



Physical Parameters from photometric SEDs



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L. Pozzetti - Euclid Italia 23-25 Febbraio 2022

Physical Parameters from photometric SEDs

→ GAEV-SWG WP1: Physical parameter estimates from photometric SEDs

Aim: Contrast different methodologies for SED estimation, provide inputs to OU-PHZ, and work with them on implementing the best algorithm(s)

Members: **Lucia Pozzetti (coordinator)**, S. Arnouts, H. Aussel, M. Banerji, V. Beckmann, **L. Bisigello**, **M. Bolzonella**, **M. Brescia**, J. Brinchmann, F. Castander, **S. Cavuoti**, R.R. Chary, S. Charlot, T. Contini, O. Cucciati, E. Daddi, G. De Lucia, F. Fontanot, **S. Fotopoulou**, B. Garilli, A. Grazian, **O. Ilbert**, **A. Humphrey**, Pascale Jablonka, K. Jahnke, S. Juneau, **C. Maraston**, M. Moresco, **S. Paltani**, M. Salvato, **M. Scodeggio**, A. Sonnenfeld, **M. Talia**, D. Thomas, L. Tresse, **E. Zucca**.

→ Pipeline development: @ OU-PHZ (leader: **S. Paltani**): WP3.105 (PPs leaders **M. Bolzonella**, **C. Maraston**) & WP3.102 (classification: **S. Fotopoulou**)

→ Pipeline implementation: @ OU-PHZ+SDC (**F. Dubath**, **W. Hartley**, **A. A. Ayllon**)



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Physical Parameters from SEDs - Pipeline @ OU-PHZ

Methods: SED fitting + Machine Learning (NNPZ)

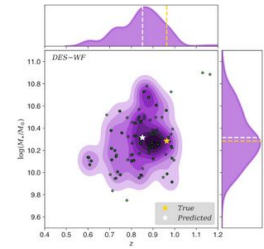
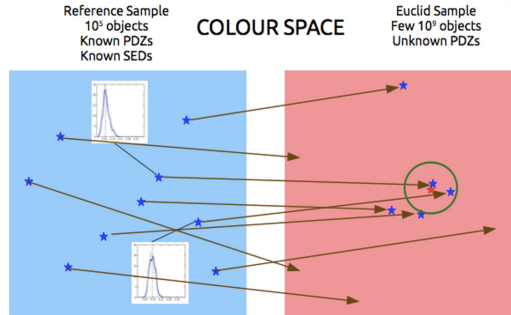
Input:

Reference sample (objects with known PPs+PDFs) derived using SED fitting [**PHOSPHOROS** for zphot and PPs]

Output

Derive PPs from the reference sample using NNPZ

→ **DATAMODEL**



Joint-PDF by
Mucesh, Hartley+2021



PPs Data Model

for each PPs → (median, mode, 68%):

- zphot
- Stellar Mass, Total Mass
- SFR & SFH (type & tau+burst) + meanSFR
- A_V + dust law (slope, bump width & height)
- Age + weighted-age
- SED
- + List of NNPZ to derive PDF[PPs|z]
- Z star, Zgas
- Rest frame photometry
- Galaxy classification
- Quality Flag
- AGN (Lfrac, Lbol, E(B-V))
- AGN SED

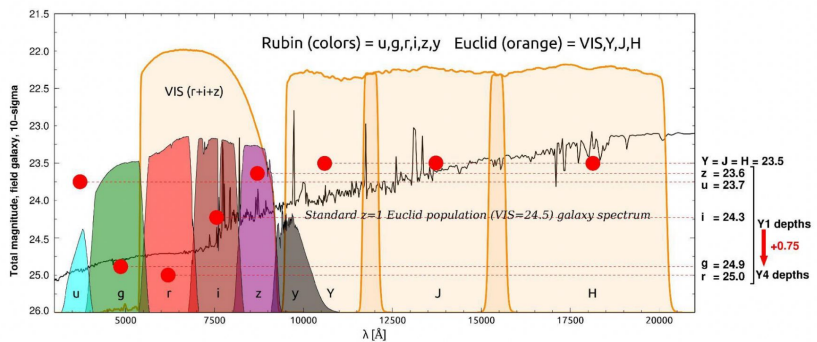
- already in PHOSPHOROS+NNPZ
- TBD
- desiderata from GAEV-SWG+WP1

