Automatic scattered field estimation for the Stripe82 survey

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Abstract. The low surface brightness Universe is one of the last frontiers in observational Astronomy, even a deep large multi-band survey such as the SDSS/Stripe82 is essentially blind to the presence of small (<10 arcsec) extended sources with surface brightness fainter than 28.6 mag/arcsec^2 (Stripe82 limiting surface brightness in the r-band). At surface brightness levels fainter than 29 mag/arcsec^2 the night sky looks extremely complex, with multiple features such as dust filaments, scattered light from both stars and galaxies, extremely faint objects, tidal features around galaxies, etc. In this context, removing the scattered light produced by the brightest point-like sources is essential to exploit the deepest data. In this contribution, we introduce an automatic method to characterize and remove the scattered light in all 5 bands (ugriz) of the SDSS-Stripe82 survey.

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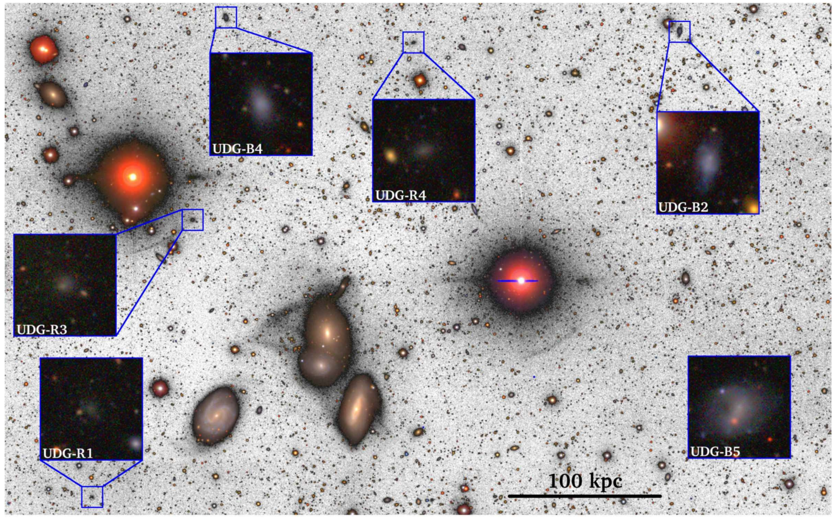
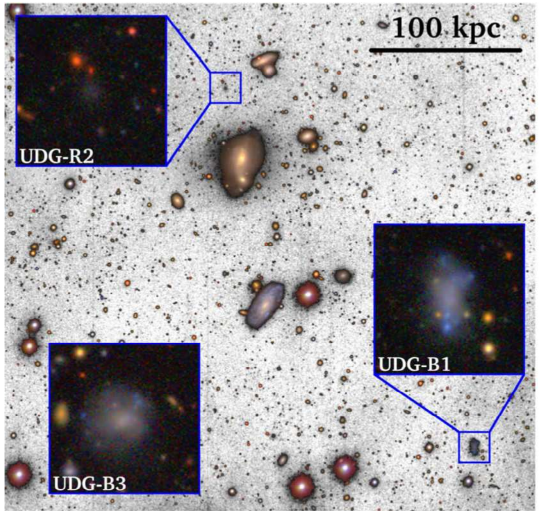
Fundación BBVA

