

# SPRITZ

Spectro-Photometric Realisations of Infrared-selected Targets at all-Z



C. Gruppioni (INAF – OAS)  
on behalf of the SPRITZ team

# OUTLINE

- ★ Team and INAF leadership
- ★ Scientific Motivation
- ★ Results
- ★ Future plans
- ★ Critical Issues
- ★ Fundings

# SPRITZ TEAM

**Coordinator:** C. Gruppioni (OAS)

**SPRITZ manager:** L. Bisigello (UniPD/OAPD)

(20 people: 11.7 FTE total, 9 FTE total INAF, 8.1 TI)

- **INAF-OAS:** C. Gruppioni, M. Bolzonella, F. Calura, A. Feltre, G. Lanzuisi, S. Marchesi, L. Pozzetti + F. Pozzi (UniBO) + L. Vallini (SNS)
- **INAF-OAC:** M. Brescia, S. Cavuoti, G. Riccio, C. Tortora
- **INAF-OAPD:** A. Zanella + L. Bisigello, P. Cassata, G. Rodighiero, F. Sinigaglia (UniPD)
- **INAF-OAB:** I. Delvecchio
- **INAF-IRA:** V. Casasola

# SPRITZ TEAM

**Coordinator:** C. Gruppioni (OAS)

**SPRITZ manager:** L. Bisigello (UniPD/OAPD)

## Team's main expertise:

- **Galaxy and AGN evolution from deep multi wavelength surveys:** Gruppioni, Bolzonella, Feltre, Pozzetti (OAS), Delvecchio (OAB), Casasola (IRA), Bisigello, Cassata, Rodighiero (UniPD), Pozzi (UniBO)
- **Photo-ionisation models and ISM physics:** Feltre, Gruppioni (OAS), Zanella (OAPD), Vallini (SNS), Pozzi (UniBO)
- **Astroinformatics:** Brescia, Cavuoti, Riccio, Tortora (OAC), Bisigello (UniPD)
- **Hydrodynamical simulations:** Calura (OAS), Vallini (SNS), Zanella (OAPD)
- **X-ray surveys of AGN and galaxies:** Lanzuisi, Marchesi, Gruppioni (OAS), Bisigello (UniPD)
- **Radio continuum and HI surveys:** Casasola (IRA), Delvecchio (OAB), Tortora (OAC), Rodighiero, Bisigello, Sinigaglia (UniPD)



# INAF LEADERSHIP

**Coordinator:** C. Gruppioni (OAS)

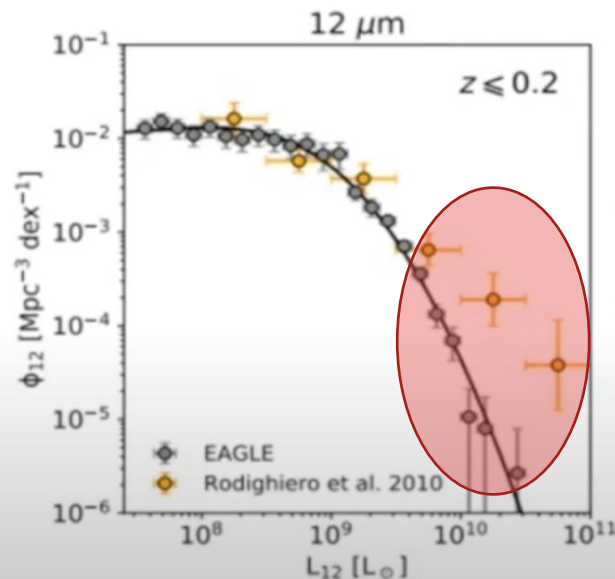
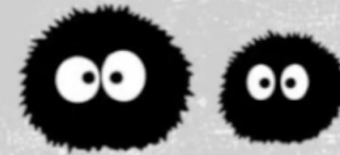
**SPRITZ manager:** L. Bisigello (UniPD/OAPD)

- **INAF has leadership role in SPRITZ:** the simulation is entirely within and managed by INAF
- It can be applied to a wide range of current and future facilities. It is currently used to create galaxy and AGN mock catalogues for the **Pre Launch Key projects of Euclid** (optical/near-IR), for **Athena** (X-ray) and for the NASA probes **PRIMA** (far-IR) and **AXIS** (X-ray).
- The base simulation is available at <http://spritz.oas.inaf.it>, where catalogues tailored on different missions can be retrieved to different sensitivities and resolutions
- The SPRITZ Team includes members of the science teams of the above missions.

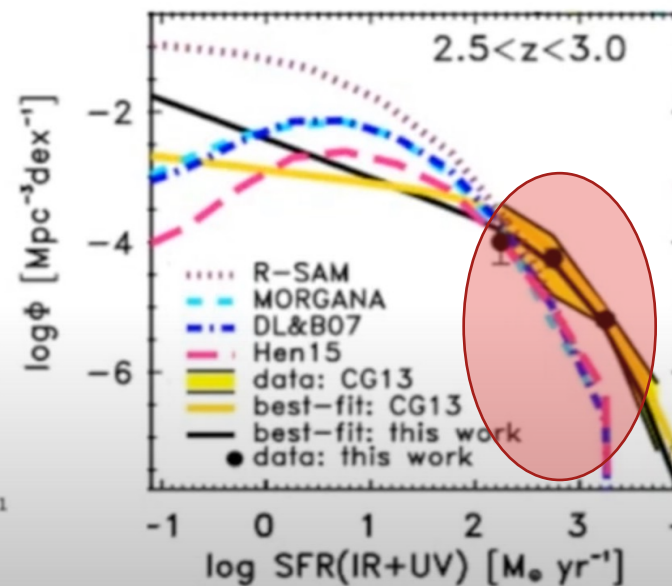
# WHY SPRITZ?