Photometry

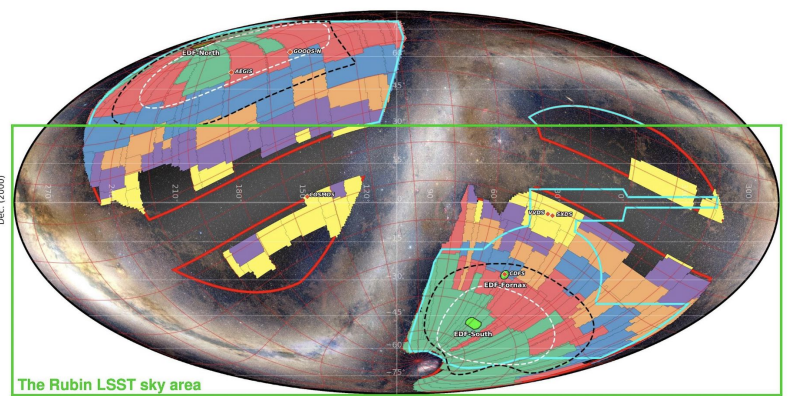
EUCLID bands (VIS,Y,J,H)
 + **ALL EXT bands:**

North	South
u CFHT	u LSST
g JEDIS	g LSST / g DES
r CFHT	r LSST / r DES
i PanSTARRS	i LSST / i DES
z PanSTARRS	z LSST / z DES
z HSC	y LSST

Matching depths between Rubin-LSST and Euclid



by J-C. Cuillandre



65% of the Euclid Region of Interest (17,354 square degrees)
 RSD 2020c ECTile realization of a Euclid Wide Survey within the 17 Kdeg² RoI: 14,668 deg² over 6 years in 2025
 by J-C. Cuillandre

Legend:
 - Red box: Euclid Wide Survey Region of Interest (RoI) - 17 Kdeg² compliant with a 15 Kdeg² survey
 - Black/White box: Best 2600 deg² (black) and 1300 deg² (white) SNR areas per galactic cap
 - Green box: Euclid Deep Fields (EDF, from north to south): 10-10+23 deg²

Logos: Euclid, ESA, CERN, etc.

→ Discussion and recommendations for Rubin-Euclid Derived Data Products Working Group (DDP-WG)

Euclid-Rubin sharing of photometric DDPs fundamental for PPs and galaxy classification

+ IRAC → small area BUT not in OU-MER catalogue



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Pre-Launch Science Key Projects on PPs

From Pre-Launch Science Key Project Document

5.12 Galaxy & AGN Evolution SWG

5.12.1KP-GEV-1: Simulated Euclid data for galaxy & AGN evolution

[Coordination: GAEV-SWG; involving LU-SWG, OU-PHZ, COSIM-SWG]

Co-coordinated by Margherita Talia & Marc Huertas Company

- **Paper 3: Galaxy Photometric SEDs and rare sources** Team: M. Bolzonella, S. Cavuoti, L.Pozzetti, M. Brescia, A.Humphrey, O.Ilberty, M.Talia, O.Cucciati
- **Paper 4: Galaxy Physical Properties Performances and effects on PPs relations and distribution functions** Team: M.Bolzonella, L.Bisigello, A.Humphrey, L.Pozzetti, C.Maraston, O.Ilberty, S.Cavuoti, G.Riccio, M.Brescia, M.Talia, O. Cucciati

5.12.2KP-GEV-2: Euclid forecasts for galaxy & AGN evolution

[Coordination: GAEV-SWG, OU-PHZ] Co-coordinated by Viola & Sotiria

- **Paper(s) 6: Galaxy classification** Team: A.Humphrey, G.Riccio, S.Cavuoti, M.Brescia, L. Pozzetti, L.Bisigello, M.Talia





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On going work/papers using galaxy mocks



Tests: SED fitting

PPs estimate with hyperz
galaxy mocks:

- **DC3**: from COSMOS2015 zphot+ simulated magnitudes in 9 filters (u,g,r,i,z,VIS,Y,J,H)
- **MAMBO** (SHAM+EGG by M.Bolzonella, L.Pozzetti, G.Girelli)
- **GAEA** (SAMs by F. Fontanot, G. DeLucia et al.)

