

The Southern Photometric Local Universe Survey

Poster: F. Almeida-Fernandes^{1,2} + S-PLUS Collaboration* | Project P.I. C. Mendes de Oliveira¹



¹Instituto de Astronomia, Geofísica e Ciências Atmosféricas da USP, São Paulo, Brasil

²NSF's NOIRLAB, Tucson, AZ (visiting Postdoc)

✉ felipe.almeida.fernandes@usp.br



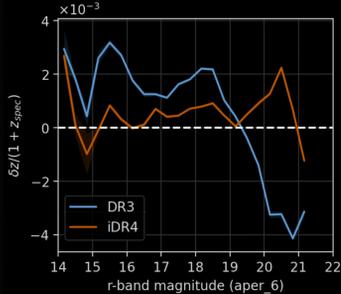
a 12-filter photometric survey

*See www.splus.iag.usp.br for the full list of collaborators | September 2022 | Background Image: S-PLUS observations mosaic by Fábio Hérpich

Photometric Redshifts

Lima et al. (2021)

Fig. from S-PLUS iDR4 Documentation



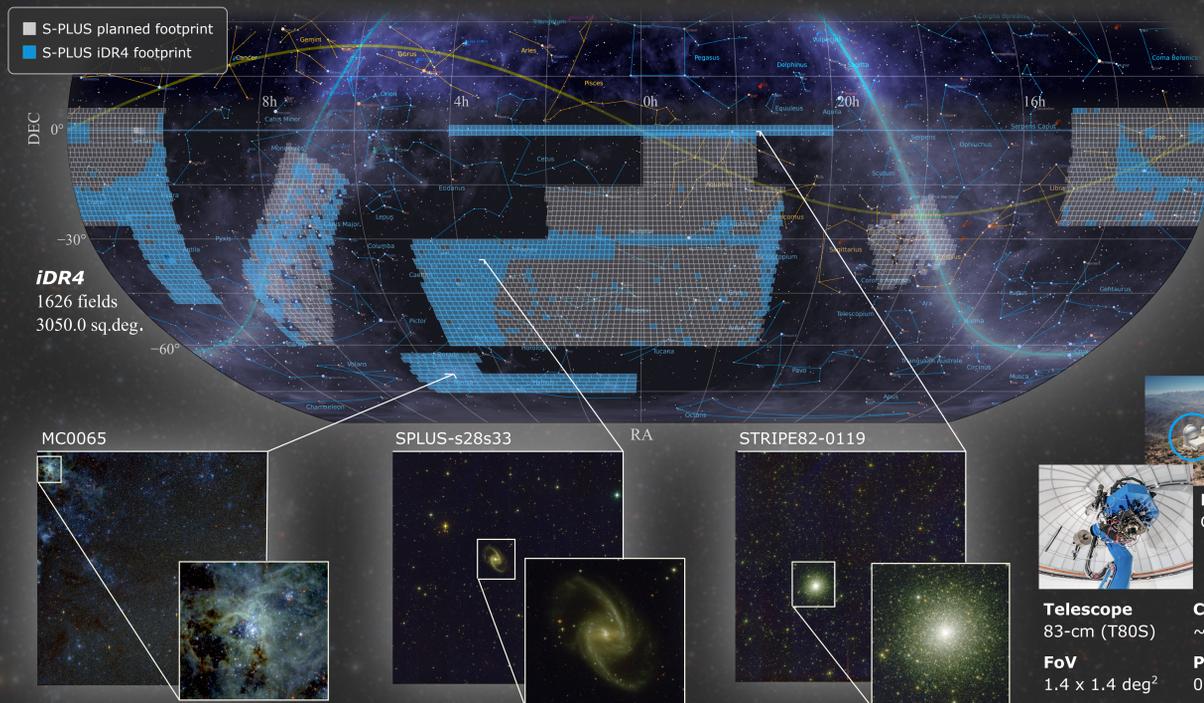
Average normalized redshift bias as a function of r magnitudes (in comparison to the spectroscopic values from the training sample), for DR3 and iDR4.

The photometric redshift estimates are obtained using Bayesian Mixture Density Network, a supervised machine learning algorithm. The model is trained using all 12 S-PLUS (APER_6) magnitudes as well as morphological features complemented by 2MASS (J, H, K) and unWISE (W1, W2) magnitudes.

Different metrics used to evaluate the results against spectroscopic values show that the model is able to provide accurate and low-biased single point estimates, while also generating well-calibrated PDFs, for redshifts between 0.007 and 0.6.