- Current hydrodynamical and cosmological simulations of galaxy formation and evolution struggle in reproducing the number densities of IR-detected galaxies.

## The dusty monsters



Beare et al. 2020



Gruppioni et al. 2015

# WHY SPRITZ?

Project started in 2019, when INAF was strongly involved in the planning of the ESA+JAXA M5 candidate mission SPICA: ASI funded a contract to make predictions for mid-/far-IR surveys with SPICA.

L. Bisigello dedicated post-doc to build a simulator starting from the Herschel heritage (under C. Gruppioni supervision)



## *SPRITZ publications:*

### *"Simulating the infrared sky with a SPRITZ"*

L. Bisigello, C. Gruppioni, A. Feltre, F. Calura, F. Pozzi, C. Vignali, L. Barchiesi, G. Rodighiero and M. Negrello, 2021, A&A, 651, A52,

### *"Simulating infrared spectro-photometric surveys with a SPRITZ"*

L. Bisigello, C. Gruppioni, F. Calura, et al., 2021, PASA, 38, 64

### *"SPRITZ is sparkling: simulated CO and [C II] luminosity functions"*

L. Bisigello, L. Vallini, C. Gruppioni, et al., 2021, A&A, submitted

<http://spritz.oas.inaf.it>

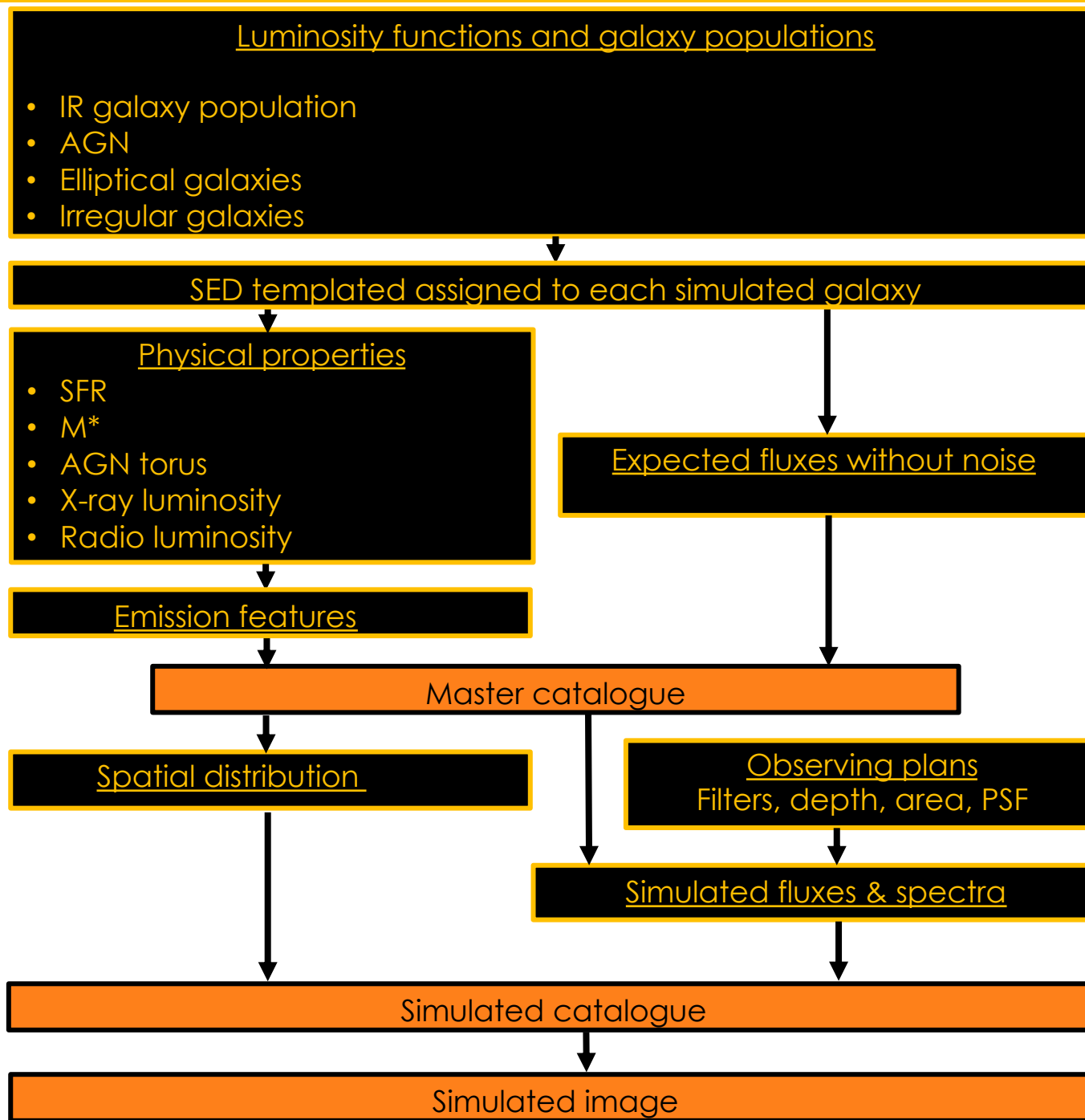
# SPRITZ: THE SPECTRO-PHOTOMETRIC REALISATIONS OF INFRARED-SELECTED TARGETS AT ALL-Z



- SPRITZ is a versatile, phenomenological new simulation tool created for IR survey planning, now working also from radio to X-rays wavelengths.
- SPRITZ was originally developed for planning the **SPICA** Surveys:
- It starts from the Herschel infrared luminosity functions, and models the multiwavelength properties of both galaxies and AGN (different populations, evolving separately).
- It reproduces a large set of available observations and can be used to obtain, in a fully consistent way, simulated observations for a broad set of current and future facilities (e.g, **JWST, Euclid and Athena**) with photometric capabilities as well as low-resolution spectroscopy.



