GALCLOCK

GALaxies, Clusters and Lensing for Observational Cosmology in the KiloDegree Survey (KiDS)

MARIO RADOVICH

AUDIZIONI INAF RS1, MAY 19 2022

On behalf of…

15. Personale INAF coinvolto

#	Nome	E-mail	Struttura	TI	Qualifica	Ruolo nel Progetto	FTE Accertate (2022/23/24)	FTE Presunte (2022/23/24)
1	mario.radovich	mario.radovich@inaf.it	O.A. PADOVA	Y	RICERCATORE	Clusters; KiDS PT; KiDS Board	[0.3, 0.3, 0.3]	[-1.0, -1.0, -1.0]
2	sandro.bardelli	sandro.bardelli@inaf.it	OAS BOLOGNA	Y	RICERCATORE ASTRONOMO	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
3	carlo.giocoli	carlo.giocoli@inaf.it	OAS BOLOGNA	Y	RICERCATORE	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
4	emanuella.puddu	emanuella.puddu@inaf.it	O.A. CAPODIMONTE	Y	TECNOLOGO	Clusters	[0.5, 0.5, 0.5]	[-1.0, -1.0, -1.0]
5	mauro.sereno	mauro.sereno@inaf.it	OAS BOLOGNA	Y	RICERCATORE	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
6	fedor.getman	fedor.getman@inaf.it	O.A. CAPODIMONTE	Y	TECNOLOGO	KiDS PT	[0.2, 0.2, 0.2]	[-1.0, -1.0, -1.0]
7	crescenzo.tortora	crescenzo.tortora@inaf.it	O.A. CAPODIMONTE	Y	RICERCATORE	Galaxy Properties; Strong Lensing	[0, 0.1, 0.1]	[0.1, -1.0, -1.0]
8	francesco.labarbera	francesco.labarbera@inaf.it	O.A. CAPODIMONTE	Y	RICERCATORE ASTRONOMO	Galaxy Properties	[0, 0, 0]	[-1.0, -1.0, -1.0]
9	massimo.brescia	massimo.brescia@inaf.it	O.A. CAPODIMONTE	Y	RICERCATORE	Machine Learning	[0, 0, 0]	[-1.0, -1.0, -1.0]
10	stefano.cavuoti	stefano.cavuoti@inaf.it	O.A. CAPODIMONTE	Y	RICERCATORE	Machine Learning	[0, 0, 0]	[-1.0, -1.0, -1.0]

16. Personale Associato INAF coinvolto

#	Nome	E-mail	Struttura	TI	Qualifica	Ruolo nel Progetto	FTE Accertate (2022/23/24)	FTE Presunte (2022/23/24)
1	lauro.moscardini	lauro.moscardini@unibo.it	Università di Bologna	Y	Professore Ordinario	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
2	federico.marulli	federico.marulli@unibo.it	Università di Bologna	Y	Associate professor	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
3	chiara.spiniello	chiara.spiniello@inaf.it	University of Oxford, UK	N	Hintze Fellow, post-doc	Galaxy Properties; Strong Lensing	[0, 0, 0]	[-1.0, -1.0, -1.0]
4	giuseppe.dago	gdago@astro.puc.cl	Pontificia Universidad Católica de Chile	N	Post-Doc	Galaxy Properties; Strong Lensing	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
5	nicola.napolitano	nicola.napolitano@inaf.it	Uni Sun Yat-sen	Y	ordinario	Galaxy Properties; Strong Lensing	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]
6	giovanni.covone	giovanni.covone@unina.it	Uni Federico II	Y	Prof. associato	Clusters	[0.1, 0.1, 0.1]	[-1.0, -1.0, -1.0]

… and also: G. Castignani, G. Lesci (UniBO), L. Ingoglia (UniNA)

A (short) introduction to KiDS

2005: ESO acceptance of a proposal for a public survey of 1500 sq. degrees

KiDS *P.I.: K. Kuijken (Leiden Univ.)* *state of the art Weak Lensing with OmegaCAM@VST*

VIKING: Parallel proposal on VISTA (P.I. Sutherland/Edge)

Data products: ugri+ZYJHK photometry

2011: VST first light: KiDS started !

2013: First KiDS ESO release (50 sq. degrees)

2016: VIKING terminated at 1300 square degrees

2017: KiDS-DR3 public release (450 sq. Deg.), VST+VIKING photometry (KV450)

2019: KiDS DR4 public release (1000 sq. Deg.)

2020: KiDS observations completed !

