Growing up at high-redshift: from proto-clusters to galaxy clusters

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Abstract Book: oral communications and posters

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Invited Speakers

Hans Boehringer (MPE, Garching, Germany)
Emanuele Daddi (CEA-Saclay, France)
Gabriella de Lucia (INAF-Trieste)
David Elbaz (CEA-Saclay, France)
August Evrard (University of Michigan, USA)
Marijn Franx (Leiden Observatory, The Netherlands)
Raphel Gobat (CEA-Saclay, France)
Henk Hoekstra (Leiden Observatory, The Netherlands)
Chris Lidman (Australian Astronomical Observatory)
Felipe Menanteau (Rutgers University, USA)
Florian Pacaud (University of Bonn, Germany)
Mark Brodwin (University of Missouri-Kansas City, USA)
Bram Venemans (MPIA, Heidelberg, Germany)

Oral contributions:

Speaker: **Jose Afonso (CAAUL)**
Title: **The environments of faint Ultra Steep Spectrum radio sources**

Radio observations have become an efficient way to trace high redshift overdensities, by the identification of High-redshift Radio Galaxies (HzRGs). Showing signs of large amounts of dust and star-formation, these sources are associated with the most massive systems and appear to be linked to the growth of (proto-)cluster environments at z~2-5.
One of the most efficient tracers of HzRGs relies on the relation between the steepness of the radio spectra and redshift, and the so-called Ultra Steep (radio) Spectrum (USS) criterion has been successfully used with largest area and relatively bright radio surveys. This raises the question of whether a significant population of apparently fainter USS sources, either at even higher redshifts and/or with lower AGN power, is being missed by such surveys. With the appearance of sensitive low-frequency radio facilities such as the Giant Metrewave Radio Telescope (GMRT) and the Low Frequency Array (LOFAR), it has become viable to extend the search for and subsequent study of USS sources to the micro-Jy regime.
Using Giant Metrewave Radio Telescope and Very Large Array radio observations of the Lockman Hole at 610 MHz and 1.4 GHz, we have recently started a detailed analysis of a sample of 58 USS sources at the faintest radio fluxes. By using deep infrared data at 3.6 and 4.5 micron from the Spitzer Extragalactic Representative Volume Survey (SERVS), we find sources with spectroscopic and photometric redshifts ranging from z=0.1 to z=2.8. However, a significant redshift-undetermined population still remains, with much fainter optical and MIR magnitudes, strongly suggesting the existence of more distant sources.
In order to further understand the faint USS source population, and taking full advantage of the sensitivity of SERVS and the multiwavelength data associated with the Lockman Hole, we have started a detailed characterization of their environments. By comparing to the population of known HzRGs, and their respective clustering properties, this will help in understanding the potential of the next-generation of multiwavelength deep radio surveys (in particular, EMU, WODAN and LOFAR) to trace the growth of large scale structure in the distant Universe.

Speaker: **Stacey Alberts (University of Massachusetts-Amherst, USA)**
Title: **Tracing the Evolution of Star Formation Activity in Galaxy Clusters Out to z~2**

The role of environment in high redshift star formation activity is still very much an open question. Recent observations have hinted at a reversal in the star formation rate-density relation at z>1 in the field, while two high redshift clusters have been shown to have an increased fraction of actively star forming galaxies toward their cluster cores. These results point to an important transition epoch wherein high density environments go from actively star forming to passively evolving. In this study, we present a statistical analysis of the star formation activity from z=0-2 in 315 clusters identified in the IRAC Shallow Cluster Survey in the 9 square degree Bootes field. Using a mass-limited sample of spectroscopically- and photometrically-confirmed cluster members, we perform a stacking analysis in the Herschel SPIRE bands (250, 350, and 500um) to determine the average total infrared luminosity, dust-obscured star formation rates (SFRs) and specific star formation rates (sSFRs) for clusters in redshift bins from z=0-2. When compared to a mass-limited sample of field galaxies at the same redshifts, we recover the local SFR-density relation at low redshift and show that the average SFR in clusters draws even with and may even surpass the average SFR in the field at high redshift. Further analysis of this effect is performed through stacking as a function of cluster-centric radius, through the identification and stacking of cluster members already on the red sequence, and through controlling for cluster richness and AGN fraction in cluster members.

Speaker: **Stefano Andreon**
Title: **Quenching in galaxy clusters during the last 10 Gyr: role of secular evolution, galaxy mass and environment.**

Galaxy mass and environment are known to play a key role in galaxy evolution: looking at galaxy colors at different redshifts, fixed galaxy mass and environment, offers a powerful diagnosis to disentangle the role of each. In this talk, we study at the same time the dependence of the fraction of blue galaxies on secular evolution, environment and galaxy mass with a well-controlled cluster sample spanning the last 10 Gyr ($0 < z < 2$). We found that the mass and environmental quenchings are separable, that environmental quenching does not change with epoch, and that mass quenching is a dynamical process.

Speaker: **Eduardo Bañados (Max Planck Institute for Astronomy**
Title: **The galaxy environment of quasars z~6**

High-redshift quasars are believed to reside in the most massive halos in the early Universe and should therefore be located in fields with an overdensity of galaxies, which will eventually evolve into galaxy clusters seen in the local Universe. However, despite many efforts, no unambiguous relation between galaxy overdensities and high-redshift quasars has been found, mainly due to the difficulty of finding galaxies with accurate redshifts above z~6.
Using deep narrow band imaging we study the environment of the z=5.72 quasar ULAS J0203+0012. This is the first time we are able to study Lyman alpha emitters (LAEs) near a high redshift quasar.
Additionally, we have carried out a study of i-dropout galaxies including spectroscopic redshift information around the quasars SDSS 1306+0356 (z=5.99 and SDSS 1030+0524 (z=6.28). With this extra information, we can put better constraints in our knowledge of galaxy populations around high-redshift quasars.
The main result of this work is that no clear enhancement of LAEs or dropout galaxies has been found in the surroundings of these three quasars in comparison with blank fields. We explore different explanations and interpretations for this non-detection of galaxy overdensities.