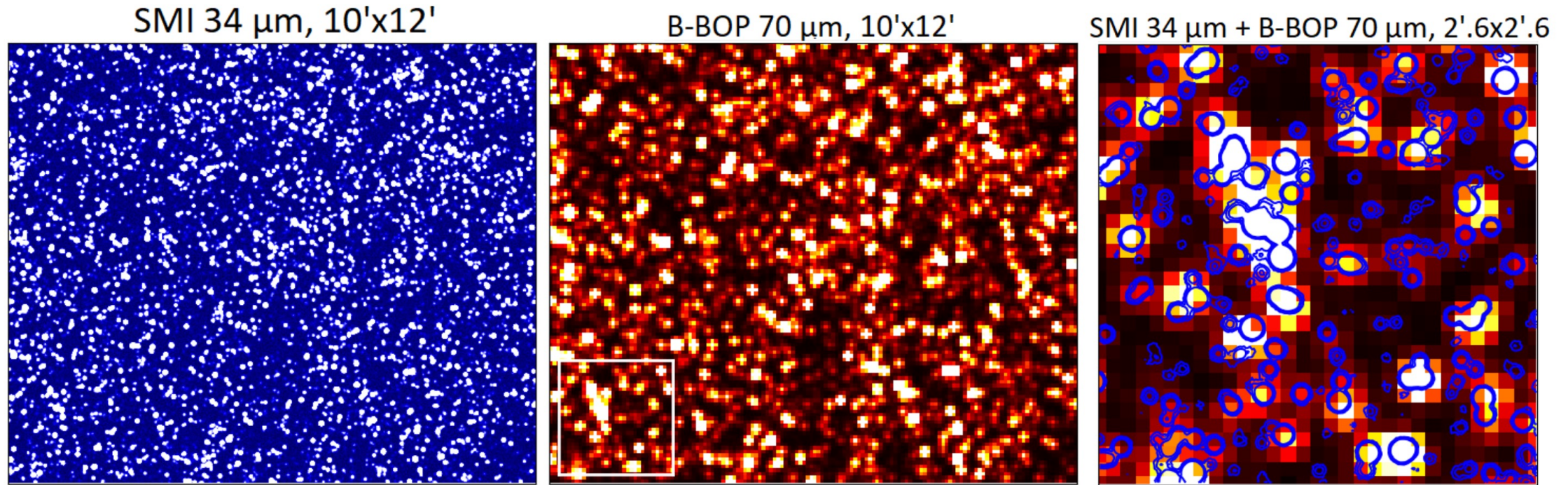




## SPRITZ workflow

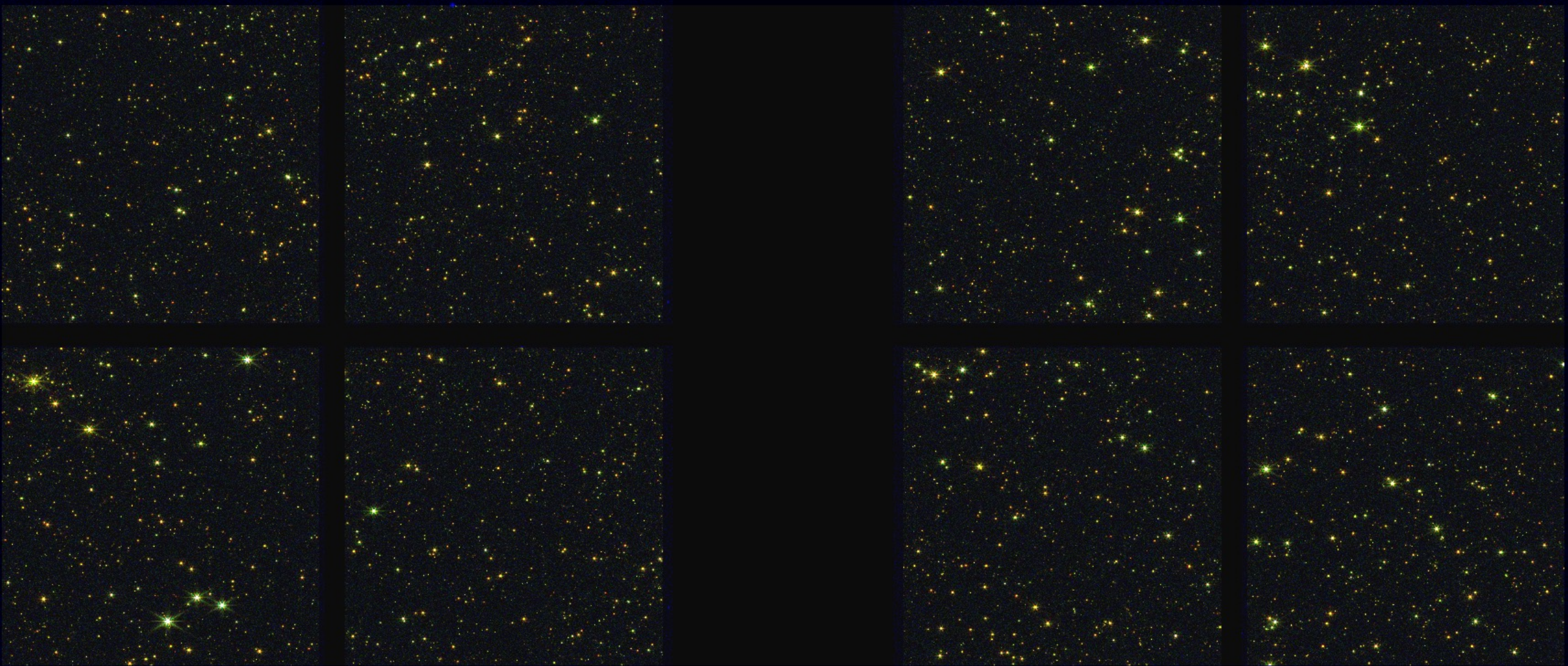


# MAIN RESULTS OF SPRITZ



**Figure 2.** *Left:* Simulated SMI image at 34  $\mu\text{m}$  of a field of 10'  $\times$  12', which corresponds to a single SMI pointing. *Centre:* Simulated B-BOP image at 70  $\mu\text{m}$  of the same field. The B-BOP field-of-view (2'.6  $\times$  2'.6) is shown for comparison in the bottom left (*white square*). *Right:* Zoom-in of the B-BOP image in