EUCLID Strong Lensing Science Working Group Report...

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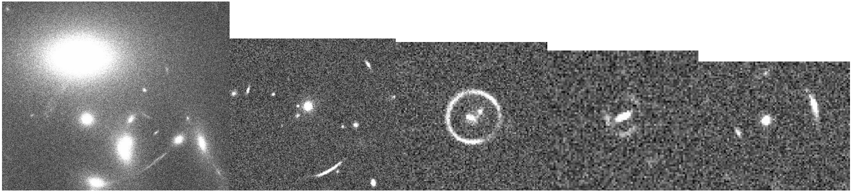
December 3, 2012



SLSWG goals

SLSWG will evaluate EUCLID capabilites in strong lensing.

What we expect:

- Over 15 000 deg^2, there are $\sim 5000 - 10\,000$ cluster and group lenses, $\sim 100\,000$ galaxy-galaxy lenses.

SLSWG goals

What we hope:

- to use those lenses for the study of DM peaks up to redshift ~ 1
- to probe DM substructure , time delays
- cosmology related evolution of lensing statistics

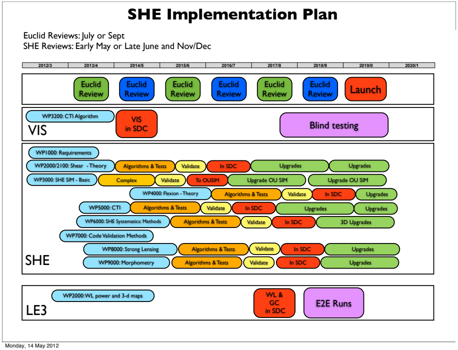
SLSWG goals

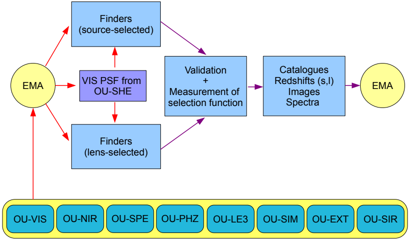
What we need:

- detect most of the candidates automatically
- compute the selection function
- compute the probability distribution functions wrt arc properties

SLSWG goals

SLSWG participates to OU-SHE WP 8000





EC	SGS	PHASE:	B	WP Ref:	WP8000
WP Title:	Strong lensing			Revision:	Version 0.1
				Date:	10/05/12
Country:	Switzerland	Institution:	EPFL	Sheet:	1 of 1
WP Manager:	F. Courbin	Manag. Inst.:		PT Ref:	PT ref. number
Start Event:		Start Date:	01/01/12	Product:	Product name
End Event:		End Date:	30/12/25	Delivery:	EMA

WP Objectives:

Develop algorithms to find strong lensing systems at all spatial scales: individual galaxies, groups and clusters. The best possible selection function of these algorithms, when applied to Euclid data, should also be provided.

The main science drivers for strong lensing are:

- To study of the spatial distribution of dark matter at all scales
- To constrain the cosmological parameters (lens counts, lensing tomography)
- To study galaxy structure and evolution
- To provide a tool to study distant sources (natural telescope)
- To find "exotic lenses" (jackpot lenses, cosmic strings, unexpected lensing configurations)

WP Inputs:

This WP requires data from many other OUs, including EXT. The required data will be:

- VIS and NIR images and PSFs with associated noise maps and mask files
- Catalogues of bright galaxies, groups and clusters, including photometry and photo-z
- 2D spectra with associated PSF, noise maps and mask files
- Ground based optical spectra, when available, with associated noise maps and mask files
- Ground based optical images and PSFs with associated noise maps and mask files
- Composite (3-band) images to visually separate lenses and sources
- A tool to quickly visualize any specific object in EMA, in multi-band

All images should be accessible as stamps between 5 arcsec and 10 arcmin on a side

WP Tasks:

The strong lensing science goals require samples of strong lenses of different types and spatial scales. These samples will include:

- Galaxy scale lenses
- Group scale lenses
- Cluster scale lenses
- Bright lensed sources, including gri dropouts
- Lensed quasars

