

GalaPy, a really fast C++/Python API for modelling galaxy SEDs and other cool stuff

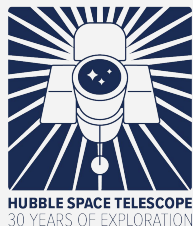
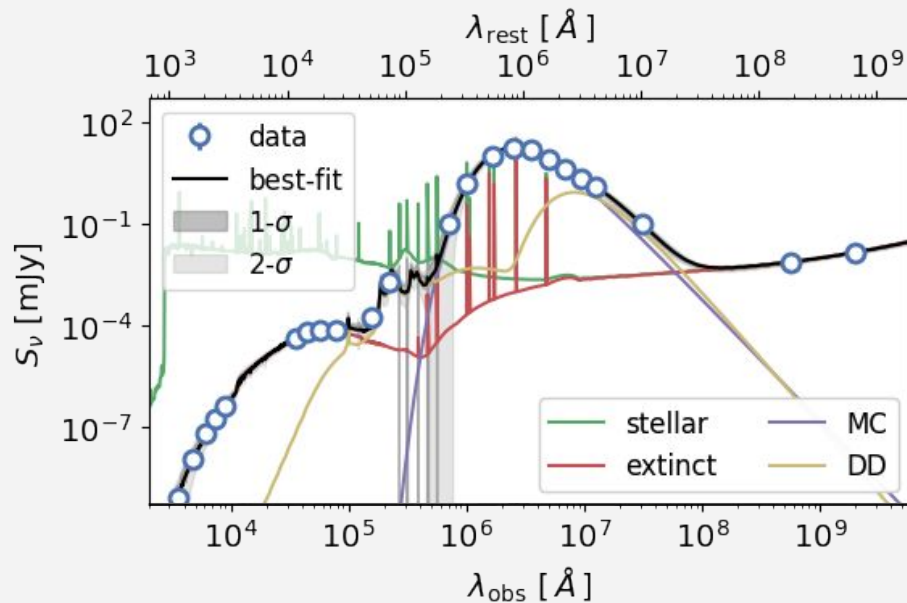
Tommaso Ronconi
@ Spoke-3 General Meeting,
June 2023



Collaborators:
Andrea Lapi
Martina Torsello
Alessandro Bressan
+others!

tronconi@sissa.it

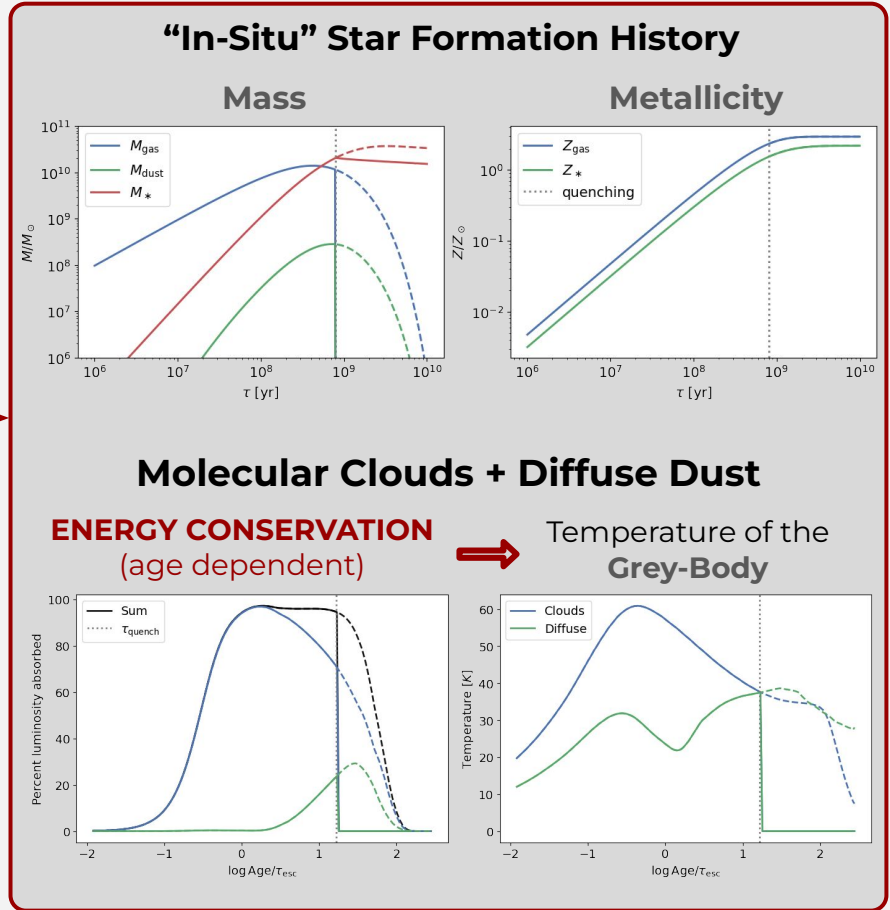
What is a Spectral Energy Distribution (SED)?