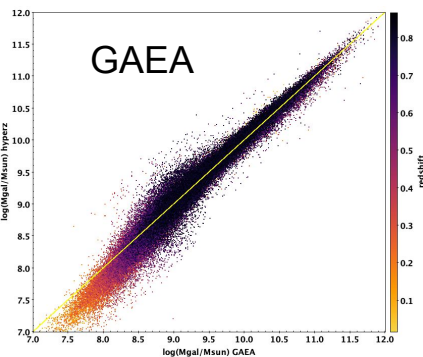
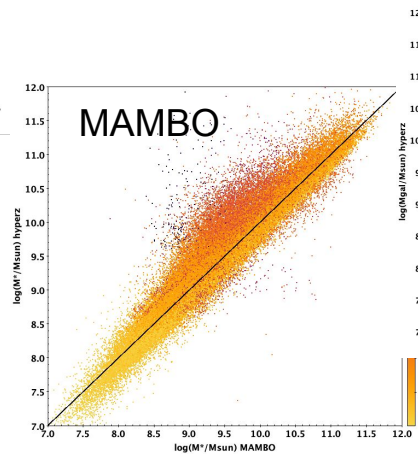
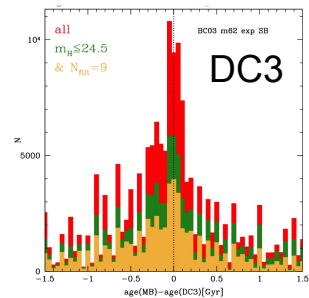
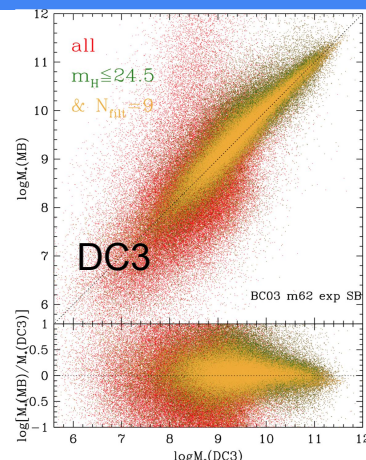
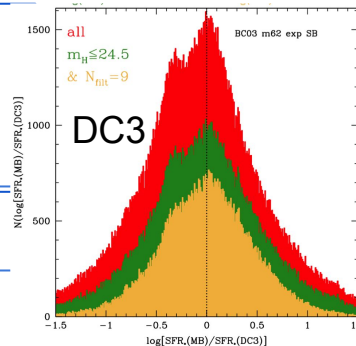
→ Photometry perturbed + zphot by O. Cucciati, M. Bolzonella et al. in WP6

Adding zphot noise

$$\sigma_{\log M} = 0.32$$

$$\sigma_{\log \text{SFR}} = 0.41$$

$$\sigma_{\text{age}} = 0.5\text{-}1 \text{ Gyr}$$

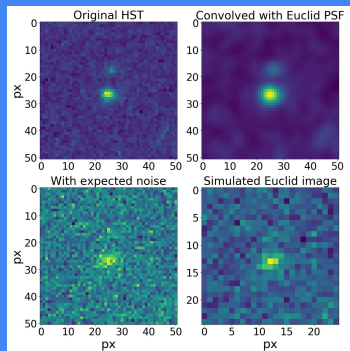


tests: ML

Galaxy mock:

- Simulated fluxes from COSMOS15
- Simulated H-band images from COSMOS-DASH(Mowla+2019)

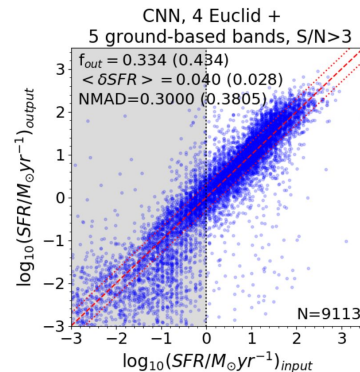
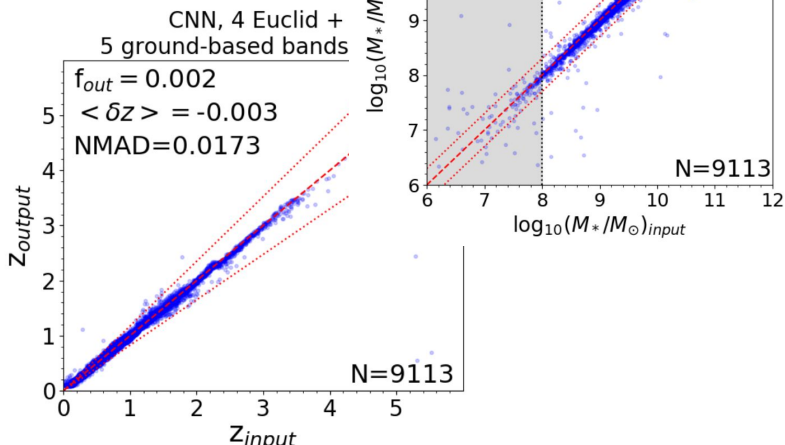
→ Convolutional Neural Network with 4 Euclid filters + ugriz + H-band images