1. Context of the research



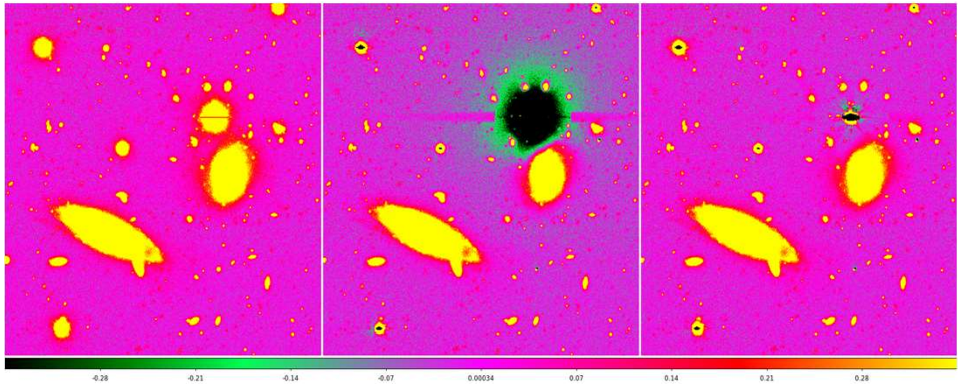


Stripe 82 is a 2.5 degree wide stripe along the Celestial Equator in the Southern Galactic Cap (-50º < R.A. < 60º, -1.25º < Dec- < 1.25º) with a total area of 275 square degrees in all the five Sloan Digital Sky Survey (SDSS) bands. It has been imaged by the SDSS multiple times between 1998 and 2004 in 82 runs (94 to 5052) and between 2005 and 2007 in 222 additional runs (5566 to 7202). See http://research.iac.es/proyecto/stripe82//

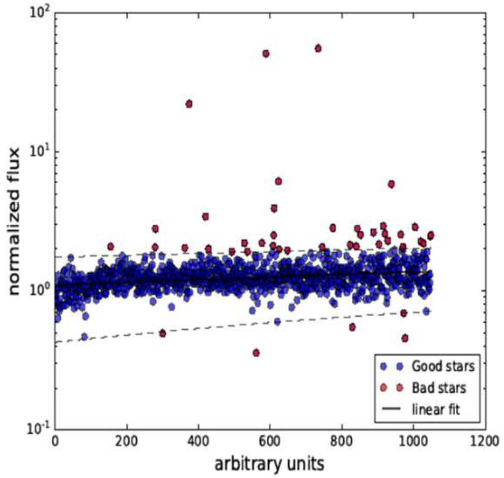
The coadded dataset reaches a mean surface brightness limit of μ[3σ, 10 x 10 arcsec^2] = 27.9, 29.1, 28.6, 28.1 and 26.7 mag arcsec^{-2} for the *u*, *g*, *r*, *i* and *z* bands respectively. For point sources it reaches 50% completeness limits (3σ level) of 24.2, 25.2, 24.7, 24.3, 23.0 mag for the *u*, *g*, *r*, *i* and *z* bands respectively. This is around two magnitudes deeper than the single-epoch SDSS (Fliri & Trujillo 2016).

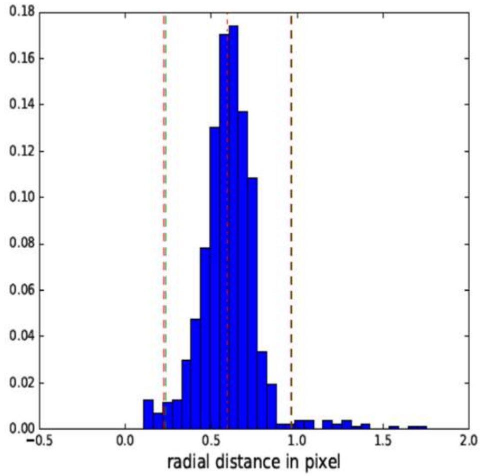
2. Description of the work & methodologies

Original image | Iteration 1 | Iteration 2



- Initial source locations are identified from the GAIA catalogue.
- The real location in the image is estimated adjusting a parametric model optimized with a quadratic function.
- The flux is measured along a circle around the star at a certain radial distance.