Speaker: **Rob Bassett (Swinburne University of Technology)**
Title: The Structural Properties of Cluster Galaxies at z=1.62 and the Morphology-Density Relation

I will discuss our work to understand the dependence of environment on the structural and morphological properties, and star-formation and stellar-masses of galaxies in a z = 1.62 proto-cluster and in the field using near-IR imaging data from Hubble Space Telescope Wide Field Camera 3 data of the Cosmic Assembly Near-IR Deep Extragalactic Legacy Survey (CANDELS). The cluster and field galaxies exhibit a clear color-morphology relation: galaxies with colors of quiescent stellar populations generally have morphologies consistent with spheroids, and galaxies with colors consistent with ongoing star formation have disk-like and irregular morphologies. The size distribution of the quiescent galaxies in the cluster show a deficit of compact (< 1 kpc), massive galaxies compared to field galaxies at z=1.6. As a result, the cluster quiescent galaxies have larger average effective sizes compared to field galaxies at fixed mass. The size evolution of cluster quiescent galaxies is slow from z~1.6 to the present compared to field galaxies, which implies they experienced accelerated evolution prior to z=1.6. I will also show that the strongest environmental dependence appears in quiescent galaxies at clustercentric distances of 1-1.5 Mpc. These quiescent galaxies have significantly smaller Sersic indices and larger sizes compared to other quiescent galaxies in the cluster or the field, and they are more typical of star-forming galaxies at this redshift. We argue that these galaxies have been processed as they near the cluster environment, and the evidence favors models where gas accretion is suppressed. If this is generalizable, the it implies that the environment accelerates morphological evolution as galaxies transition to satellites in the forming cluster. We argue that the cluster galaxies require dissipationless (i.e., gas-poor or "dry") mergers to reorganize the disk material and to match the relations for ellipticity, stellar mass, size, and color of early-type galaxies in z< 1 clusters.

Speaker: **Kaustuv Basu (AlfA, University of Bonn)**
Title: **Redshift evolution of the radio luminosity function in clusters of galaxies**

Understanding the properties of the radio emitting galaxies in cluster environments is not only important for galaxy evolution studies, but also for the current X-ray and Sunyaev-Zel'dovich (SZ) effect cluster surveys where their non-thermal emission will act as a "contaminant". Of particular concern is the impact of radio contamination on the SZ decrement signal of high-z clusters. Any bias in the mass-observable scaling relation will be particularly critical for high-z, where clusters carry the maximum leverage in constraining the dark energy equation of state. Two things constitute the study of the evolution of radio galaxies: A) their luminosity distribution inside the cluster volume, and B) the change in their spectral slope with redshift. Concerning the first component, we have measured the first statistically significant redshift evolution of the radio luminosity function (RLF) inside galaxy clusters. The result shows a strong increase in the volume averaged radio luminosity with redshift. I will present the details of this measurement and discuss some implications. As an illustration of radio source contamination in
SZ imaging, I will discuss some lessons that we learned from the observation of high-z clusters with the APEX-SZ experiment.
Reference: Sommer, M., Basu, K., Pacaud, F. et al. 2011, A&A, 529, 124

Speaker: **Andrea Blviano (INAF-Trieste)**
Title: **High-z clusters astrophysics with Euclid**

I will present estimates for the selection function of galaxy clusters for the planned Euclid spectroscopic and photometric surveys. Based on these estimates I will assess the possible impact that these Euclid cluster surveys will have on our knowledge of galaxy evolution in z>1 clusters.

Speaker: **Filiberto Braglia (Imperial College London)**
Co-Authors: Dave Clements
Title: **Detecting dusty protoclusters with Planck and Herschel**
We are conducting a joint study of Planck sources detected in selected fields from the Herschel Multi-Tiered Extragalactic Survey (HerMES), with the aim of detecting compact, dusty protoclusters by means of their integrated far-IR flux.
Starting from the Planck Early Release Compact Source Catalogue (ERCSC), we selected compact sources ("clumps") not identified as known sources in the HerMES fields, where multi-wavelength follow-up from the UV to the FIR is often available.
Our ongoing combined analysis of Herschel fluxes, three-dimensional overdensities of galaxies, optical and nIR colours and SEDs of individual galaxies confirm the presence of several groups of galaxies at various stages of assembly and across a wide interval of cosmic time. So far, we were able to confirm five clumps as groups of galaxies ranging from z~0.7 to z>2 and at various evolutionary stages, from full-fledged clusters to protoclusters in the very process of assembly.
This preliminary study shows the feasibility of using combined Planck and Herschel data to detect efficiently protoclusters of galaxies at virtually any redshift and without bias with respect to their formation history. It is the first step toward building a larger sample of high-redshift protoclusters that will allow to probe the cosmic star-formation and mass assembly history of galaxy clusters, eventually providing strong constraints on models of structure formation and evolution.

Speaker: **Malcolm Bremer (U. Bristol)**
Title: **Identifying evolving massive structures at z~5 with Lyman break galaxies**

We present an exploration of galaxy clustering and a search for evolved and collapsing massive structures at z~5. These structures are traced by spectroscopically-confirmed Lyman break galaxies identified in deep observations of multiple widely-separated fields. Most of these fields are blank-sky areas from ERGS (the ESO Remote Galaxy Survey) and several are chosen for hosting known z~5 quasars. We show that the use of spectroscopic, rather than photometric redshifts are crucial to identifying significant clustering at these redshifts. The structure is often only revealed through the true 3-D distribution of LBGs and is missed or ambiguously traced by photometric surveys alone.
We identify several spectroscopically-confirmed structures at z~5, potentially protoclusters, in both the "blank" and quasar-selected fields. We show that while there is clear evidence for clustering of LBGs around some quasars, not all show overwhelming signatures of this. In particular, we find 3-D clustering in some "blank" fields that is as strong or stronger than that in the most clustered quasar field. So while z~5 quasars, with their massive black holes and relatively massive host galaxies may well trace significant overdensities in the high redshift matter distribution, they are not unambiguous tracers of the most overdense regions (most massive halos) at these redshifts. We explore how these results constrain the nature of z~5 LBGs and show that the relationship between the LBGs and the mass of their hosting halo cannot be as simple as has been previously suggested by purely photometric studies.

Speaker: **Mark Brodwin (University of Missouri-Kansas City)**
Title: **Evolution of the cluster galaxy populations at the highest redshifts**

I will describe the emerging evidence for an epoch of significant growth of cluster galaxies at z ~ 1.5. This evidence finally rules out the simple monolithic collapse models that, despite being unphysical -- or at least unhierarchical, adequately describe cluster evolution at z < 1. Measurements of rapid evolution in rest-frame near-infrared luminosity functions, non-passive evolution in color-magnitude relations, and enhanced rates of mergers, star formation and AGN activity, all suggest the z ~ 1.5 era is a very active one in the formation and assembly of massive cluster galaxies.