2022: KiDS DR5 internal release (final area: 1350 sq. Deg+ 20 sq. Deg covering fields with deep public spectroscopy)

2023: KiDS DR5 public release (legacy)

ESO Public Surveys Proposal Form — Phase 1

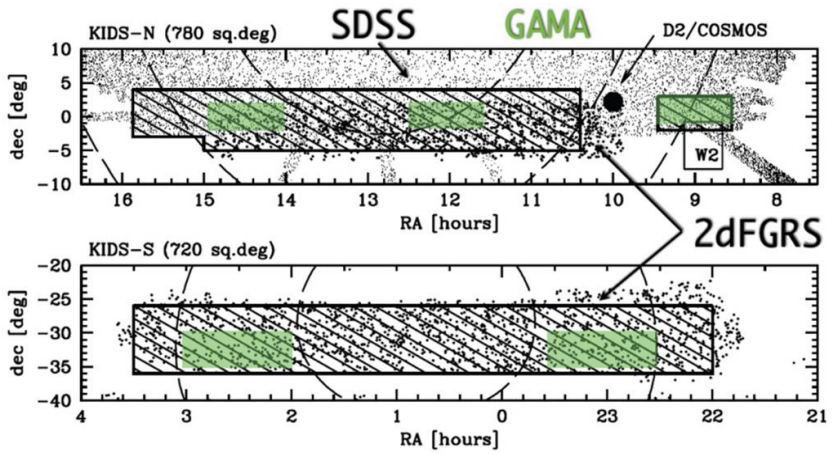
1 KIDS: a 1500-square degree cosmological survey with VST/OmegaCAM

PI: Konrad KUIJKEN, Leiden Observatory, The Netherlands
~~Ralf Bender~~, ~~Hans Böhringer~~, ~~Massimo Capaccioli~~, Thomas Erben, ~~Ulrich Hopp~~, ~~Yannick Mellier~~, ~~Mark Neeser~~, John Peacock, Mario Radovich, ~~Roberto Saglia~~, Peter Schneider, ~~Peter Schuecker~~, ~~Stella Seitz~~, ~~Roberto Silvotti~~, ~~Will Sutherland~~, ~~Andy Taylor~~, Edwin Valentijn, ~~Steve Warren~~

1.1 Abstract:

We propose a large (1500 square degree in $u'g'r'i'$, 2800 in i') public imaging survey with VST/OmegaCAM, dubbed the Kilo-Degree Survey (KIDS). It targets two regions of the sky where massive redshift surveys have taken place, and where near-infrared surveys will soon begin: an equatorial strip on the North Galactic Cap, and a patch around the South Galactic Pole. In terms of area coverage and sensitivity, KIDS interpolates between the ongoing Sloan Imaging Survey, which is about 2.5 magnitude shallower but 7× wider, and the roughly 1 magnitude deeper, 9× smaller-area CFHTLS-Wide survey at CFHT.

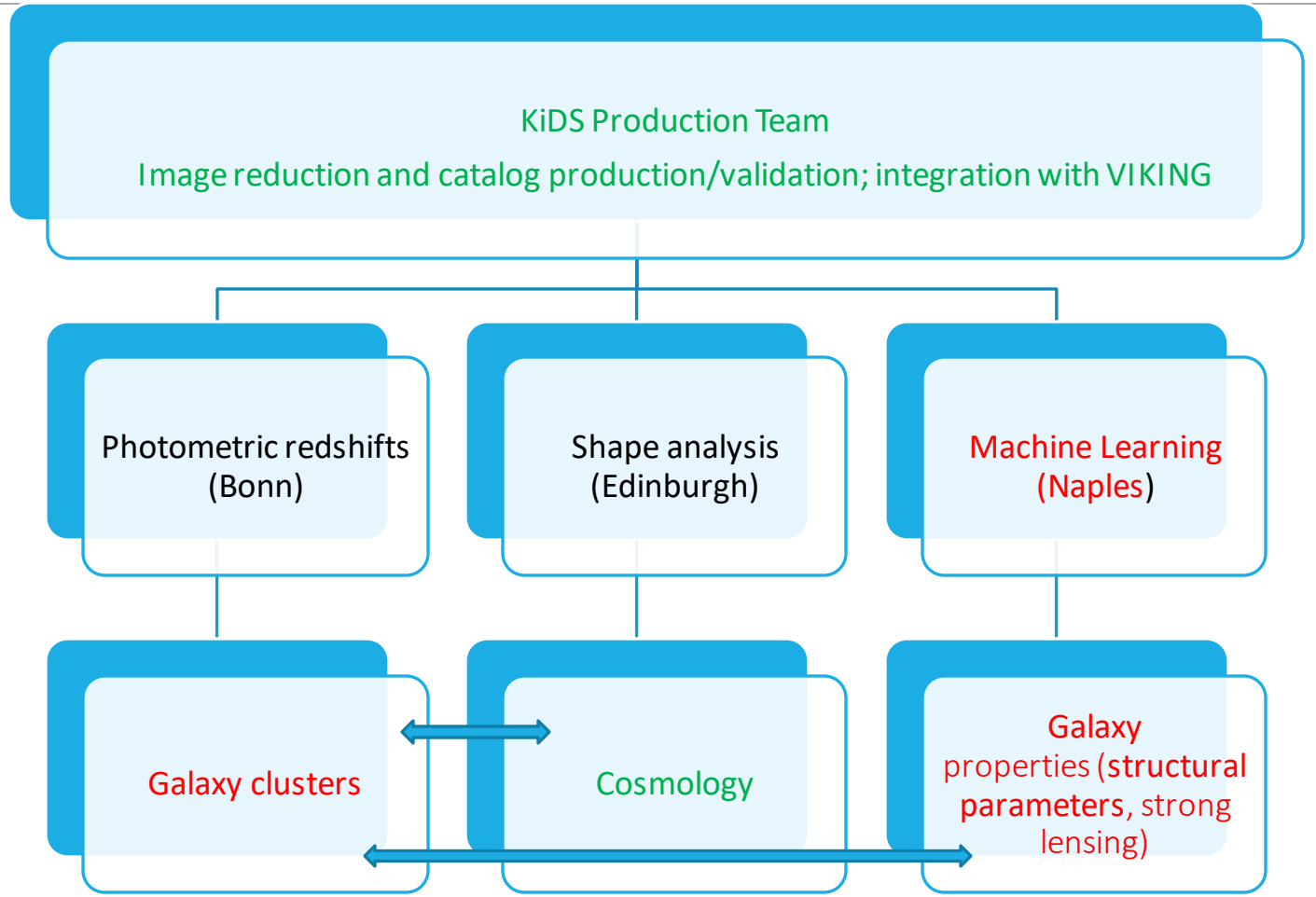
The survey has been designed with weak lensing as a major goal. Image quality is expected to be a factor of two better than SDSS, and slightly better than CFHTLS-Wide. It will yield a large, homogeneous data set with photometry from u' to K, with 200,000 spectra available for the brightest galaxies in the field. Expected science results include a sample of $z > 6$ quasars, several thousand galaxy clusters beyond redshift 1, the power spectrum of the galaxy distribution around redshift 1, and a detailed understanding of the structure of galactic halos as function of galaxy type and environment.