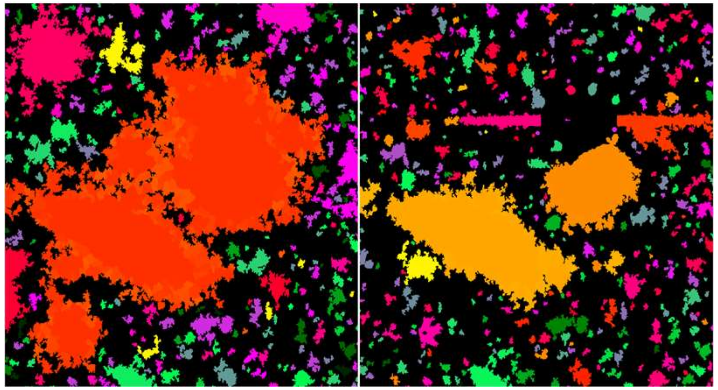




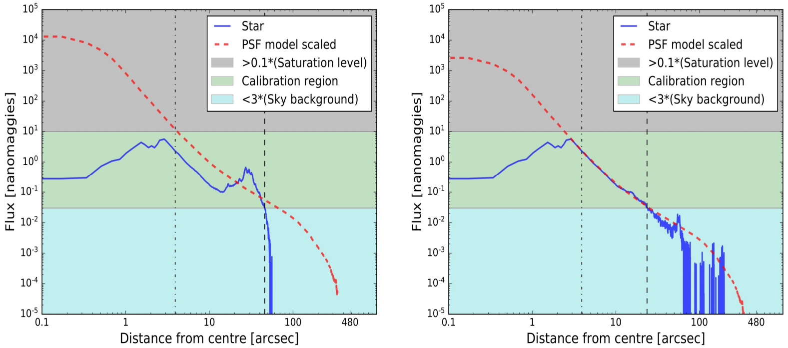
That process is repeated twice. A final refinement is performed in both the flux estimation and the shift location to correct possible outliers.

2. Description of the work & methodologies

Segmented images at iterations 1 and 2



Radial profiles



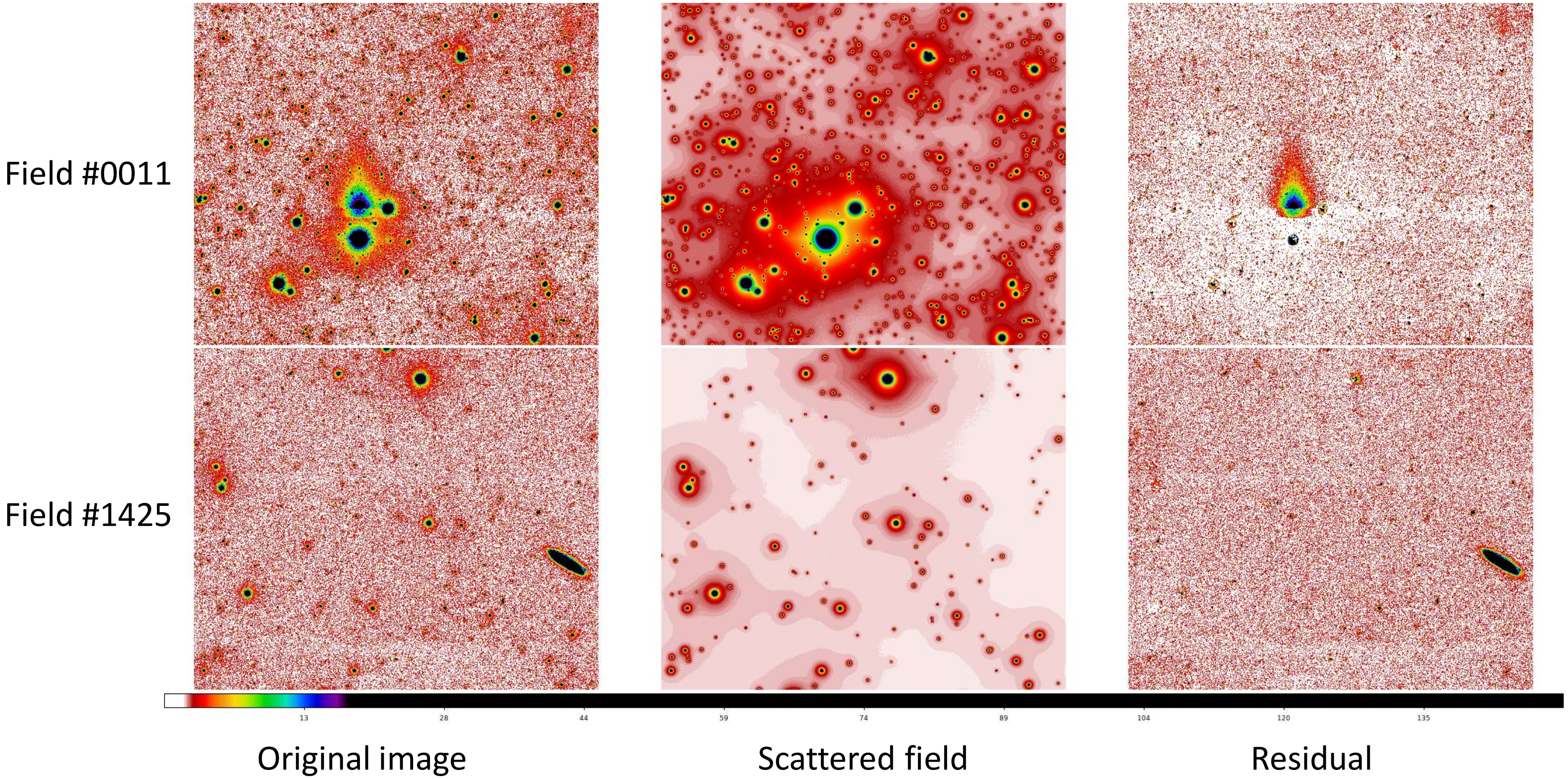
Objects in the image below the sky level are identified and masked in order to estimate the stellar flux.