Speaker: **Anthony Gonzalez (University of Florida)**
Title: **IDCS J1426.5+3508: A Massive, Strong Lensing Cluster at z = 1.75**

We report the discovery of IDCS J1426.5+3508, an IR-selected, massive galaxy cluster in the IRAC Distant Cluster Survey (IDCS). HST and Keck data spectroscopically confirm IDCS J1426.5+350 at z=1.75. The hot intracluster medium is detected in both shallow archival Chandra data and in follow-up Sunyaev-Zel'dovich (SZ) imaging with CARMA. IDCS J1426.5+3508 is by far the most distant cluster yet detected via the SZ effect, and with a mass of M_{200} = (4.3 +/- 1.1) 10^{14} $M_{\odot}$, is the most massive z > 1.4 galaxy cluster found to date. It is among the rarest, most extreme clusters ever discovered, and is an evolutionary precursor to the most massive known clusters at all redshifts. However, the most surprising property of IDCS J1426.5+3508 is the discovery in HST imaging of a giant gravitational arc, the location and curvature of which suggest that the lensing mass is nearly coincident with the brightest cluster galaxy. The strong lensing and SZ/X-ray masses are consistent if the arc is located at z > 3. We explore the cosmological implications of this unique system, considering the likelihood of the existence of a strongly lensing galaxy cluster at this epoch in an LCDM universe. We find the existence of this strongly lensed galaxy greatly exacerbates the long-standing giant arc problem.

Speaker: **Yi-Kuan Chiang (University of Texas at Austin)**
Title**: A Systematic Approach to Cluster Formation in the Early Universe: Observations, Simulations, and New Surveys**

A growing number of high-z clusters (z<2) is being discovered as part of deep optical, IR, and SZE surveys. To study the formation of these clusters it is important that we probe the epoch of proto-clusters at z>2. Because the study of protoclusters is still limited by small number statistics and a wide range of selection techniques, we are performing a simulation-assisted approach that combines observations of (proto-)clusters with a large, statistical sample of clusters extracted from cosmological simulations coupled with simulated observations. We track the positions and velocities of dark matter halos and galaxies in over 3,000 clusters as well as the field from z~6 to z=0. We derive the probability that a structure having a galaxy overdensity d_g defined by a set of observational selection criteria is indeed a proto-cluster. We also show how well we can constrain the basic properties of the future cluster (e.g., total mass, merger history, virialization redshift) based on the observed properties (d_g, size, velocity dispersion) of its proto-cluster, and apply this to a large sample of proto-clusters found around quasars and radio galaxies and in random fields. Last, we introduce the upcoming HETDEX wide-field Lya survey (led by our team at UT Austin) that will probe a ~3 Gpc^3 volume at 1.9 < z < 3.5 containing the progenitors of ~30,000 clusters.

Speaker: **Emanuele Daddi (CEA-Saclay)**
Title**: Stars to ashes, gas to dust: weighing the ISM in galaxies to z=2**

Speaker: **Helmut Dannerbauer (Universitat Wien, Institut fur Astrophysik)**
Title: **Revealing Dusty Starbursts around a Large Scale Structure at z=2.2**

Searching for massive, dusty starbursts offers the great opportunity to trace galaxy overdensities and thus the cosmic web in the distant universe. We observed with APEX-LABOCA at 870 micron the field of the proto-cluster around the High-z Radio Galaxy MRC1138-262 at z=2.16. We report the discovery of a larger number of so-called submm galaxies around this large scale structure at z=2.2. Our LABOCA observations are complemented by exquisite multi-wavelength coverage of this structure (including VLA, Herschel, Spitzer, HST, VLT) thus allowing us the secure identification of a large part of the counterparts of the LABOCA sources and describing their nature and properties. Furthermore, we present the results of our VLT near-infrared spectroscopy, confirming that at least four submm galaxies within 1.5 Mpc are proto-cluster members. To summarize, our analysis suggest that indeed we are tracing the cosmic web in this proto-cluster field through dusty starbursts. Finally, we discuss prospects for ALMA studies of this source population in fields of galaxy (proto-) clusters at z=2.

Speaker: **Gabriella de Lucia (INAF-Trieste)**
Title: **Modeling the formation of cluster galaxies: recent progress and challenges**

I will review recent progress in theoretical studies of the evolution of the cluster galaxy population, and of the brightest cluster galaxies. I will highlight the problems and criticalities, and discuss ongoing and future developments.

Speaker: **Ricardo Demarco (Department of Astronomy, Universidad de Concepcion)**
Title: **Clusters at z > 1.5 from the SpARCS Infrared Cluster Survey**

Between z = 2 and z = 1, the main progenitors of present-day massive clusters undergo rapid collapse, and have high rates of galaxy merging and assembly. Cluster members transform from actively star-forming to quiescent. The SpARCS survey is one of the largest surveys designed to detect clusters of galaxies at z> 1, and has discovered hundreds of IR-selected clusters in the 50 square degree Spitzer

SWIRE Legacy Fields. I will present new spectroscopically-confirmed clusters at z > 1.5, and explain what this survey is teaching us about galaxy evolution in these, the densest of environments.

Speaker: **Catrina Diener (institute for Astronomy, ETH Zurich)**
Co-Authors: Simon Lilly
Title: **Galaxy groups at z~2 in zCOSMOS-deep**

The zCOSMOS-deep sample contains 3502 galaxies with spectroscopic redshifts between 1.8<z<2.8 in the COSMOS field. We established a group finder that takes into account the large measurements uncertainties at this redshift and identified 42 “associations” in this redshift range. They each contain three to five galaxies that lie within 500 kpc in projected distance and within 700 km/s in velocity. Based on the extensive analysis of mock catalogues generated from the Millenium simulation, I will discuss the properties of the observed structures as well as their evolution until redshift zero.
Although few of them are likely to be fully virialised when we observe them, most will subsequently virialise within the next several billion years. The mocks also suggest that these proto-groups are indeed the progenitors of todays ~10^{14}-10^{15} $M_{\odot}$/h clusters and that moreover, we are seeing a significant fraction (~ 75%) of those progenitors already at z~2.