the B-BOP field-of-view. Blue contours are the superimposed SMI image (5, 10 and 20 $\sigma$ ). Each point corresponds to one galaxy or blends of several galaxies simulated with SPRITZ, depending on source blending, down to the noise level.



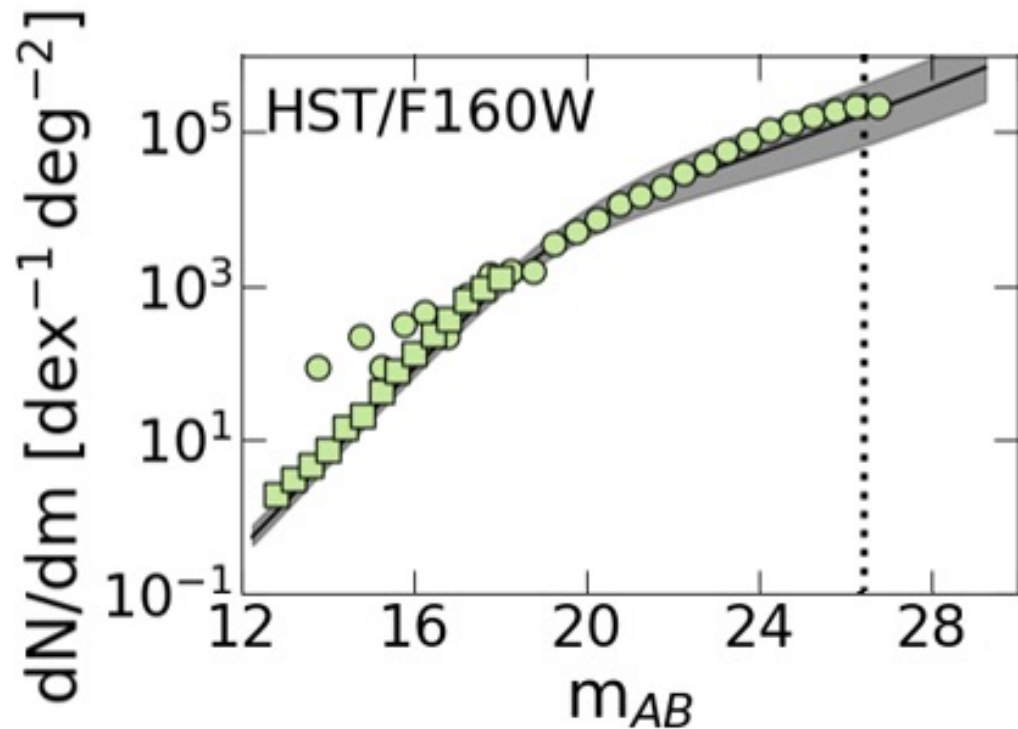


Three color image of a simulated JWST/NIRCam pointing, considering the F090W (blue), F277W (green) and F444W (red) filters.

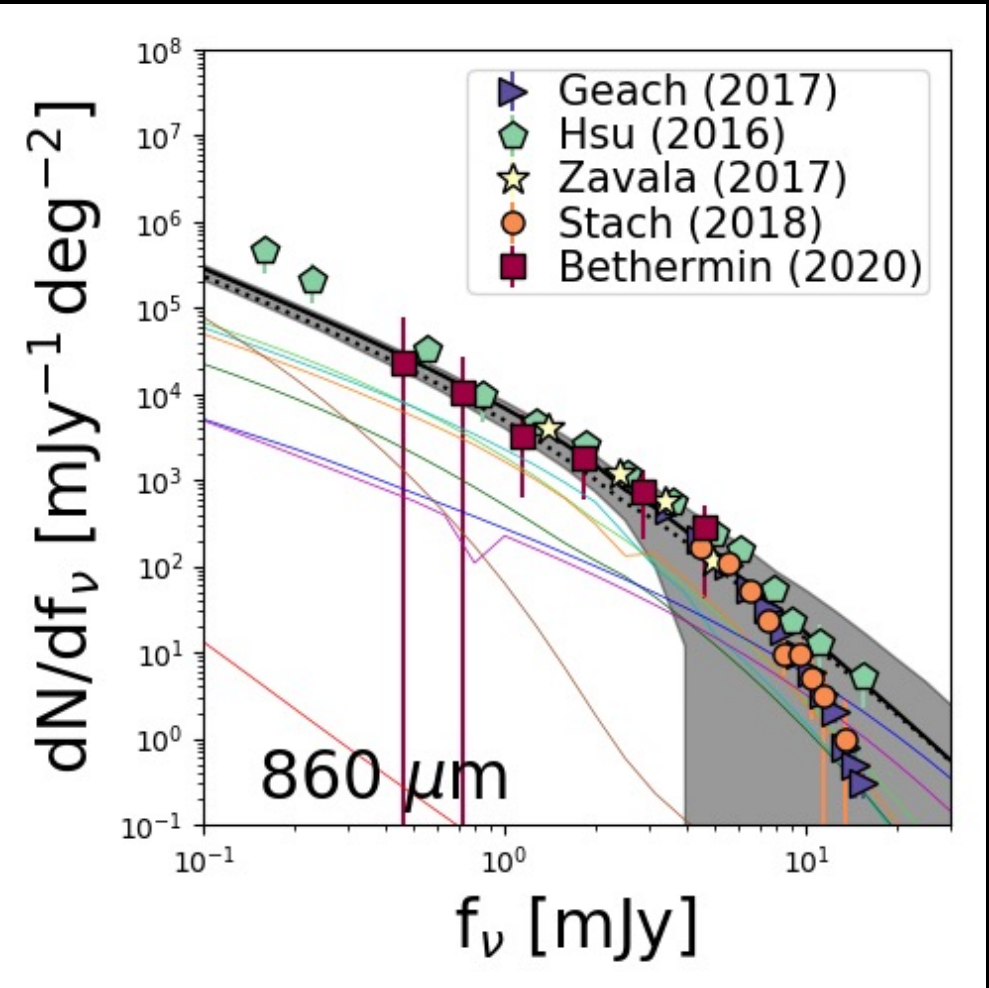
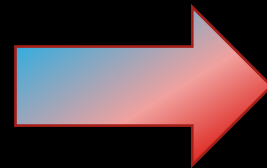