In the image on the left (it 1), one can see how the star to be subtracted is confused with a nearby galaxy.

If sources of light contamination (e.g., internal reflections, galaxies, etc.) are in the vicinity of the star, the first estimation of its flux can be erroneous. This is the reason a second iteration is necessary.

This 2-loop procedure is done across all stars in the field of view.

4. Results

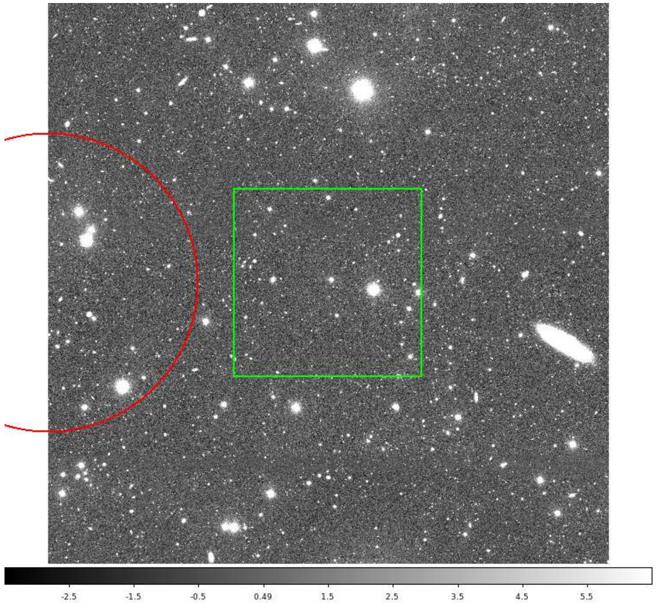


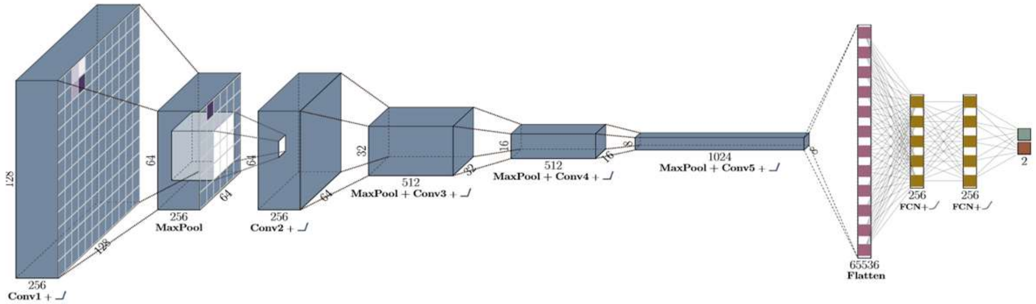
Results after removing all point-like sources until magnitude 18, at Gaia G passband, in two different fields with a different star population density.

Leftmost panels show the original image (I), middle panels show the estimated scattered field (S) with this method, and rightmost panels show the residual (R), i.e., I = S + R.

The PSF model used is an average estimation for the whole Stripe82. A particular model for each one of the fields will reduce over subtraction.

5. Impact and prospects for the future





- This method allow us to characterize and correct the scattered light at the central portion of all Stripe82 fields of view (FOV).
- Taking into account that the PSF radius considered is 8 arcmin, the central 594x594 arcsec portion of the image (green box) is fully corrected by all possible external sources within the same FOV, as can be seen if we place such PSF (red circle) in a hypothetical star at the edge of the FOV.
- We are now working to create a training dataset from these central boxes to correct the rest of the FOV using Machine Learning techniques, which will be essential for much larger datasets such as LSST.