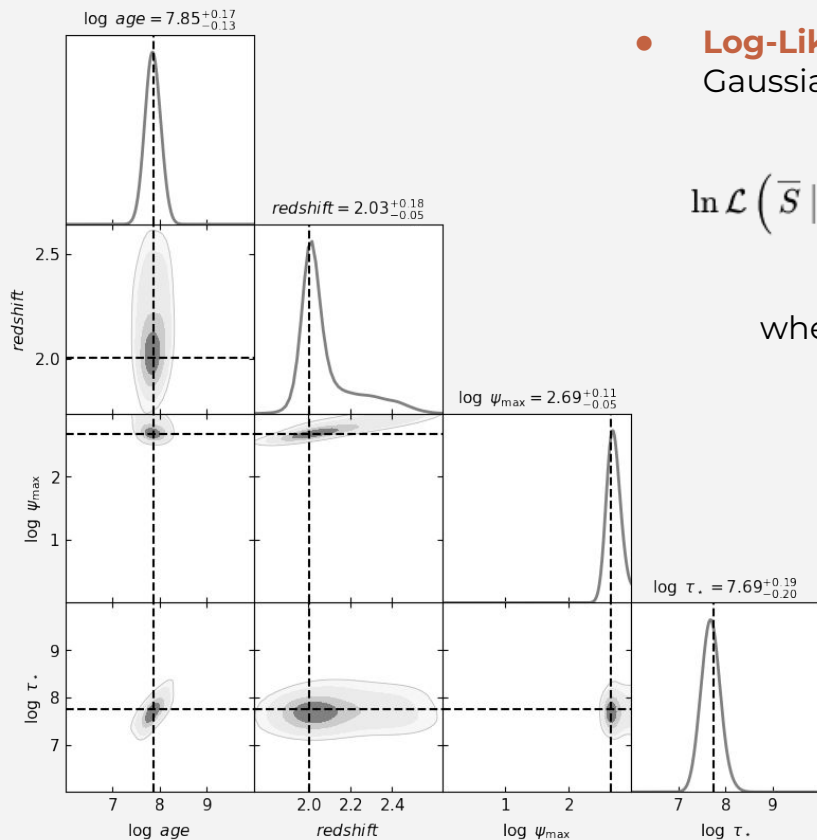
Why a new SED fitting library?



- **Updated physical modelling**
 - **Analytical solutions** for Galaxy Evolution
 - **2-components** dust model with **AGE DEPENDENT ENERGY BALANCE**
- **High performance**
 - **Hybrid C++/Python** optimised implementation
 - **Shared memory parallelism** through Python
- **Bayesian inference**
 - **Markov Chain Monte Carlo** with **emcee**
 - **Dynamic Nested Sampling** with **dynesty**



Bayesian parameter-space sampling



- **Log-Likelihood**

Gaussian accounting for systematic error

$$\ln \mathcal{L}(\bar{S} | \theta, f_{\text{sys}}) \equiv -\frac{1}{2} \sum_i \left\{ \frac{[\bar{S}_i - \bar{S}_i(\theta)]^2}{\sigma_i^2(\theta, f_{\text{sys}})} + \ln [2\pi \sigma_i^2(\theta, f_{\text{sys}})] \right\}$$