SDSS, 2dF, GAMA redshift surveys, Herschel-ATLAS

A KiDS (partial !) overview

INAF:
Contributing
Leading

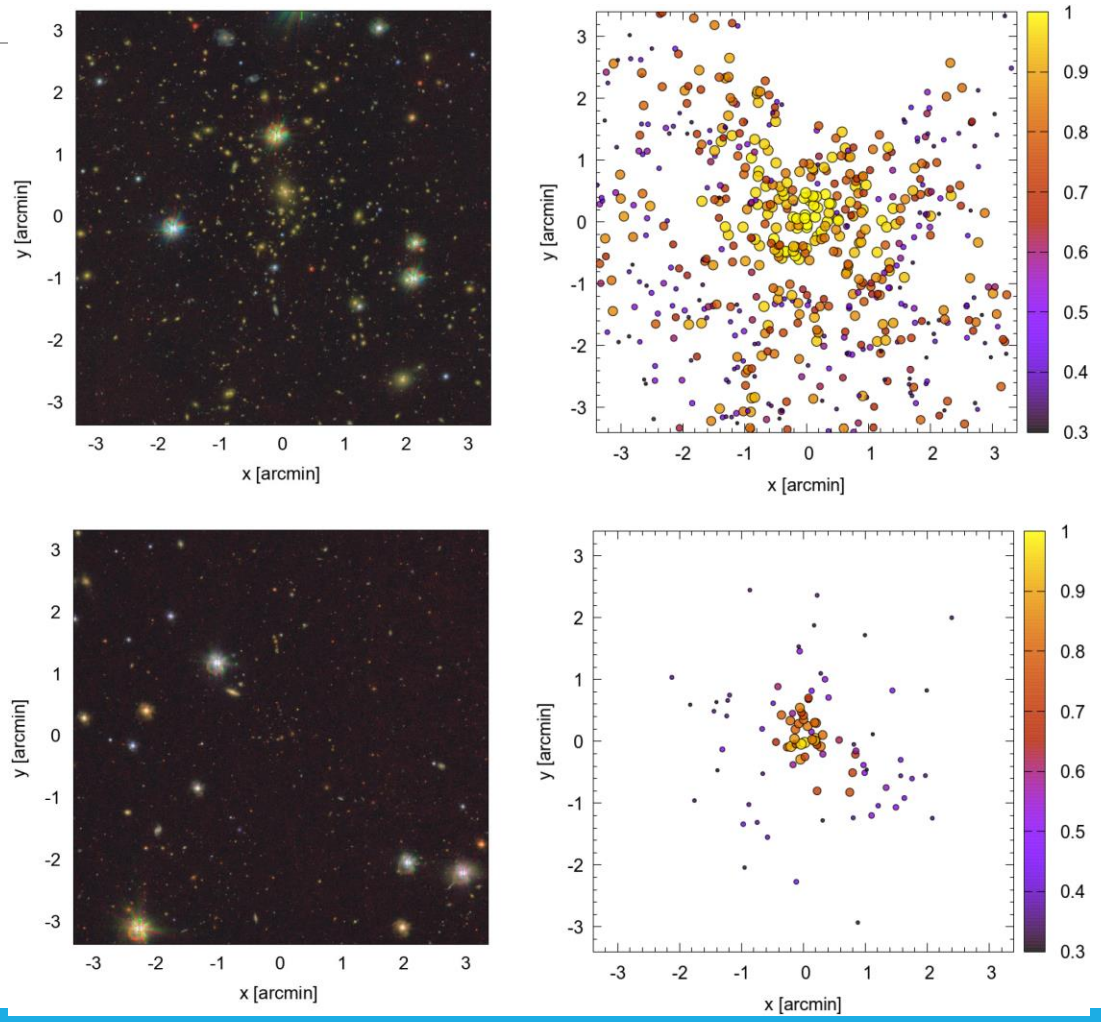


Searching for clusters in KiDS

First implementation on real data of the AMICO (Adaptive Matched Identifier for Clustered Objects) tool for cluster detection (M. Maturi - Univ. Heidelberg; L. Moscardini, F. Bellagamba, M. Roncarelli - Univ. Bologna), later selected for EUCLID.

AMICO search for overdensities in position/redshifts, no a priori assumption on a red-sequence as with other cluster search algorithms

It also produces membership probabilities and purity/completeness based on mock catalogs.