Euclid: Derivation of galaxy physical properties with deep machine learning using mock fluxes and H-band images

L. Bisigello,^{1,2,3} C. Conselice,^{4,1} M. Baes,⁵ M. Bolzonella,² M. Brescia,⁶ S. Cavuoti,⁶ O. Cucciati,² A. Humphrey,⁷ L. K. Hunt,⁸ C. Maraston,⁹ L. Pozzetti,² C. Tortora,⁶ S. E. van Mierlo,¹⁰

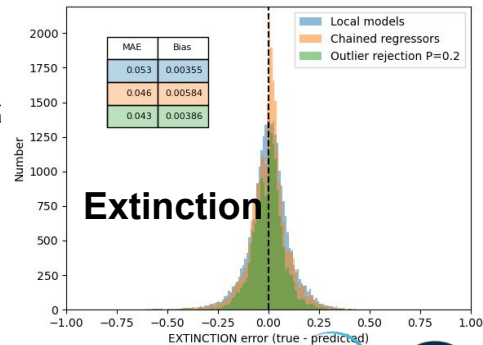
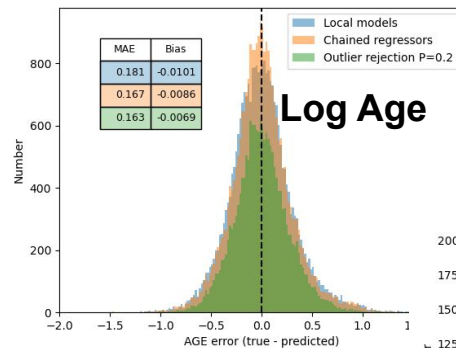
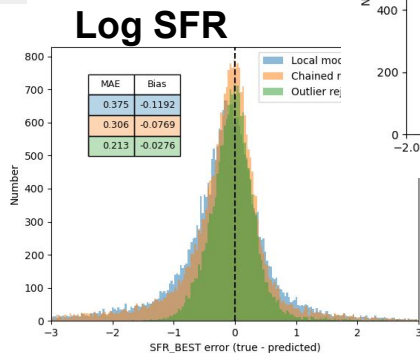
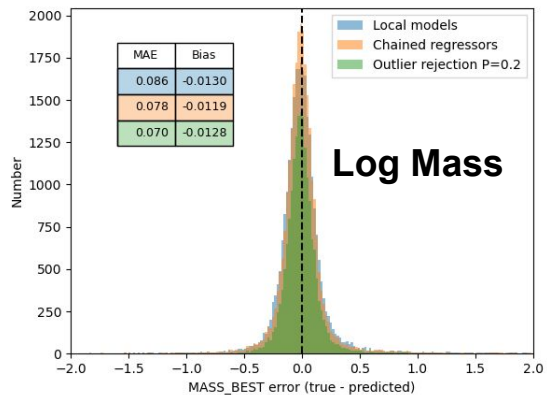
NMAD_{logM} = 0.05
 NMAD_{logSFR} = 0.3