# MAIN RESULTS OF SPRITZ



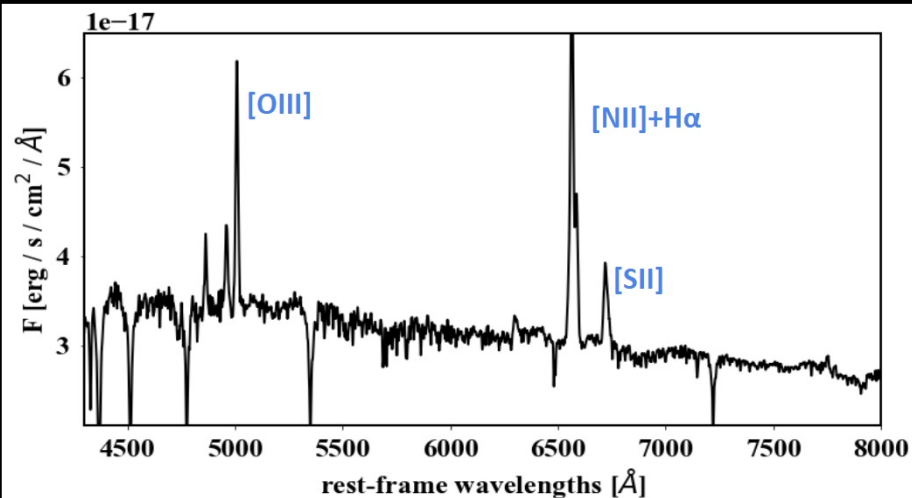
observables (source counts, LFs, SMFs, SFR- $M^*$  plane)  
reproduced from UV to sub-mm  
and also X-rays and radio!





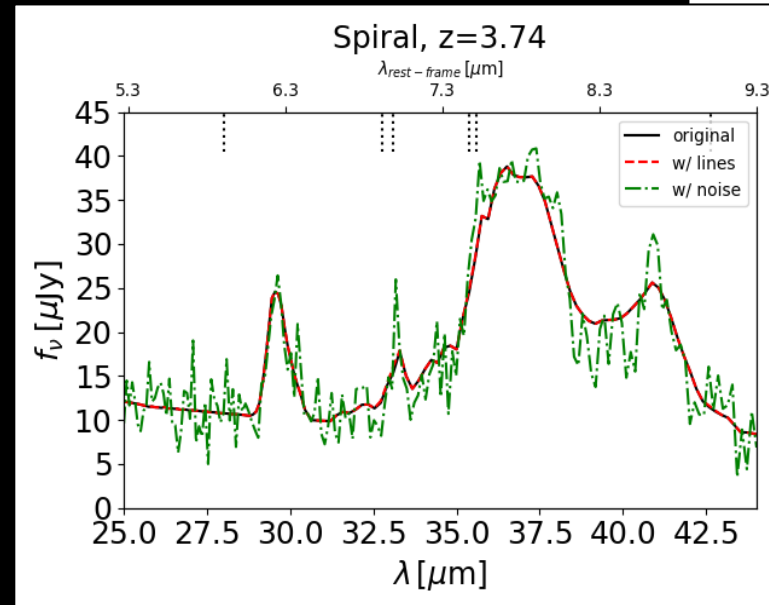
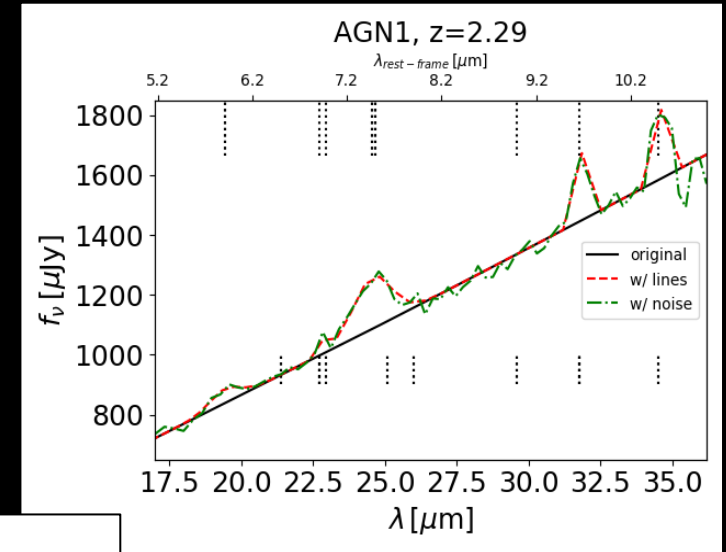
Derive mock  
fluxes and  
spectra