The S-PLUS Project

S-PLUS is an ongoing photometric survey observing an area of ~9000 deg² in the Southern Hemisphere, of which ~4500 sq. degrees are already observed. The filter system covers the whole optical range and includes 4 SDSS-like filters (g, r, i, z), the Javalambre u filter, and 7 narrow bands (J0378, J0395, J0410, J0430, J0515, J0660 and J0861), also from the Javalambre system and centered around key spectral features. The narrow-bands of S-PLUS enable several different scientific applications, from the study of single stars to the identification and characterization of galaxy clusters.

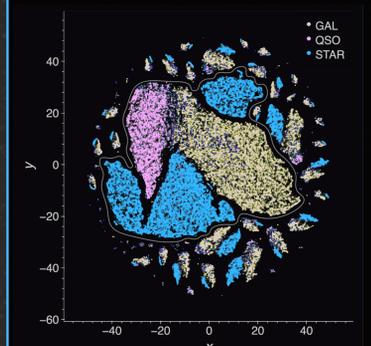


Filter System

filter	u	j0378	j0395	j0410	j0430	g	j0515	r	j0660	i	j0861	z
$\lambda_{\text{ref}} (\text{\AA})$	3533	3773	3941	4095	4292	4758	5133	6252	6614	7671	8608	8937
$W_{\text{eff}} (\text{\AA})$	323	136	101	192	194	1312	204	1274	147	1438	403	1275
$\langle \lambda \rangle T_{\text{exp}} (\text{s})$	227	220	118	59	57	33	61	40	290	46	80	56
Phot. Depth (for S/N > 5)	20.3	19.8	19.2	19.4	19.4	20.5	19.6	20.5	20.4	20.1	19.1	20.1

On the discovery of stars, quasars, and galaxies

Nakazono et al. (2021 - Fig 5c)



Two dimensional projection, using t-SNE, of the classification (that includes the WISE magnitudes) for the S-PLUS DR2.

The QSO/star/galaxy photometric classification is provided for all sources as a Value Added Catalog, and includes probabilities for each class. The classification is performed by two Random Forest algorithms: one using only S-PLUS data and another that additionally includes WISE magnitudes (W1, W2). The later produces better results.

EXPERIMENT	CLASS	Precision (%)	Recall (%)
RF_12S	QSO	91.99 ± 0.41	89.31 ± 0.97
	STAR	95.55 ± 0.46	89.59 ± 0.44
	GAL	91.26 ± 0.41	95.7 ± 0.29
RF_12S+2W	QSO	95.48 ± 0.12	94.83 ± 0.26
	STAR	98.61 ± 0.08	97.06 ± 0.25
	GAL	96.97 ± 0.15	98.14 ± 0.08

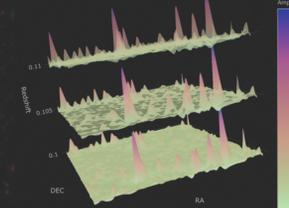
Estimated for Data Release 2

Extragalactic Science

Galaxy Clusters

Werner et al. (in prep.)

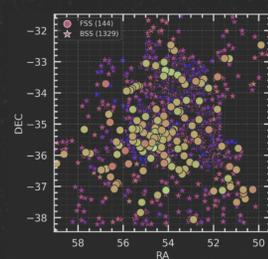
Presents a catalog of 5533 groups and clusters of galaxies detected in S-PLUS in the STRIPE82 region. The groups were selected using PzWav, an algorithm that detects clusters by finding peaks in galaxy density maps. In relation to a simulation-based mock sample, it is expected that this catalog is 82% complete for redshifts between 0.1 and 0.4, for clusters with $M_{200} > 10^{14} M_{\odot}$.



Fornax Cluster

Calderón et al. (2022 - Fig 3) Smith Castelli et al. (2022)

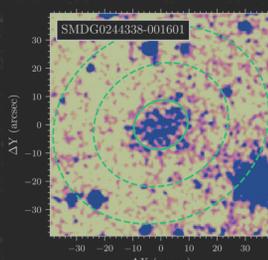
S-PLUS has a research group dedicated to the study of galaxies in the Fornax Cluster. Recent published results include SED-fitting and characterization of the galactic population of the cluster in relation to the background galaxies.



Ultra-diffuse Galaxies

Barbosa et al. (2020 - Fig 2)

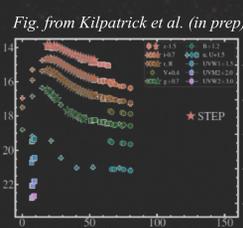
S-PLUS data was used in combination to the SMUDGes survey in order to conduct the first systematic study of the stellar populations of ultra-diffuse galaxies (UDGs). Ages, metallicities and masses were determined through Bayesian modeling of the optical colors for 100 UDGs distributed along the STRIPE82 region.