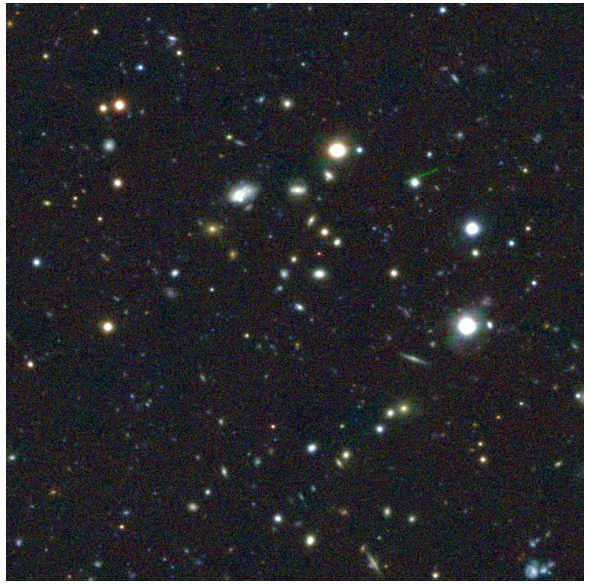
Z = 0.3

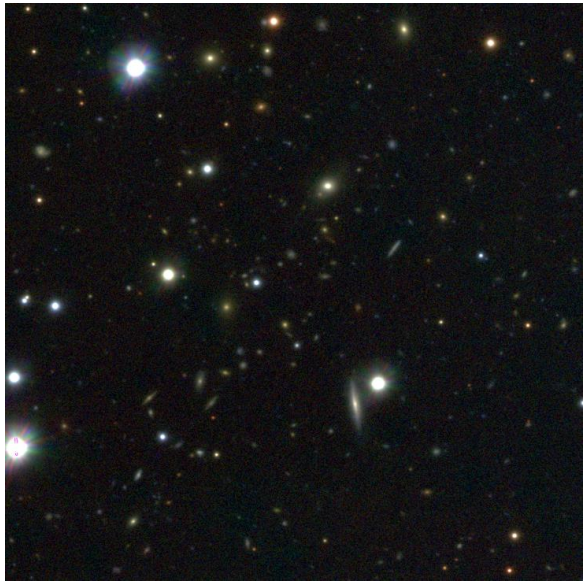
Z = 0.4

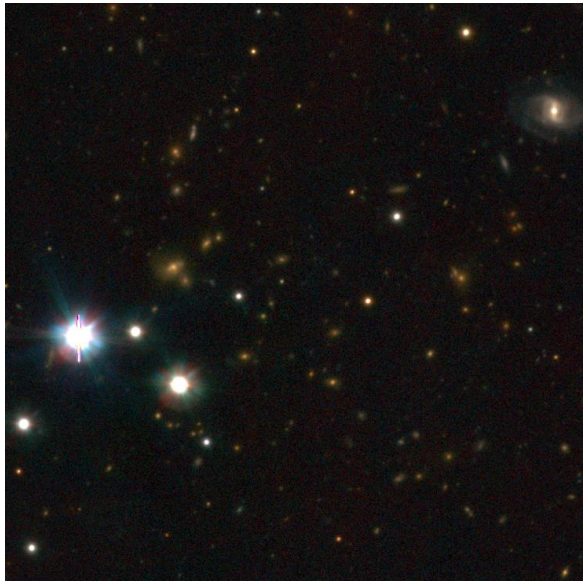
Z = 0.5

SDSS

KiDS

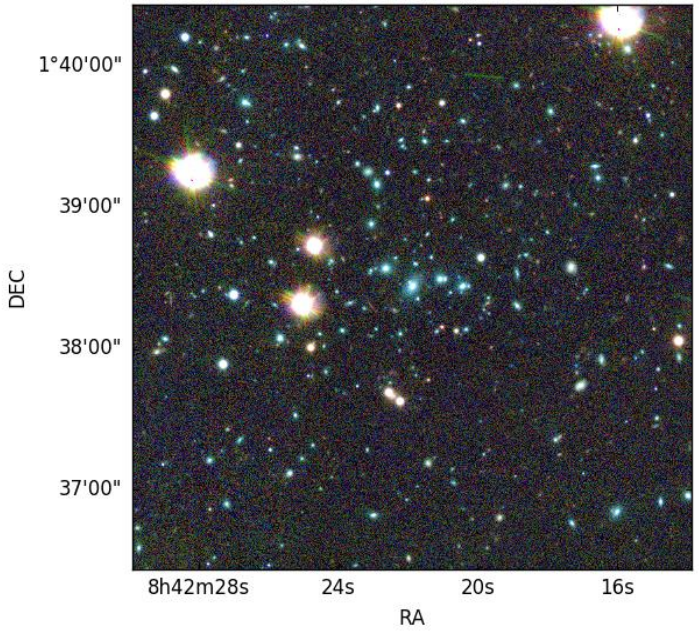


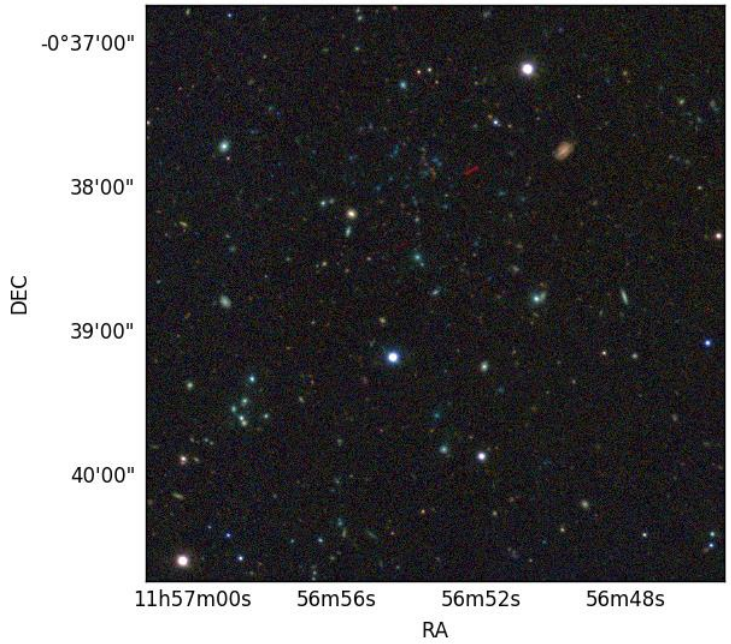




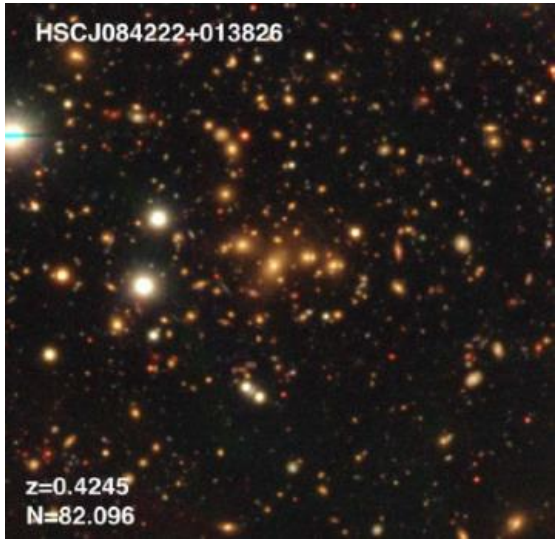
Clusters in KiDS vs. SDSS

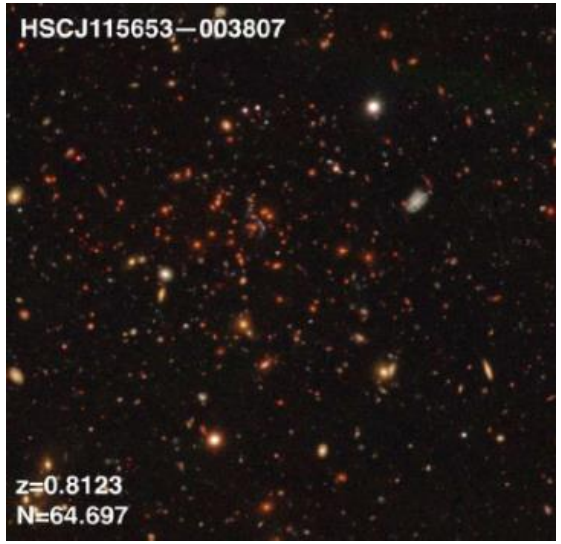