Speaker: **Florence Durret (IAP, Paris)**
Title: **Hundreds of distant clusters in the CFHTLS Wide fields**

The four Wide fields of the CFHTLS cover 154 square degrees in five optical bands. We have developed a method to search for galaxy clusters, based on drawing galaxy density maps in photometric redshift bins with an adaptive kernel technique, and detecting structures in these maps at chosen significance levels. Our method was also applied to the Millennium simulation to assess the validity of our cluster detection rates.
We have found 746 candidate clusters at redshifts z>=1.0 with a detection level of at least 3sigma, showing that this is a powerful method to detect distant clusters in large optical imaging surveys. We will present here the main properties of the detected clusters (colour-magnitude relations, luminosity functions) and their evolution with mass and redshift. Preliminary results on our search for clusters in the Stripe 82 zone will also be discussed.

Speaker: **David Elbaz (CEA-Saclay)**
Title: **Looking for a signature of environment/merger effects on star-formation and black hole growth with *Herschel***

The impact of the environment on the star-formation and black hole growth activity of galaxies has become even more subtle to quantify since the discovery that the stellar mass of an individual galaxy seemed to control its future growth. Yet more massive galaxies lie in denser environments and the SFR-M* relation does not necessarily involve only internal mechanisms, hence determining the actual cause of galaxy evolution is even more complex. Previous studies of these effects were based on SFR indicators relying strongly on uncertain extrapolations. Here we will show which new light brings Herschel on these issues. While evidence is found that the role of mergers has been overstated in the past, environment effects may not be uniquely attributed to strong starbursts and may be hidden within the dispersion of the scaling laws found for star-forming galaxies.

Speaker: **Ghazaleh Erfanianfar (MPE)**
Title: **X-ray Galaxy groups in DEEP2 fields**

Groups of galaxies are important laboratories to study galaxy evolution and formation, as they are in the stage between field and the densest environment in the universe, massive clusters and as many as 50%

to 70% of all galaxies reside in galaxy groups. It is crucial to study galaxy population over a range of cosmic time to understand the effect of group environment on galaxy population. The All-Wavelength Extended Groth Strip International survey (AEGIS) brings together deep imaging data from X-ray to radio wavelengths and optical spectroscopy over a large area (0.5-1 deg^2). Using the various sources of data in this field, we can study the galaxy properties. The combination of the DEEP2 and DEEP3 spectroscopic data sets in this field provides the largest sample of accurate spectroscopic redshifts at z>1 with the highest precision velocity information and the highest sampling density among the current generation of deep spectroscopic redshift that make EGS one of the best-suited fields in which to study the relationship between environment and galaxy structure at z>1.
We could identify X-ray galaxy groups using deep Chandra observation in this field and provided a group catalogue with X-ray properties and also dynamical mass measurement. We also compare them with optical groups which are derived from Voronoi-Delaunay method (VDM). Furthermore, using our XMM-Newton observations and DEEP2 spectroscopy we identified galaxy groups in other DEEP2 fields and studied their X-ray properties. We have over 40 X-ray selected groups with z>0.7 and among them 10 galaxy groups with z>1 with a galaxy group candidate in z=1.54.

Speaker: **August E. (Gus) Evrard (U. Michigan)**
Title: **Simulations of Galaxy Clusters: Past and Present**

Numerical simulations of cosmic structure formation continue to improve, but directly modeling the baryonic components of galaxies and clusters of galaxies continues to pose significant challenges. The physics of cluster cores is an especially difficult problem. This talk will offer a partial review the current (complex) state of affairs. I will then explain current efforts to generate multiple synthetic sky surveys to support science from the Dark Energy Survey and related observations, and close by offering some thoughts on where simulation technologies, and the community of computational cosmologists, are heading.

Speaker: **René Fassbender (MPE)**
Title**: The X-ray luminous Galaxy Cluster Population at 0.9 < z <~ 1.6**

XMM-Newton has been the unrivaled workhorse for X-ray selecting new high redshift galaxy clusters in the first half of cosmic time, in particular based on serendipitous archival searches. The most successful survey in this field has been the XMM-Newton Distant Cluster Project (XDCP), which has compiled a spectroscopically confirmed X-ray cluster sample of >35 systems at z>0.8 (20 at z>1) with a homogeneous redshift coverage all the way out to z~1.6. This talk will present our current observational understanding of the properties of the most distant massive X-ray luminous galaxy clusters up to z~1.6 and discuss their connection to X-ray AGN activity in their environments.

Speaker: **Cosimo Fedeli (Department of Astronomy, University of Florida)**
Title: **Cluster concentration-mass relation and baryonic cooling**

I review the concentration-mass relation of groups and clusters of galaxies as measured in a variety of works based on X-ray emission, gravitational lensing, and velocity structure. I highlight the fact that the normalization and/or the negative slope of the measured relations are systematically and substantially larger than expected from theoretical works based on numerical simulations. A simple spherical halo model can be constructed that includes the hot intra-cluster medium, stars, and the effect of baryonic cooling on the dark matter density profile. I show that, calibrating this simple model against observations of the baryon fractions and density profiles, returns concentrations that are in better agreement with observations, thus alleviating the problem although not solving it completely. I conclude by discussing the issues that are still open and the role of the z > 1 cluster population that is being discovered nowadays.

Speaker: **Marijn Franx (SRON)**
Title: **Formation and evolution of the most massive galaxies**

We will review the formation and evolution of massive galaxies. Near-IR surveys have found very massive galaxies to z=3 and beyond, and have provided a wealth of information.

Speaker: **Alexander Fritz (INAF IASF-Milano)**
Title: **The Evolution of Cluster Early-Type Galaxies Since z=1**

We analyse the kinematic and chemical evolution of about 200 distant early-type (elliptical and S0) galaxies at $0.2<z<1$ which are located in different environments (massive clusters down to low-mass clusters). VLT/FORS, Gemini/GMOS and CAHA/MOSCA multi-object spectroscopy with intermediate-resolution have been acquired to measure the internal kinematics and stellar populations of the galaxies. From HST/ACS and HST/WFPC2 imaging, surface brightness profiles and structural parameters were derived for half of the galaxy sample. To test the effect on environment, the cluster samples are compared to a representative field galaxy sample at similar redshifts. The scaling relations of the Faber-Jackson and Kormendy relation as well as the Fundamental Plane indicate a moderate evolution for the whole galaxy population in each density regime. In all environments, S0 galaxies show a faster evolution than elliptical galaxies. For the cluster galaxies a slight radial dependence of the evolution out to one virial radius is found. Dividing the cluster samples with respect to their mass, a mass dependent evolution with a stronger evolution of lower-mass galaxies ($M<2x10^{11}$ $M_{\odot}$) is detected. This down-sizing in the evolution of the galaxies is independent from the environment. The results will be compared to predictions of stellar population models to constrain the formation, evolution and chemical enrichment of these galaxies.