Transient Extension Program

Santos & Bom et al. (in prep)

The S-PLUS Transient Extension Program aims to discover new transient sources by comparing S-PLUS observations to legacy images (e.g. DECam). The group has already successfully followed the light curves of two known supernovae, and very recently reported the discovery of a new supernovae designated AT 2022rri (TNS Astronomical Report No. 155369)



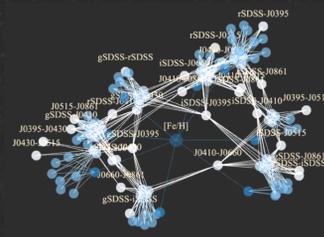
+ more

Stellar/Milky Way Science

Stellar Parameters

Whitten et al. (2021 - Fig 3)

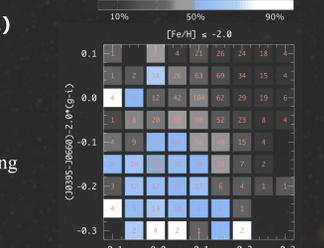
A neural-network technique was applied to S-PLUS photometry in order to measure effective temperatures, metallicities and carbon abundances for over 700,000 stars in two stellar populations: (1) halo main sequence turn-off and (2) low mass K-dwarfs in the Solar Neighborhood.



Metal-poor stars

Placco et al. (2021, 2022 - Fig 2)

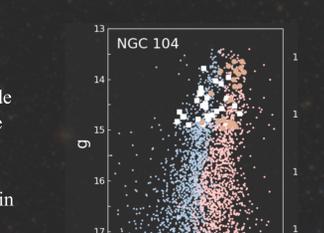
Explores the narrow-bands sensitivity to metallicity in order to build a sample of metal-poor stars. A spectroscopic follow-up confirms that 83% of the 522 selected stars have $[\text{Fe}/\text{H}] < -2.0$, including the ultra metal-poor star with the lowest ever measured carbon abundance (SPLUS J210428.01-004934.2).



Stellar Clusters

Hartmann et al. (2022 - Fig 7)

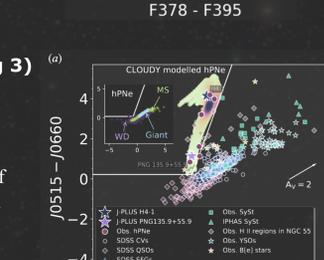
Shows that narrow bands color-magnitude diagrams reveal the existence of multiple stellar populations in 4 globular clusters: NGC 104, NGC 288, NGC 3201, and NGC 7089. Also observers radial trends in the distributions of each population.



Planetary Nebulae

Gutiérrez-Soto et al. (2021 - Fig 3)

Proposes tools to identify Planetary Nebulae candidates and separate them from other emission line sources. The identified criterias, which all make use of the narrow band filters, can be used for a systematic search of halo planetary nabulaes.



+ more

Miscellaneous

Public Data Releases

DR1 | 170 fields | 335.9 sq.deg. Mendes de Oliveira et al. (2019)

DR2 | 514 fields | 950.5 sq.deg. Almeida-Fernandes et al. (2022)

DR3 | 1117 fields | 2108.5 sq.deg. Already Available (paper in prep)

Data Access

The S-PLUS database follows the guidelines of the International Virtual Observatory Alliance (IVOA), and can be access using the Astronomical Data Query Language.

The tools to access the catalogs and the images can be found in the splus.cloud website.

SPLUS.cloud



<https://splus.cloud>

Outreach

Citizen Science at Zooniverse Identify and classify asteroids, interacting galaxies, and other exotic detections in the S-PLUS observations.

Working on Book "Céu Aberto" (Open Sky) We will publish S-PLUS images selected by the public.

Talk at Planetarium One of the activities at the 17th S-PLUS meeting was a talk for the general public at the Rio de Janeiro's planetarium.

Citizen Science at Zooniverse



<https://www.zooniverse.org/projects/cilopes/splus-cacaedores-de-astros>

Collaboration

S-PLUS is a Brazilian led survey, founded as a partnership between several local institutes with important financial and practical contributions from other collaborating institutes also in Chile and Spain.

Currently, S-PLUS has more than a hundred local members, as well as dozens of external collaborators all over the world.



17th S-PLUS Collaboration Meeting CBPF, Rio de Janeiro, 09/2022

Contact me if you want to join us! felipe.almeida.fernandes@usp.br