1- Development of lens finders:

- Rings finders using VIS imaging
- Arc finders using VIR imaging (and possibly NIR imaging)
- Spectroscopic finders using 2D NIR spectra

2- Simulations needed for strong lensing finders: (in the following "rings" are produced by galaxies, "arcs" are produced by groups and clusters)

- 1000 bright rings hidden in 15000 sq degree
- 30000 hidden faint rings (like in COSMOS)
- 1000 lensed quasars spanning a broad range of image separations and configurations
- 100 "jackpot" lenses (i.e., with two sources or more at different redshifts)
- Realistic blank fields with NO lenses to estimate the rate of false positives
- 2D spectra of lensed emission line objects

Note that simulations will be also developed by the SL SWG to estimate the performances of the lens modelers. This is, however, out of the scope of OU-SHE and left as a SWG task.

3- Selection functions of the finders:

TBD in more details. This will use the simulations described at point 2)

Manpower: 1 Swiss FTE starting in September 2012 + contributions from the SWG

Short-term plan (6 months):
- Identify the best arc and ring finders and test them on simulated images
- Carry out simple simulation to develop, test and train lens finders

Mid-term plan (1 year):
- Develop new finders for imaging
- Develop new finders for spectroscopy
- Start develop multi-band finders
- Use basic simulations to estimate the selection functions

Long-term (5 years):
- Develop efficient lens finders, both lens-selected and source-selected
- Develop an accurate simulation pipeline to measure the selection functions of finders

WP Outputs:

The strong lensing WP provides the data necessary to reach the science objectives of the science working group. For each sample of strong lenses of a given type, the WP will provide:

- A catalogue of lenses, with basic photometric and morphological information
- Spectroscopic or photometric redshifts for the lens(es) and source(s)
- VIS and NIR images with associated PSFs and noise maps
- When available, 2D spectra with associated PSFs and noise maps
- Total mass within the Einstein radius
- Selection functions for all samples

WP deliverable: FITS images, spectra and catalogues

SLSWG goals

Participate to OU-LE3 Cluster WP 4-3-10-2140...

Tasks:

- Identification of clusters by strong lensing
- derivation of SL cluster masses

SLSWG working method

WG meeting each 6 months:

– Kick-Off April 2012 (Lausanne).
– Pipeline meeting October 2012 (Groningen).
– Next... April 2013 (Bologna).

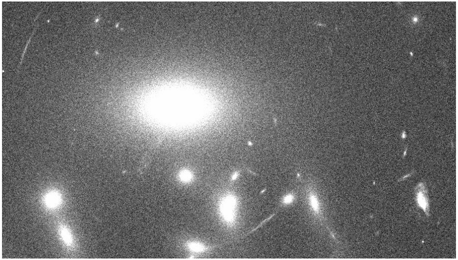
Bi-weekly teleconference (Google Hangout)

All minutes and reports may be found on
http://euclid.roe.ac.uk/projects/slswg/wiki

SLSWG current work

Assignment 1: realistic strong lensing simulations: Bologna Lens Factory (B Metcalf, M Menneghetti, C. Gioccoli)

EUCLID Vis (Menneghetti et al.)

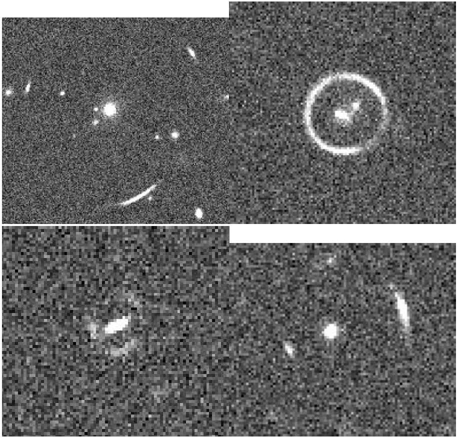


- Cluster Simulations: NFW halos, Sersic model stellar mass and light distributions of galaxies. Real background galaxies from UDF, shapelet deconvolved
- Galaxies: NFW halo, Sersic model stellar mass distribution, real HST massive galaxy light distribution. Real background galaxies from UDF, shapelet deconvolved
- Outputs: realistic single EUCLID images of simulated clusters, with many multiple image systems