tests: ML

Physical parameter estimation using ML CatBoost regressor chains

→ Estimating multiple parameters simultaneously improves the accuracy of all

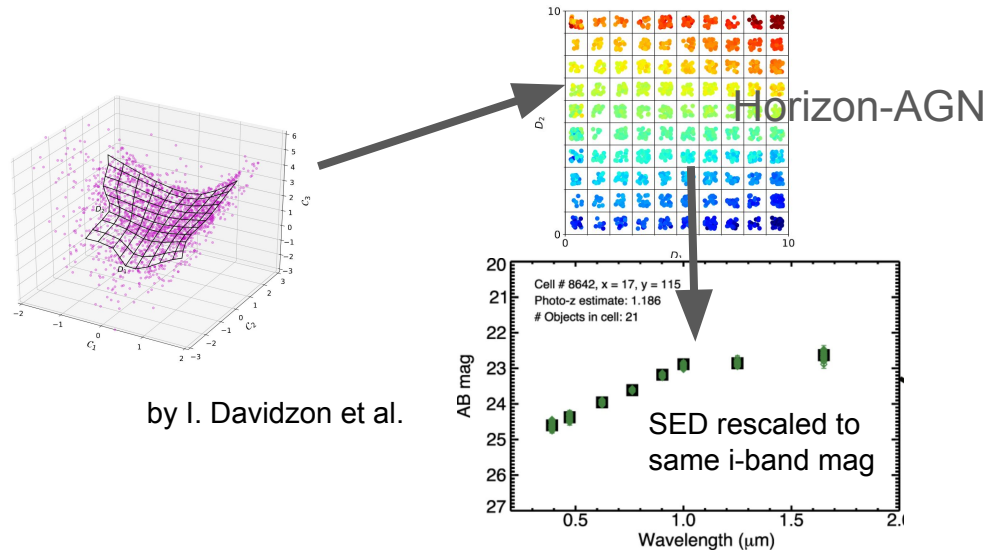


KP-GEV1 paper3: SED and rare objects

contributors: M. Bolzonella, S. Cavuoti, L. Pozzetti, M. Brescia, A. Humphrey, O. Ilbert, M. Talia, O. Cucciati
mocks: MAMBO, GAEA, SPRITZ [TBD]
techniques/codes: SOM or PCA, other ML to identify objects with similar SEDs

key paper(s)

- Characterize accurate rest-frame stacked photometric SEDs for different galaxy types and physical properties (stellar mass, SFR).
- identify rare objects excluded/underpopulated
- derive also average dust attenuation law as a function of galaxy types and redshift



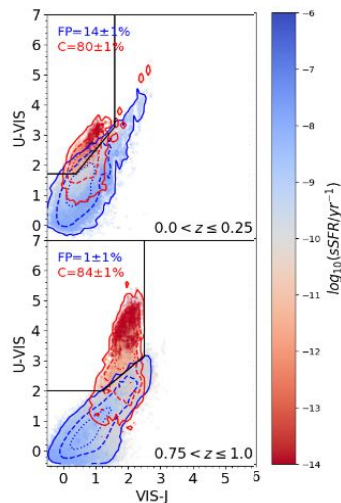
→ Use SOM pipeline for photo-z in OU-PHZ [TBC]

(outputs from DATAMODEL BIAS_ID , TOM_BIN_ID)

KP-GEV2 paper6: galaxy classification using photometry or PPs

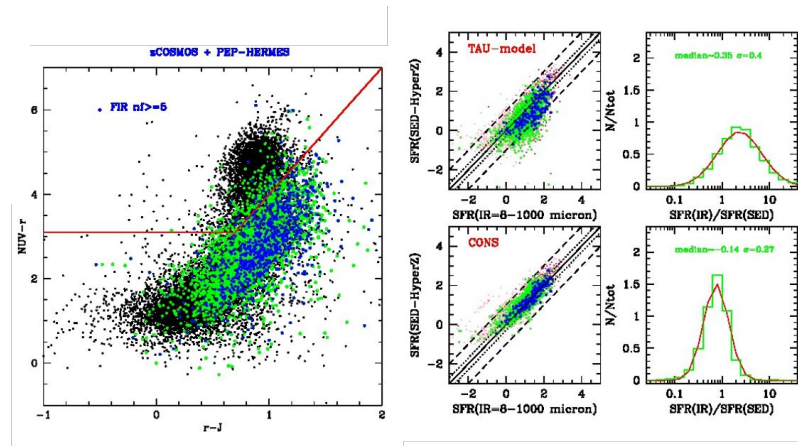
- **contributors:** A.Humphrey, G.Riccio, S.Cavuoti, M.Brescia, L. Pozzetti, L.Bisigello, M.Talia
- **mocks:** TBD
- **methods:** PPs, SOM other ML

Galaxy classification:



- up to 70% accuracy in distinguish SF from passive with Euclid + u-band (Bisigello +20)

→ use classification as prior on PPs, in particular for SFR?



by L. Pozzetti



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Issues and future activities

Next steps:

- Comparison ML vs. SED fitting results and PDF
- external photometry effects on PPs accuracy
- Reference sample (how construct it and how big ?)
- Key-papers

Priors to be tested/included (a priori, now a posteriori):

- PPs at zspec and zcluster
- Include Halpha emission ?
- Galaxy classification from photometry
- other priors ?





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Thanks Lucia