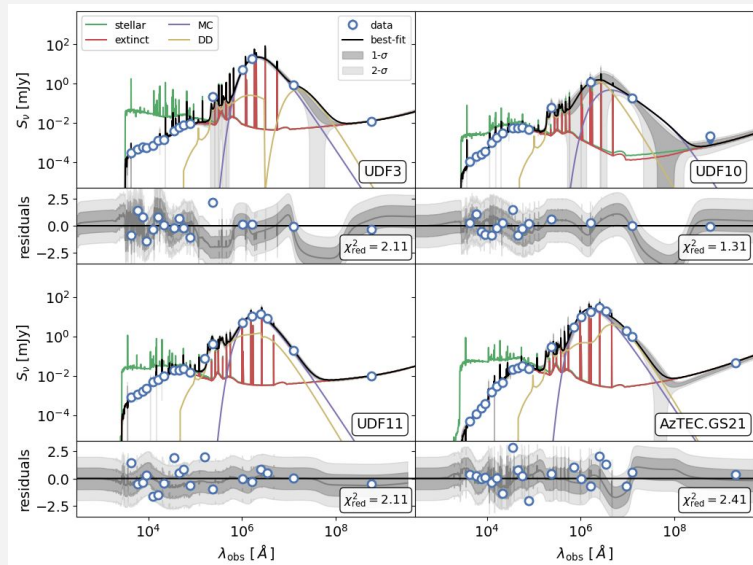
where $\sigma_i^2(\theta, f_{\text{sys}}) \equiv \bar{\sigma}_i^2 + f_{\text{sys}}^2 \bar{S}_i^2(\theta)$

- **Currently** external samplers
- **bottleneck!**
- We'll experiment with **compiled libraries** before re-inventing the wheel ([polychord](#) maybe?)

Validation: some different kind of sources

- **High-redshift dusty star-forming**

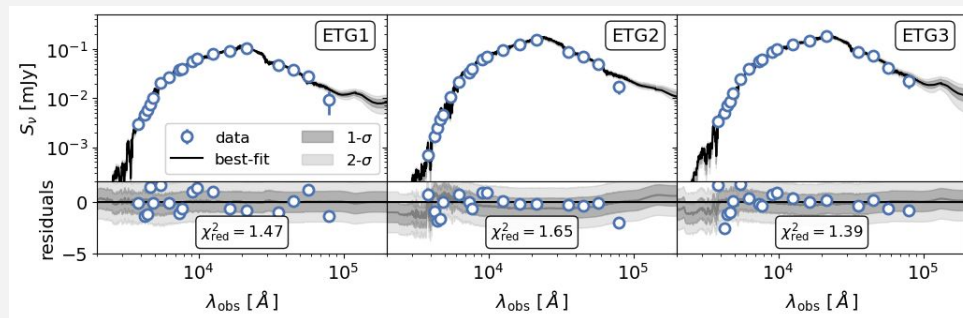
- interesting for GFE studies
- lot of candidates from JWST



Data from [Pantoni et al., 2021](#)

- **Early type galaxies**

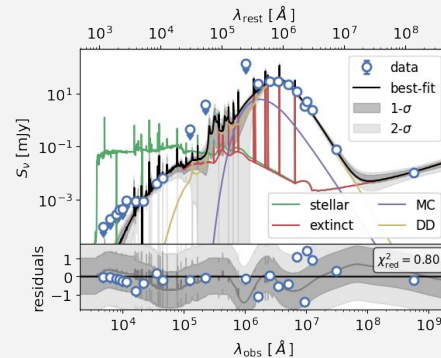
- no ISM/dust only stellar contribution
- consistency of the SFH model