SLSWG current work

Assignment 1: realistic strong lensing simulations: Bologna Lens Factory (B Metcalf, M Menneghetti, C. Gioccoli)

EUCLID Vis (Metcalf)



- Field simulations, Millenium and C. Baugh provided cone, Ray tracing of "enriched" background to increase SL density. Images are also on the Bologna lens factory database page - only one filter for now images are with noise and Euclid-like PSF. Source model: devaucouleur + exp disk

SLSWG current work

Assignment 1: realistic spectroscopic simulations (NISP): LAM, CRAL (Jullo et al.)

- Recycle as much as possible what has been donne for MUSE.

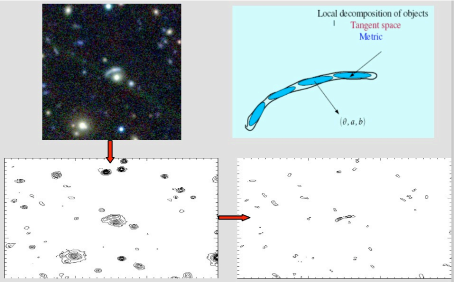
SLSWG current work

Assignment 2: Test arcfinders (Cabanac et al., Seidel et al., Gavazzi et al.)

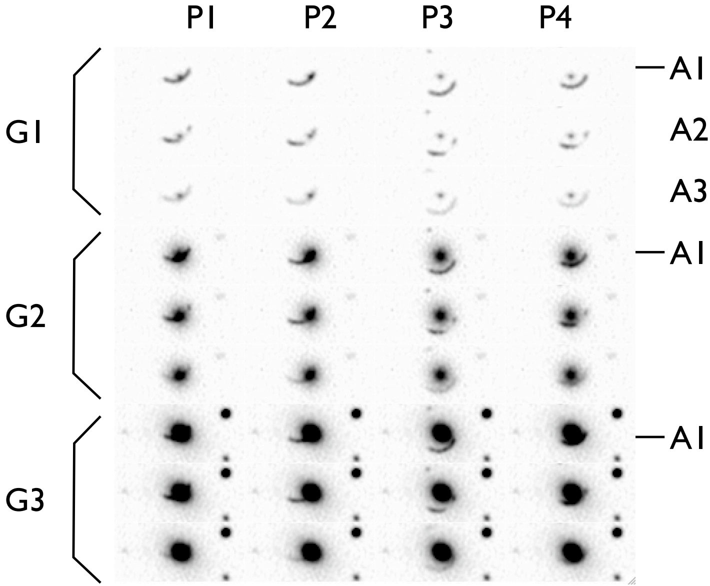
Arcfinder (More et al.)

Elongation estimator

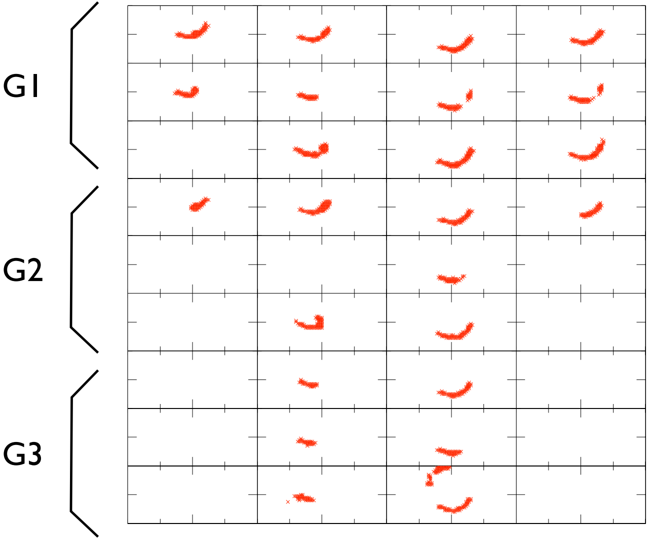
$$Q(x_0, y_0) = \frac{1}{2M} \frac{I_Y(x_0)}{SUP.[I_X(x_0+x)]_{[-M<x<M]}}$$