KiDS





HSC



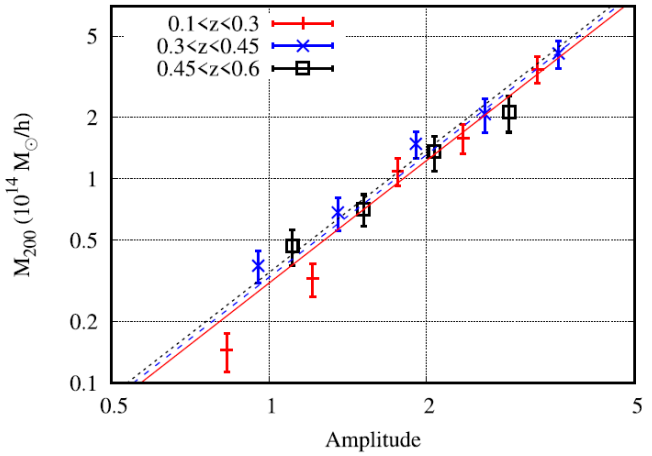


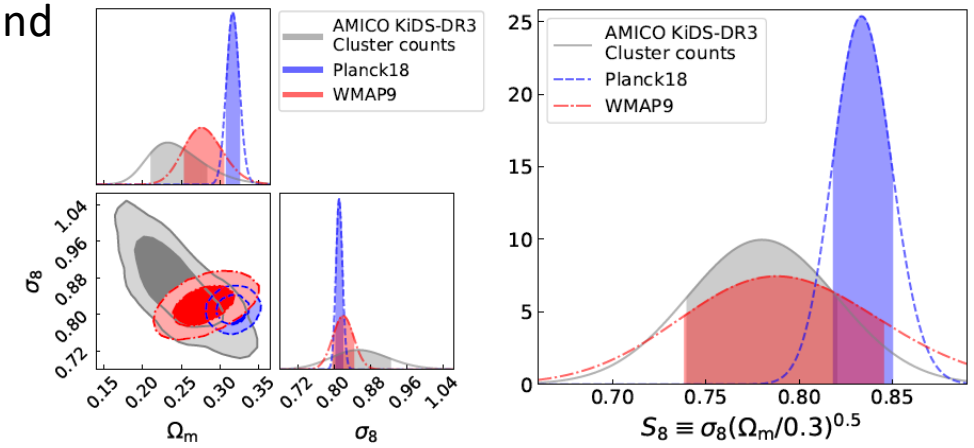
High redshift clusters detected in KiDS and Hyper-SuprimeCam

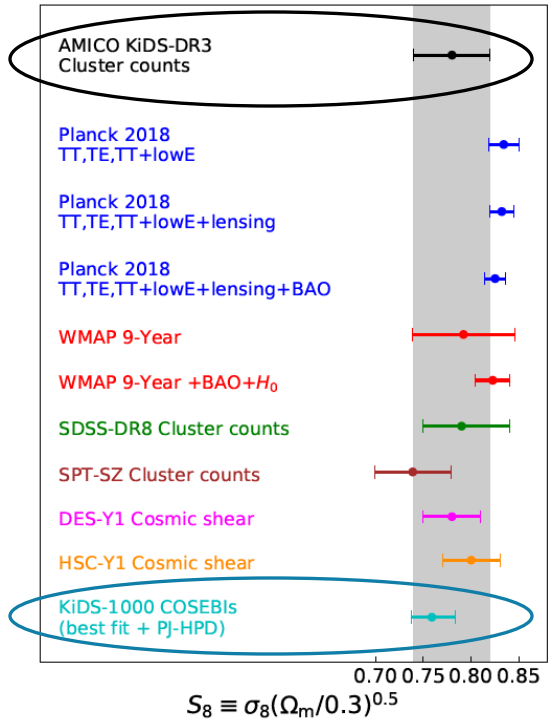
Cosmology with clusters

- Accurate shape measurements allow to calibrate by **weak lensing** the cluster mass vs. optical richness relation, thus providing a *cheap* mass estimator for large samples of clusters (Maturi+19, Bellagamba+19)
- This allowed us to use KiDS clusters for cosmology, as tracers of the underlying large-scale mass distribution *(see also scheda CLUMP)*: Sereno+20, Giocoli+21 , Lesci+22 , Ingoglia+22, Smith+22, using different methods (cluster mass, cluster counts and clustering).