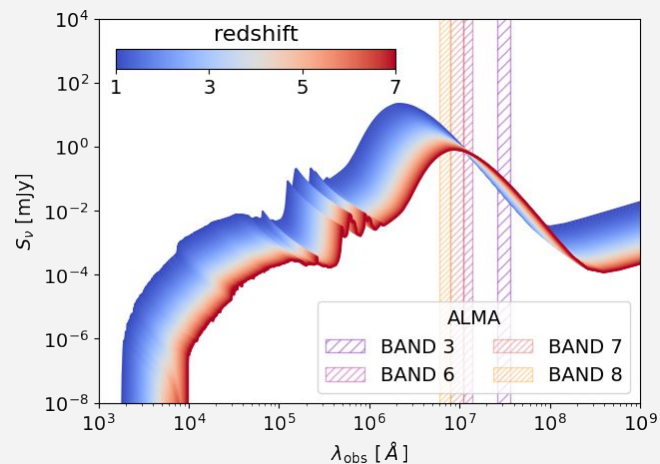
Data from [Donevski et al., 2023](#)

- **Lensed + upper limits**

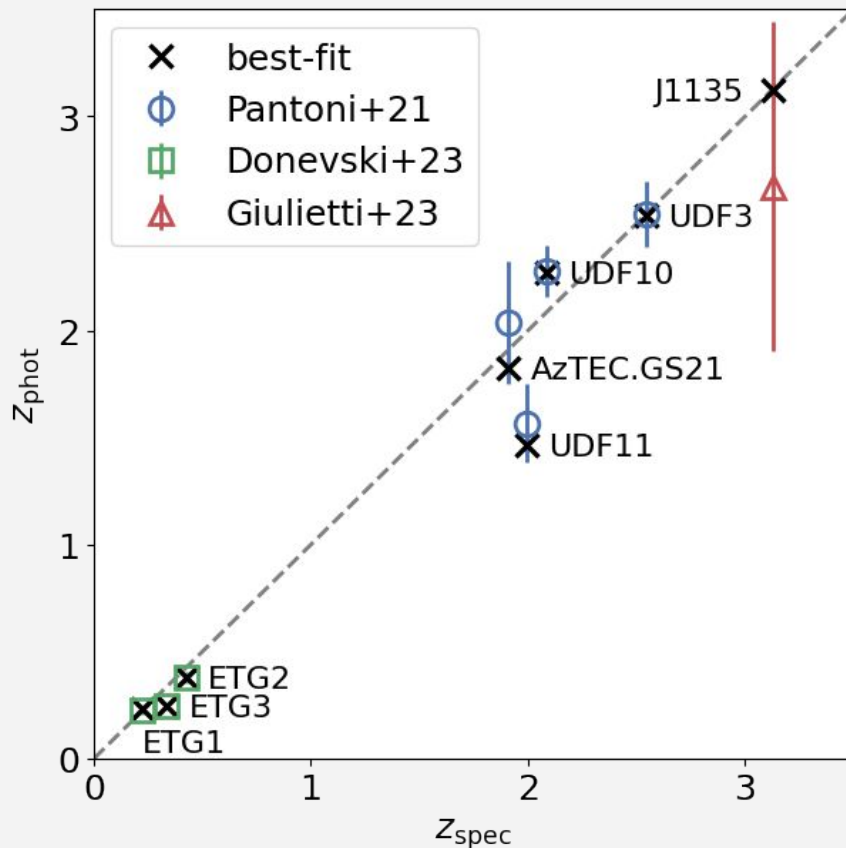
Data from [Giulietti et al., 2022](#)



Validation: photo-z of the sample cross-checked



- and it would be very nice to have this **on-the-fly**
- training a NN-model could be a solution but training with photometric data is not trivial (e.g. input space is limited)

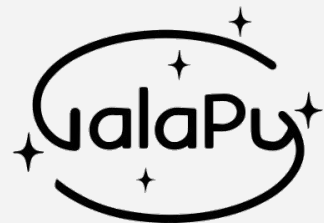


Present:

- GalaPy photometric library completed
 - final layers of user interface
 - paper **submitted** + soon code public
- Extensively **validated** on archival data
- **Fastest** of its kind

Future:

- **science:**
 - extensive spectroscopic implementation
 - consistent AGN co-evolution
- **tech:**
 - **parallelisation:** python is bad
 - **sampling**
 - **Hamiltonian:** needs differentiability
 - **Hierarchical:** for large catalogues



... and this is my last slide, thanx!