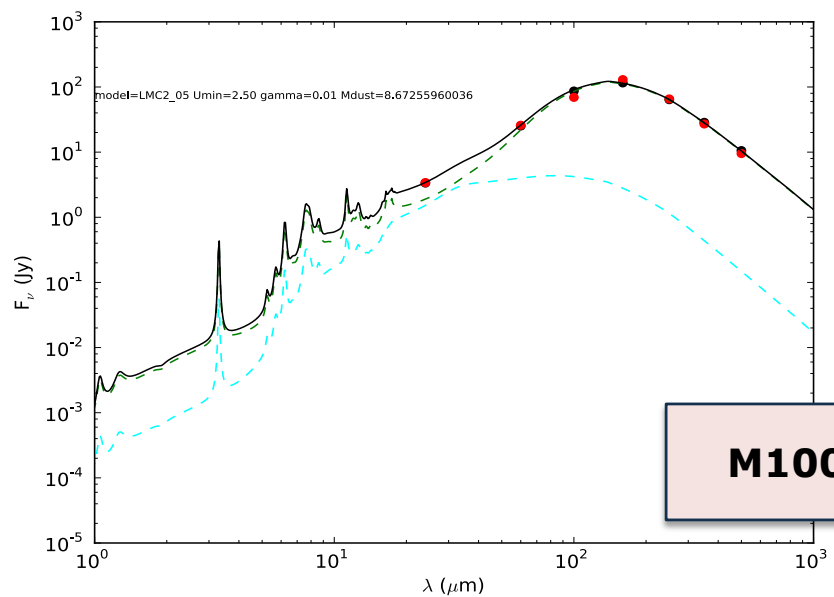
Conclusions and Perspectives

HRS is a complete sample, small enough to study the **galaxies one by one**, large enough to have good **statistical studies**.

SPIRE **photometry** has been done in a « **manual** » way, adapted to every single galaxy.

First results show that:

Dale & Helou 2002 seems to well reproduce FIR SEDs of late types.
Chary & Elbaz 2001 well reproduce mean SEDs of late types.
Elbaz et al. 2011 main sequence template well reproduce mean SEDs of late types
But **Draine et Li 2007** better reproduce HRS SEDs of late types.

The study has to be continued with **other physical parameters** (**metallicity, sSFR, Lir**)
And **other templates** to be tested.

Thank you!