Speaker: **Audrey Galametz (Observatory of Rome)**
Title: **Large Scale Galaxy structures and clusters in CANDELS**

With ~900 orbits, the Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey (CANDELS) is the largest Hubble program ever approved. It consists of a WFC3 (J,H) imaging survey of 5 fields (GOODS-N/S, UDS, COSMOS and ERS) reaching H~27 (AB) over 0.25 sq. degrees and deeper (H~28) imaging over ~120 sq. arcmin (in GOODS), coupled with an optical ACS survey. Observations, started in mid 2010, will be finalized in mid 2013. We are currently combining CANDELS data with optical to mid-IR data available in each field to build multi-wavelength catalogs (Galametz et al. in prep) in UDS and Goods-S (the first fields to be completed) and derive photo-z. We are conducting a search for high-redshift large scale structures and galaxy clusters. Goods-S is known to host a galaxy group at z~1.6. UDS also hosts one of the highest redshift galaxy cluster known to date at z~1.62 (Papovich et al. 2010, 2012). We will present new structures at z>1.4 in those two fields. We will also show that the cluster at z=1.62 in UDS is part of an ensemble of at least four galaxy groups, spreading over several Mpc. The high--resolution of the CANDELS data also permits us to study the color-morphology relation in dense environments. Due to such a diversity of structure types (high-z clusters, groups, sparse structures), we will also present the first result of our investigation on the dependence of galaxy properties (stellar masses, morphology, age, SFR) with environment.

Speaker: **Raphael Gobat (CEA Saclay)**
Title: **The emergence of the first structures and their scaling relations**

The redshift range z=1.5-2, and especially around z~2, is particularly interesting as a formative epoch where the first "true" clusters clusters acquire their distinctive characteristics. Processes considered as crucial for the formation of the core population are thought to occur, and thus be most easily studiable, at

this stage. Recently, a series of discoveries in this previously inaccessible redshift range have started to bridge the gap between the massive virialized structures of the last 9 Gyr and the vigorously active protoclusters of the early Universe. These new "intermediate" clusters allow us to study the coevolution of cluster galaxies and their host structure very close to their formation epoch. I will discuss their properties, focusing on the the most distant of these objects confirmed so far, Cl J1449+08567, presenting the latest results on its galaxy population and its interactions with the young environment.

Speaker: **Tobias Goerdt (UA Madrid)**
Title: **Gravity-driven Ly-alpha blobs from cold streams into galaxies**

We use high-resolution cosmological hydrodynamical adaptive mesh refinement (AMR) simulations to predict the characteristics of Ly-α emission from the cold gas streams that fed galaxies in massive haloes at high redshift. The Ly-α luminosity in our simulations is powered by the release of gravitational energy as gas flows from the intergalactic medium into the halo potential wells. The ultraviolet UV background contributes only <20 per cent to the gas heating. The Ly-α emissivity is due primarily to electron-impact excitation cooling radiation in gas at ~2.10^4 K. We calculate the Ly-α emissivities assuming collisional ionization equilibrium at all gas temperatures. The simulated streams are self-shielded against the UV background, so photoionization and recombination contribute negligibly to the Ly-α line formation. We produce theoretical maps of the Ly-α surface brightnesses, assuming that ~85% of the Ly-α photons are directly observable. We do not consider transfer of the Ly-α radiation, nor do we include the possible effects of internal sources of photoionization such as star-forming regions. Dust absorption is expected to obscure a small fraction of the luminosity in the streams. We find that typical haloes of mass M_v ~ 10^{12}-10^{13} M_{solar} at z ~ 3 emit as Ly-α blobs (LABs) with luminosities 10^{43}-10^{44}erg/s. Most of the Ly-α comes from the extended (50-100kpc) narrow, partly clumpy, inflowing, cold streams of (1-5) x 10^4K that feed the growing galaxies. The predicted LAB morphology is therefore irregular, with dense clumps and elongated extensions. The integrated area contained within surface brightness isophotes of 2.10^{-18}erg/s/cm^2/arcsec^2 is ~2-100arcsec^2, consistent with observations. The line width is expected to range from 100 to more than 1000km/s with a large variance. The typical Ly-α surface brightness profile is ~ $r^{-1.2}$ where r is the distance from the halo centre. Our simulated LABs are similar in luminosity, morphology and extent to the observed LABs, with distinct kinematic features. The predicted Ly-α luminosity function is consistent with observations, and the predicted areas and line widths roughly recover the observed scaling relations. This mechanism for producing LABs appears inevitable in many high-z galaxies, though it may work in parallel with other mechanisms. Some of the LABs may thus be regarded as direct detections of the cold streams that drove galaxy evolution at high-z.

Speaker**: Daniel Gettings (University of Florida)**
Title: **The Massive Distant Clusters of WISE Survey**

The Massive Distant Clusters of WISE Survey (MaDCoWS) is a comprehensive program to detect and characterize the most massive galaxy clusters in the Universe at z>1 over the full extragalactic sky. The foundation for this program is data from the NASA Wide-field Infrared Survey Explorer (WISE).
The depth is sufficient to identify the most massive clusters ($M \geq 10^{15}$ $M_\odot$) out to z=1.4 as overdensities of galaxies that are red in the two shortest wavelength passbands. In this talk I will give an overview of the survey, describing the motivation and search method, and presenting results for the first spectroscopically and photometrically confirmed clusters from this program.