- Simulated optical spectra:  
**SPRITZ** is currently used for  
Euclid survey simulations

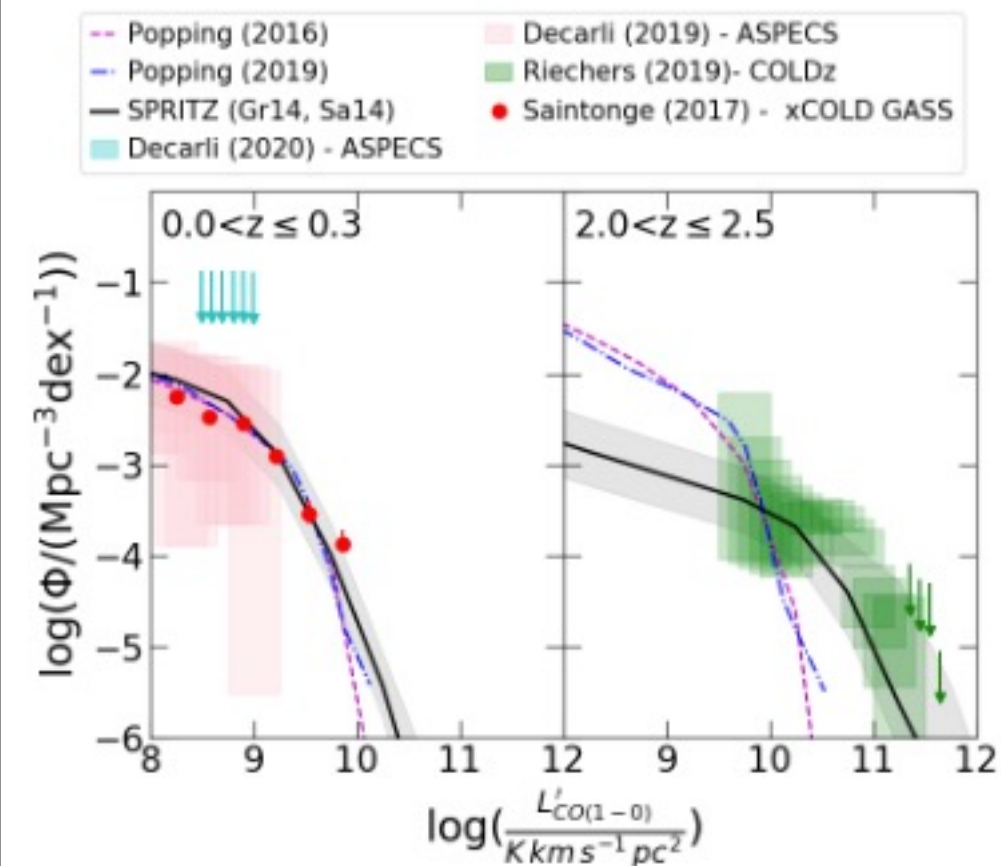
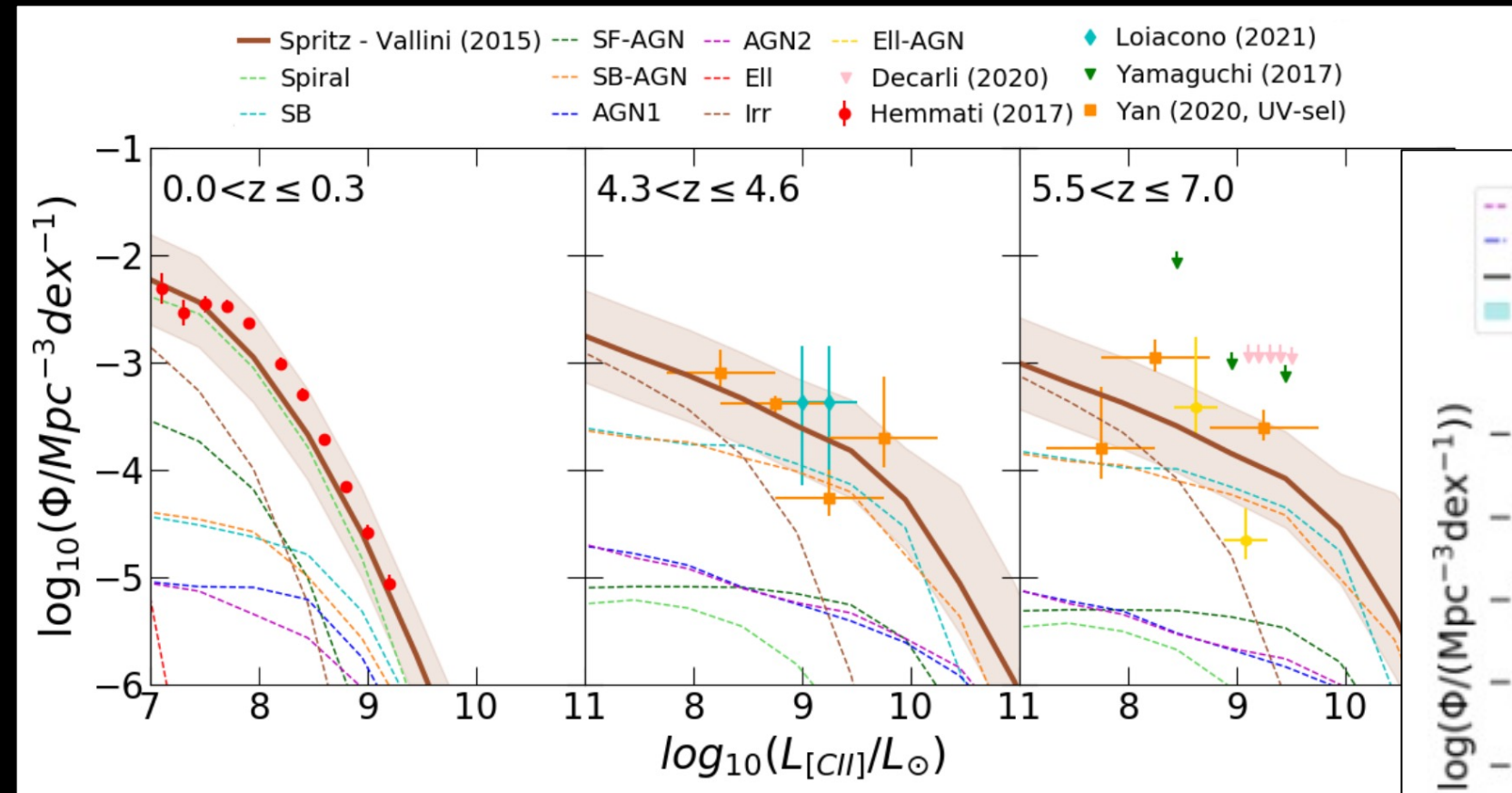