Results based on KiDS-DR3.
KiDS-DR4 in progress



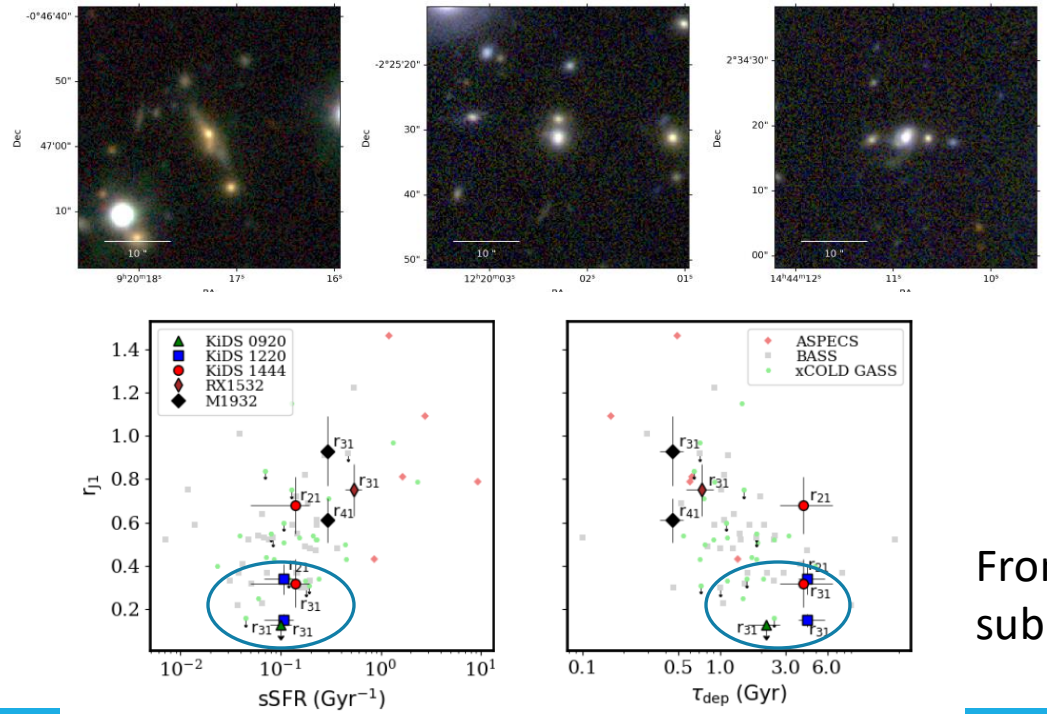




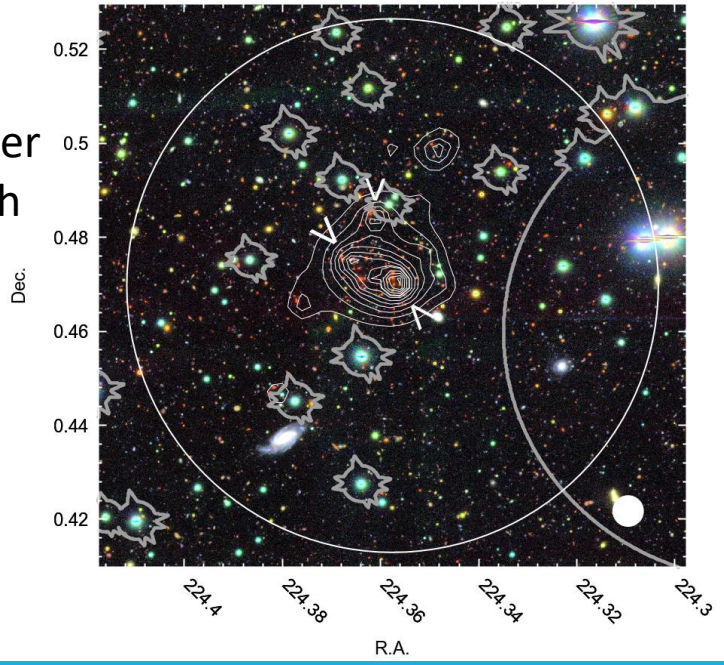
From Lesci+22

Cluster properties

- Galaxy properties (star formation, BCG luminosity, cluster luminosity function) as a function of cluster mass and redshift (Radovich+20, Puddu+21). Fraction of SF cluster members increasing with redshift (z =0.5-1)
- IRAM-30m follow-up of 6 star-forming BCGs at z=0.3-0.5, 4/6 detected in CO lines (Castignani+22a,b). Large reservoir of molecular gas M_{H2} = (5-10) 10^{10} $M_{\odot}$, SFR = 20-30 $M_{\odot}$: high depletion times (recent accretion ?)