Speaker: **Ruth Grutzbauch (Centro de Astronomia e Astrofisica da Universidade de Lisboa)**
Title: **The early effect of the cluster environment on star-formation: the case of XMMU J2235.3-2557**

We present a study of star formation in the galaxy cluster XMMU2235.3-2557 at z~1.4, the most massive galaxy cluster at high redshift known to date. We measure star-formation rates of individual cluster members using narrow-band (Halpha) imaging with the Near Infra-Red Imager NIRI at Gemini-North. Our imaging fully covers the cluster centre (R~500 kpc) and extends diagonally out to a projected cluster radius of 1.5~Mpc towards the north-east, reaching a detection limit in SFR of ~ 1 $M_{\odot}$/yr.
Excluding likely stars and foreground galaxies we find a total sample of 163 galaxies, of which 14 are spectroscopically confirmed cluster members. A total of 32 galaxies (20%) are identified as excess line-emitters and therefore the most likely to be cluster members. We also find a high fraction of galaxies in our sample (46%) consistent with being on the cluster's well developed red sequence, which are likely to be passive cluster members with evolved stellar populations.
In agreement with other studies we find that in the cluster core all galaxies show suppressed or no evidence of star formation, regardless of their brightness. Towards the cluster outskirts we do observe the presence of star formation, however at a lower rate than it would be expected for galaxies at the cluster's redshift. Furthermore the star-formation rates are not increasing continuously with distance from the cluster core, but we rather see evidence for a quenching radius (R_Q~200 kpc) within which star formation is rapidly shut-off. This could be caused either by interaction with the ICM (ram pressure stripping) or frequent high velocity encounters (harassment) caused by the high galaxy density in the cluster centre where the crossing time at R_Q is about 0.25 Gyr.
We also investigate the role of stellar mass in the suppression of star formation by estimating specific SFRs, i.e. the star-formation rates per unit stellar mass. We find that at fixed stellar mass, galaxies in the cluster centre have lower specific SFRs than the rest of the cluster galaxies, which in turn have lower specific SFRs than field galaxies at the same redshift by a factor of a few to 10. We observe this effect out to ~1.5 Mpc, i.e. more than the virial radius of the cluster.
We conclude that star formation in this cluster is effectively shut off in the cluster centre already at z=1.39, when the universe was only ~4.5 Gyr old. Galaxies at larger radii from the cluster centre are moderately forming stars, but not reaching the average SFR of field galaxies at this redshift.
For the first time we can demonstrate through measurements of individual SFRs that already at very early epochs the suppression of star-formation is an effect of the cluster environment which persists at fixed galaxy stellar mass.

Speaker: **Nina Hatch (University of Nottingham)**
Title: **The effect of environment in the early Universe: a comparison of proto-cluster and field galaxies at z~2.**

The primary factor in determining the properties of a galaxy may well be its surroundings during its birth as early galaxy growth is likely to be regulated by environment. To investigate the influence of environment in the early Universe we present a detailed study of z~2 proto-clusters around high redshift radio galaxies, and compare their member galaxies to z~2 field galaxies. We use these early progenitors of galaxy clusters to understand how environment affects galaxies during their formative epoch.

We measure the extent and galaxy overdensity of the proto-clusters and use these quantities to estimate when they will collapse into clusters. We will show that z > 2 proto-clusters are nurseries of young star-forming galaxies, with a star-formation density that is 10 times greater than the field, and we will present the colour distribution of a flux-limited sample of proto-cluster galaxies, showing the relative blue/red galaxy fraction does not significantly differ from the field. We then select clean samples of proto-cluster and field H-alpha emitters and compare their properties, including stellar mass, star formation rate, colour and specific star formation rate. We will show that the proto-cluster galaxies are forming stars at a similar rate to field galaxies, so the star formation rate is neither enhanced nor inhibited in star forming proto-cluster galaxies. However, the proto-cluster galaxies are already twice as massive, and have lower specific star formation rates than their field counterparts. Thus the proto-cluster galaxies are further evolved than the field galaxies. We conclude that these dense proto-cluster environments promotes galaxy growth in the early Universe, and that cluster galaxies differed from field galaxies even before the cluster virialized.

Speaker: **Masayo Hayashi (National Astronomical Observatory of Japan)**
Title: **A star-bursting proto-cluster associated to a radio galaxy at z=2.53**

We present a discovery of a proto-cluster in vigorous assembly and hosting a strong star forming activities, associated to a radio galaxy USS~1558-003 at z=2.53, as traced by a wide-field narrow-band Hα imaging with MOIRCS on Subaru Telescope. The redshift of 2.53 is nearly the maximum redshift where we can capture Hα line with a near-infrared instrument on a ground-based telescope at high sensitivity. We find 68 Hα emitters with fluxes down to 2.6 10^{-17} erg $s^{-1}cm^{-2}$ and 42 Distant Red Galaxies (DRGs). Their spatial distribution indicates that there are three prominent clumps of Hα emitters and/or red galaxies, one surrounding the radio galaxy and another located at ~1.5 Mpc away to the south-west (SW), and the other located in between the two. These three systems at the same redshift are very likely to merge together in the near future and may grow to a single more massive cluster at later times. Whilst most Hα emitters reside in the ``blue cloud'' on the color-magnitude diagram, some emitters have very red colors similar to DRGs. Interestingly, such red Hα emitters are located towards the faint end of the red sequence (but are still among most massive Hα emitters), and they tend to be located in the high density clumps. The star forming activity is very high in this proto-cluster amounting to 1.1 10^4 $M_{\odot}yr^{-1}$ for the entire field (excluding the radio galaxy), of which 40% is confined in the SW clump. This is one of the notable sites where the progenitors of massive galaxies in the present-day clusters were in their vigorous formation phase. We do not see any statistically significant difference in the distributions of individual star formation rates or stellar masses of the Hα emitters between the dense clumps and the other regions, although there is an hint that those in the SW clump may have higher star formation rates. Also, the clump hosting the radio galaxy may contain less integrated star formation rate per unit stellar mass, suggesting it is more evolved system than the other clumps.

Speaker: **Michaela Hirschmann (Osservatorio Astronomico di Trieste - INAF)**
Title: **Environmental history of galaxies in high-density regions**

We present a detailed analysis of the "environmental history" of galaxies living in high-density regions, using galaxy merger trees obtained from applying a semi-analytic model to a large cosmological dark matter simulation. In addition to halo mass, we consider different definitions for calculating the environmental density, which are often used in observational studies. In order to quantify the effect of environmental history and to constrain the time-scale and nature of physical processes that establish the observed trend, we consider observational estimates (SDSS) for the quiescent fraction of galaxies (using sSFR as a tracer) and their variation with density, halo mass and parent halo-centric distance. Comparisons with observational estimates suggest relatively long gas consumption time-scales in satellite galaxies. In the framework of our models, this appears difficult to achieve by using a non-instantaneous stripping of the hot gaseous component associated with galaxies, and points towards a more fundamental problem in modeling the star formation and feedback process in satellite galaxies.