- Simulated mid-IR SPECTRA @17-36  $\mu\text{m}$

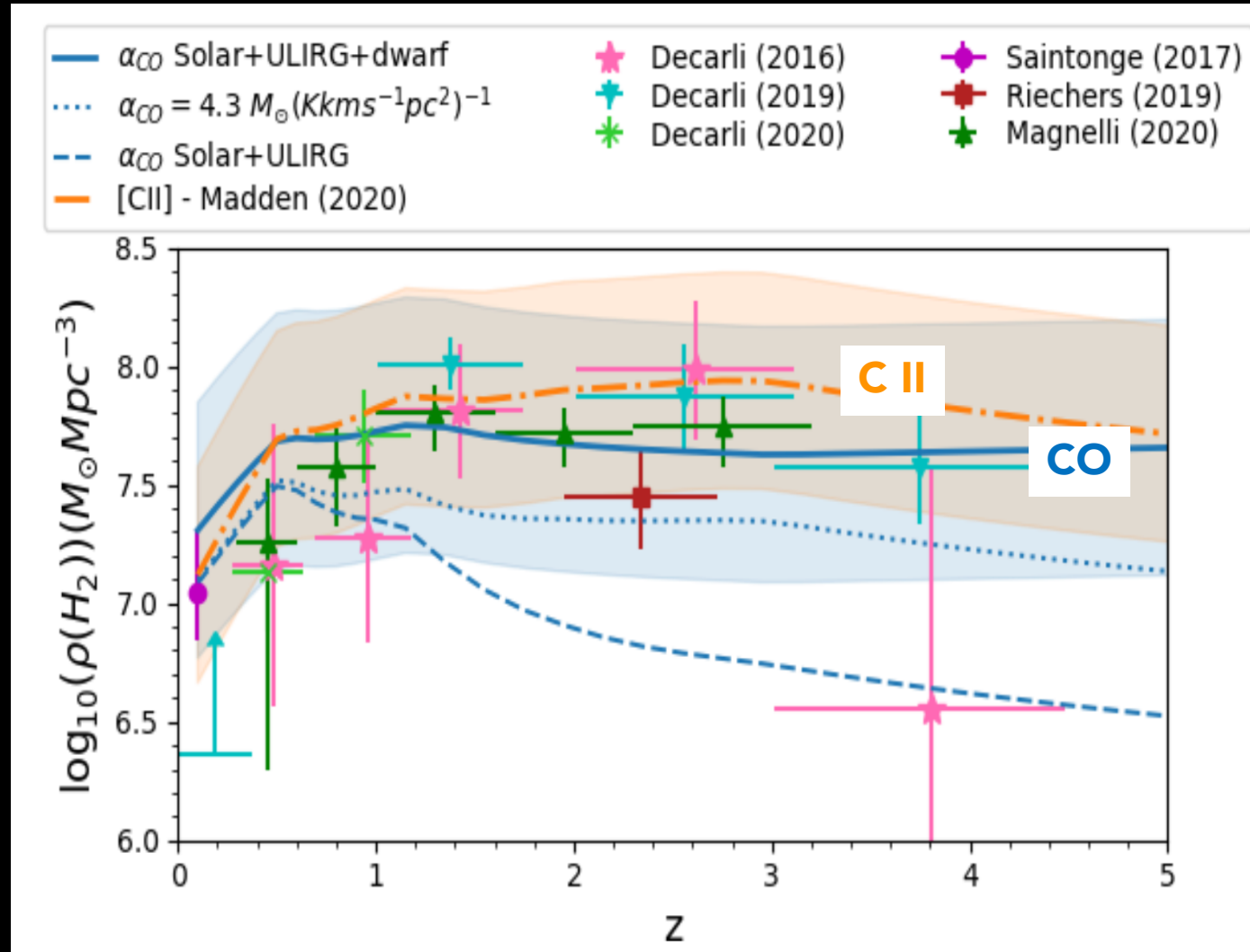
**SPRITZ** is currently being  
developed and tested  
for PRIMA spectro-  
photometric survey  
In the mid-/far-IR bands



# [C II] AND CO LUMINOSITY FUNCTIONS



# MOLECULAR GAS MASS DENSITY



# FUTURE PLANS

- **Construction of realistic galaxy images via machine learning**

Brescia, Bisigello, Cavuoti, Riccio, Tortora (AdR #1)

- **Emission lines from UV to far-IR and mm from photo-ionisation models**

Gruppioni, Feltre, Pozzi, Vallini, Zanella (AdR #2)