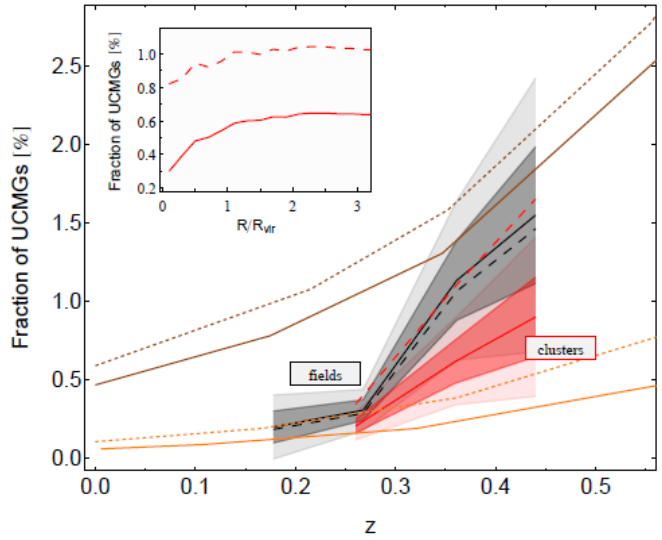
Possible merging cluster at z=0.9 detected both in KiDS and HSC, observed with NIKA2 (analysis ongoing)

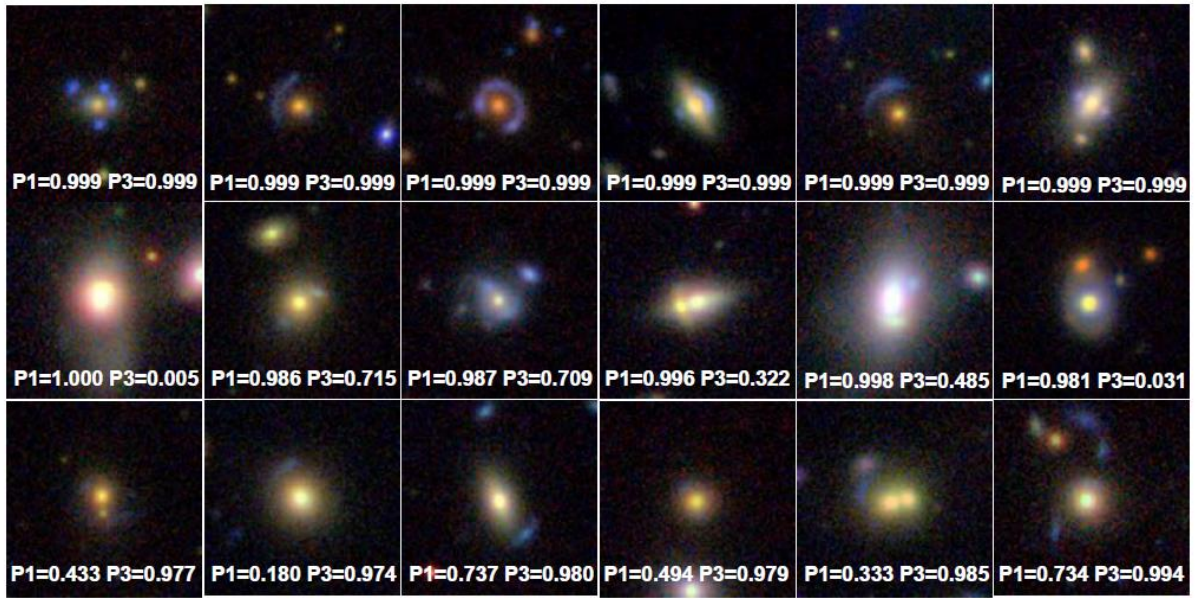


From Castignani+22a, submitted

Galaxies…

- Searching for *ultracompact massive galaxies* (Tortora+18) up to z=0.5, 92 of which spectroscopically confirmed (Scognamiglio+20), *see scheda INSPIRE*. Tortora+20: no significant correlation found until now with the environment (field or cluster)





- Searching for strong lensing (Li+21) with ML techniques: 268 High Quality strong lens candidates found in KiDS. *See also schede Lens-ML, and AstroInformatics about ML techniques*

Issues and critical points

Compared to future surveys (EUCLID, LSST), the depth of surveys such as KiDS is much lower, BUT they offer a unique way to develop and test *NOW* new algorithms and approaches.

All the analysis requires a preprocessing of the catalogs, to be optimized for the AMICO run (minimizing stellar contamination, removing areas corrupted by artefacts, ...)

With DR4, we already have issues to efficiently handle the data, slowing down the scientific analysis

2022/2023 will be crucial to exploit the *final KiDS DR5 release* and prepare *for the future (e.g. WAVES on 4MOST)*

As a a minimal approach, we decided to submit a minigrant proposal to have the local data storage for DR4/DR5 data (and partecipate to meetings)