Speaker: **Henk Hoekstra (Sterrewacht Leiden)**
Title: **Weak Lensing and structure formation: current status & future prospects with Euclid**

Weak gravitational lensing has developed into a powerful probe of the large scale structure in the Universe. An important application is the study of the masses of clusters of galaxies, which can be compared to the baryonic properties. This is a key step into the use of clusters as cosmological probes, but also can help provide insights into feedback processes that govern the complex process of galaxy and cluster formation. In this review I will introduce weak gravitational lensing, with a particular focus on how it can be used to study the masses of high redshift clusters. I will present some recent results and provide an overview of what can be expected in the coming 10-15 years.

Speaker: **Marc Huertas-Company (GEPI, Paris Observatory)**
Title: **Size evolution of quiescent galaxies and large-scale environment**

I will present recent results from our group on the mass--size relation of quiescent early-type galaxies. I will focus in particular on how the growth of passive galaxies depends on morphology, stellar mass and large scale environment and on how these results correlate with predictions of state-of-the art semi-analytical models.
More precisely, I will present the main results of a recent work in which we study the size evolution from z~1 to present of a sample of 298 group and 384 field log(M*)>10.5 quiescent early-type galaxies from the COSMOS survey. I will show that the galaxy size growth depends on early--type galaxy morphology, i.e.. passive elliptical galaxies evolve differently from lenticular galaxies. At the low mass end ($10.5<\mathrm{Log}(M/M_{\odot})<11$), ellipticals do not show significant size growth from z~1 to present. On the other end, massive ellipticals ($\log(M/M_{\odot})>11$) also approximately doubled their size. Also lenticulars do show a significant evolution since z=1 but the degree of size evolution is independent of stellar mass. Finally, our data also reveal that the galaxy mass--size relation and the size growth does not seem to depend strongly on environment, (i.e. group and field galaxies show the same trends) and this is at variance with the predictions of most hierarchical semi-analytical models.

Speaker: **Yusei Koyama (Durham University)**
Title: **Red starforming galaxies in distant clusters: a key population triggered by environmental effects in the early Universe?**

We present our systematic wide-field Hα emitter survey of distant galaxy clusters at z=0.4 (CL0939+4708), 0.8 (RXJ1716+6708), 1.5 (4C65.22) and 2.2 (PKS1138-262) using narrow-band filters installed on the Subaru Telescope, as well as obscured activities in/around these cluster fields based on the mid-infrared data taken with Spitzer and AKARI. Taking advantage of the wide-field of views of Subaru Telescope, our Hα survey covers wide range in environment from cluster core to surrounding structures (over ~10Mpc) at all redshifts. The most striking result of this project is that a surprisingly large number of "optically red galaxies" are showing strong Hα emissions in all redshifts, and that many of them are MIR-detected active galaxies such as dusty starbursts and/or AGNs (i.e. they are NOT just gradually fading their star formation). Interestingly, we find that the environment of such red star forming galaxies are changing through cosmic time: they are most numerous in the proto-cluster core region at z~2, while they are located in the cluster outskirts or surrounding groups at z<1. Our survey also revealed that the environment of the red star forming galaxies coincide with the "transition environment" (where we see a sharp break in the colour-density relation) at z<1, suggesting that the red star forming galaxies are triggered by the environment and related to the subsequent environmental quenching of galaxy activities. Thus, our wide-field Hα + MIR approach towards the distant cluster environments has now provided a new insight on the "hidden side" of cluster galaxy formation and evolution over ~10Gyrs.

Speaker**: Jaron Kurk (MPE)**
Title: **The evolutionary status of a large scale galaxy structure at z=1.6**

Cl0332-2742 is a large scale structure at z=1.6 with more than 40 spectroscopically confirmed members. A well-developed red sequence is present, but the massive red galaxies are not located in the region of highest galaxy density. In addition, extremely deep X-ray observations do not provide evidence for extended hot gas. To obtain an unbiased view of the angular distribution of star formation, we recently obtained H-alpha imaging. We are able to identify about 80% of the 80 narrow band excess sources, 42 of these as group members. As expected, these represent a clear overdensity of H-alpha emitters w.r.t. the field population at this redshift. We do not find evidence for a decrease of the star formation rate towards the centre of the structure, unlike that found in some high redshift galaxy clusters. We conclude that this structure is evolutionary younger than many of the known z>1.4 galaxy clusters and still in the process of formation.

Speaker**: Chris Lidman (AAO)**
Title: **Summary talk**

Speaker: **Yen-Ting Lin (Academia Sinica, Institute of Astronomy & Astrophysics)**
Title: **Constraints on the stellar mass assembly of brightest cluster galaxies**

The formation and evolution of brightest cluster galaxies, representing the most massive galaxies in the universe, remains a challenging issue in galaxy formation. I will present a novel approach that combines theoretical dark matter halo merger histories with an observed, complete cluster sample to study the evolution of brightest cluster galaxies (BCGs). Compared to the model prediction from Millennium Run, which suggests that BCGs grow in stellar mass by a factor of 3 in mass since z=1, we find that the real BCGs exhibit a slower growth (less than a factor of 2) over the same period of time. I will discuss the implication of our findings on the merger involving BCGs, as well as galaxy formation theories.

Speaker: **Felipe Menanteau (Rutgers University)**
Title: **The distant SZ cluster population from the Atacama Cosmology Telescope**

We have reached the era where microwave surveys such as the Atacama Cosmology Telescope (ACT), the South Pole Telescope (SPT) and Planck are reporting the first samples of massive galaxy clusters through the Sunyaev-Zel'dovich (SZ) effect. In this talk I will introduce a new set of optically-confirmed high redshift galaxy clusters discovered by ACT through the SZ effect observation ssince 2008 as well as our ambitious program to identify and characterize the galaxy clusters using a plethora of multi-wavelength observations (Chandra, XMM, Spitzer, Hubble, Gemini and VLT). As part of this program I will disscus our discovery of "El Gordo" as the most massive and hottest (X-ray) cluster known in the distant universe and its implications within the LCDM framework. I will also discuss our large program aimed to calibrate the different mass scaling relations for clusters necessary to exploit their counts as a function of mass and redshift to probe of structure growth and cosmology.