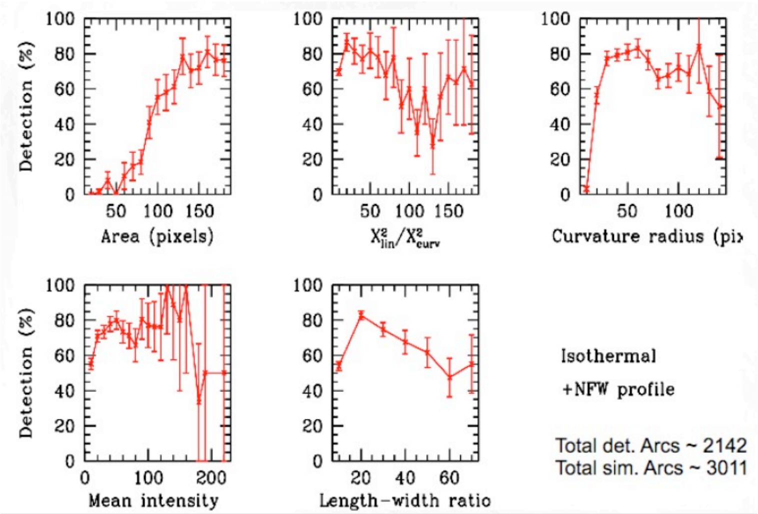


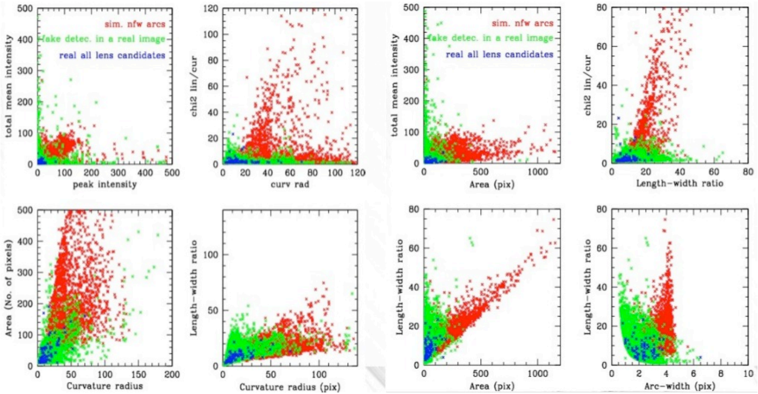
- Three arc finders already exist, two based on Alard's elongation estimator (Seidel , More). One using Gavazzi's small scale ring detector.
- The objective is to derive detector efficiencies wrt arc properties
- purity/completeness tables


P1
P2
P3
P4
G1
G2
G3
A1
A2
A3
A1
A1

More/Alard




Detection (%)
Area (pixels)
X^2_{lin}/X^2_{curv}
Curvature radius (pix
Mean intensity
Length−width ratio
Isothermal
+NFW profile
Total det. Arcs ~ 2142
Total sim. Arcs ~ 3011


sim. nfw arcs
fake detec. in a real image
real all lens candidates
total mean intensity
peak intensity
chi2 lin/cur
curv rad
total mean intensity
Area (pix)
chi2 lin/cur
Length-width ratio
Area (No. of pixels)
Curvature radius
Length-width ratio
Curvature radius (pix)
Length-width ratio
Area (pix)
Length-width ratio
Arc-width (pix)

SLSWG current work

Assignment 3: Test strong lensing modellers (Kneib et al., Jullo, Marshall et al.)

- Release publicly the simulation and organize a lensing challenge (akin to GREAT challenges)
- Probe the potential of "citizen science" for detection of none obvious cases.