- **Zoom-in studies of single galaxies through high-resolution simulations**

Calura, Vallini, Zanella

- **X-ray properties of galaxies to create simulations for Athena and AXIS**

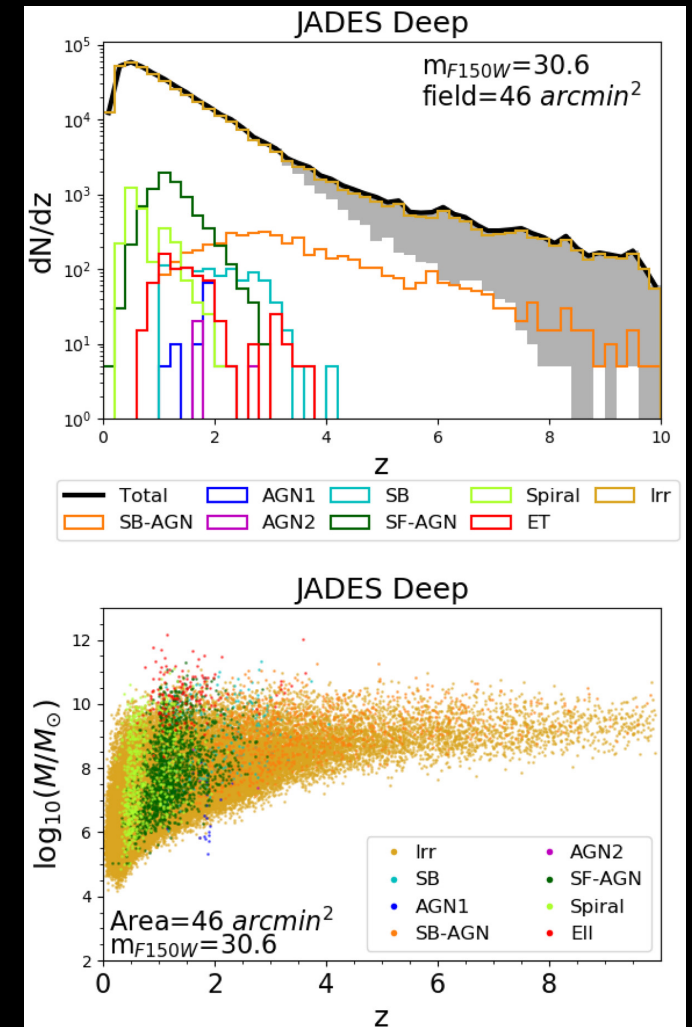
Lanzuisi, Marchesi, Bisigello, Gruppioni

- **Predictions for radio-continuum and HI-line measurements**

Casasola, Delvecchio, Rodighiero, Bisigello, Tortora, Sinigaglia

- **Creation of mock catalogues for next generation facilities**

Bisigello, Bolzonella, Cassata, Delvecchio, Feltre, Gruppioni, Lanzuisi, Marchesi, Pozzetti, Pozzi, Rodighiero, (AdR #1, AdR #2)





# MOTIVATION

- **Two main implementations would require dedicated personnel:**
  - Machine learning techniques to obtain realistic images are crucial for planning/simulating future photometric surveys (currently only point-like sources) → **connection to Astrominformatics scheder**
  - photo-models are crucial for designing spectroscopic and photometric (multi-filters) surveys (e.g., Euclid, PRIMA), for redshift determination and AGN/galaxy separation

# CRITICAL ISSUES

- **The main critical issue is the absence of man-power dedicated to the project (at least 2 AdR / TD):**

the principal implementations (realistic images through machine learning and photo-ionisation models for emission lines) cannot be completed in two years time by staff, involved in many other activities

The forthcoming data with JWST and the planning of the NASA probes and ESA missions Euclid and Athena require the implementations to be done urgently

# FUNDS

- No fundings after the end of the “Accordo attuativo ASI-INAF 2018-3131-HH.0”  
*Partecipazione italiana allo studio di fase A della missione SPICA in selezione M5*

 **ended June 2021**

- Applied for a INAF Large Grant to allow the planned implementations to be completed:
  - We plan to **hire two post-docs (AdR) for two years each** (total cost for contracts of 138,152 Euro):
    - **AdR #1** will be hired at **INAF-OAC Naples + UniPD** for the implementation of realistic images through machine learning algorithms.
    - **AdR #2** will be hired at **INAF-OAS Bologna** for the implementation of emission lines modelled through photo-ionisation codes.
  - 17,924 Euro per year for travelling / participation to meetings and workshops
  - 6000 Euro for PCs / hardware / software only for the first year (for the AdRs and their activity).
  - **Total amount requested: 180,000 Euro**



# SPRITZ

## GANTT CHART

### Deliverables and Milestones

**Coordinator:**  
Carlotta Gruppioni (CG)

**Team:**

Laura Bisigello (LB)  
Micol Bolzonella (MB)  
Massimo Brescia (MBR)  
Francesco Calura (FC)  
Viviana Casasola (VC)  
Paolo Cassata (PC)  
Stefano Cavioti (SC)  
Ivan Delvecchio (ID)  
Anna Feltre (AF)  
Giorgio Lanzuisi (GL)  
Francesca Pozzi (FP)  
Lucia Pozzetti (LP)  
Giuseppe Riccio (GRi)  
Giulia Rodighiero (GR)  
Francesco Sinigaglia (FS)  
Crescenzo Tortora (CT)  
Livia Vallini (LV)  
Anita Zanella (AZ)  
Post doc 1 (AdR #1)  
Post doc 2 (AdR #2)

**Task 1: AdR #1 acquires basic machine learning techniques**

**Task 2: AdR #2 acquires basic photo-ionisation model knowledges**

**Task 3: High-resolution zoom-in simulation**

**Task 4: X-ray implementation**

**Task 5: Radio + HI implementation**

**Task 6: Realistic images for SPRITZ galaxies**

**Task 7: Emission line models**

**Task 8: Mock catalogues creation**