Speaker: **Michael McDonald (MIT)**
Title: **The Evolution of Cool Cores in Galaxy Clusters at z>0.5 from SZ, Optical, and X-ray Surveys**

We investigate the evolution of cool cores in galaxy clusters over the range $0 < z < 1.0$ from a combination of optical, X-ray, and SZ surveys. Recent work has suggested that at $z \sim 0.5$ there is an absence of strong cool cores, suggesting that cool core clusters may be a recent phenomenon. This seems to imply that feedback, whether from AGN or cluster-cluster mergers, was more efficient only a few Gyr ago. We summarize two ongoing surveys which will allow us to quantify the high-z evolution of cool cores: i) an optical survey searching for emission-line nebulae around central cluster galaxies, and ii) the South Pole Telescope survey, which is discovering new, distant clusters via the SZ effect. Early results suggest that there may be an increase in the number density of strong cool cores at early times, suggesting an epoch of strong cooling around $z \sim 1$. We discuss these results and their potential implications for both individual galaxy and cluster-wide evolution, before finishing with a look towards future programs aimed at understanding the balance between heating and cooling processes in galaxy cluster cores.

Speaker: **Ludovic Montier (IRAP)**
Title: **First characterisation of the Planck all-sky catalogue of high-z cluster candidates**

While massive high-redshift clusters are expected to be rare in the standard LCDM, the Planck satellite, with its full-sky coverage in sub-millimetre to millimetre range, represents a unique capability to search for these progenitors of clusters of galaxies over the whole sky. Unlike previous searches targeting radio galaxies or with Spitzer MIR color selections, our method is directly selecting on the star formation rates in dusty massive galaxies within the clusters, by looking for the rarest and brightest sub-millimetre cold sources on the sky.
I will describe the detection method based on Planck/HFI data used to build the all-sky catalogue of Planck high-z candidates and present the first characterisation of the first 24 candidates confirmed with Herschel/SPIRE observations. Except for a few sources identified in the literature as strongly lensed galaxies at z=2.7 to 5.2, the major part of this sample is shown to be red over-densities, likely at z>1.5. Thus a complete follow-up with Herschel, CFHT and VLT/XSHOOTER of one of these newly discovered Planck candidates suggests that it is a potential concentration of galaxies at z = 1.7. Such an all-sky catalogue of Planck proto-cluster candidates and its associated multi-wavelength follow-up with Herschel and other facilities will allow to put new constrains on the formation epoch of galaxy clusters, to derive star-formation properties of high-z galaxies, or to understand how does the environment affect high-z galaxy evolution.

Speaker: **Adam Muzzin (Sterrewacht Leiden)**
Title: **Environmentally-Driven Galaxy Evolution at z ~ 1: Perspective from Rich Galaxy Clusters**

Recent work from field galaxy surveys has suggested that the star-formation-density relation seen in the local universe may reverse at z~1. These results are difficult to reconcile with the predictions of hierarchical models of galaxy evolution; however, they are based on small area surveys that do not contain rich galaxy clusters. Using new data from the GCLASS survey, a 220 hour Gemini/GMOS spectroscopic survey of ten rich clusters at z ~ 1, I will show that the star-formation-density relation seen in the local universe is clearly not reversed in the highest-density environments at z~1. I will also discuss the differences between the stellar populations of cluster and field galaxies. One of the most intriguing results of that comparison is that the specific star formation rates of star forming galaxies (at fixed stellar mass) are identical in both the cluster and field environments. I will argue that this independence suggests that environmentally-driven quenching of star formation must be a rapid process. The GCLASS clusters also show a significant excess of poststarburst galaxies compared to the field, which further supports the interpretation of rapid, environmentally-driven quenching of star formation.

Speaker: **Julie Nantais (Universidad de Concepcion)**
Title: **Already big but still growing: comparing galaxy evolution in clusters at z ~ 1.2 and z ~ 0.8**

In galaxy clusters between redshifts 0.8 and 1.5, the most massive early-type galaxies are already in place, but galaxies farther from the cluster center are still actively evolving. We compare stacked spectra of passive and star-forming galaxy populations of two X-ray-selected galaxy clusters, J0152 at z=0.84 and J1252 at z=1.24, sorted according to features such as luminosity, stellar mass, and the local dark matter density as determined by existing weak-lensing maps. We find that the 4000 A break is consistently fainter for all comparable galaxy populations in the z=1.24 cluster, translating into rough age differences of about 2 Gyr among the passive galaxy populations. The most dramatic difference between the two clusters is found among the star-forming galaxies in intermediate mass-density regions, in which the galaxies of the z=0.84 cluster have much more substantial contributions from intermediate-age and old stellar populations, as evidenced by the 4000 A break, Ca II H+K, and Balmer lines. This suggests that the mostly intermediate- to low-mass galaxies falling into a cluster may make significant

progress toward eventually becoming passive cluster early-types in the 1.5 Gyr between redshfits 1.24 and 0.84.

Speaker: **Forian Pacaud (Bonn University)**
Title: **XMM-LSS and XXL surveys**

XXL, the XMM X-tra Large survey, is the largest deep and contiguous X-ray survey ever performed. It will cover 50 sq. deg. to a mean depth of 10^14 erg/s/cm^2 for extended sources. In this talk, I will first review some of the practical challenges of such surveys, as unveiled by the pilot XMM-LSS project. This includes the cluster identification in the X-ray data, the modelling of the selection function and the optical validation of the high redshift candidates. I will then discuss some of the expected science outcomes of XXL and the current status of the data aquisition. Finally, I will describe a new method to extract cosmological constraints from X-ray cluster samples, the CR-HR diagrams, which was already applied succesfully to the X-CLASS archival survey.

Speaker: **Gabriel W. Pratt (CEA-Saclay)**
Title: **Galaxy Clusters: What We Are Learning From Planck**

The Planck satellite is furnishing a fresh perspective on galaxy clusters through its all-sky survey via the Sunyaev-Zeldovich (SZ) effect. This is, in fact, the first all-sky cluster survey in two decades - since the X-ray survey by the ROSAT satellite in the early 1990s. Reaching deeper in redshift, Planck is extending the volume of all-sky cluster catalogs and finding the most massive bound systems in the universe. First cluster results from Planck were published in 2011 (Planck Early Results), including an Early SZ catalog (ESZ) of 189 of the highest significance clusters, follow-up observations with XMM-Newton and statistical studies of large samples of X-ray and optical clusters. Of particular note are these statistical studies, enabled by Planck's all-sky coverage, that allow us to link the X-ray, SZ and optical properties of the cluster population through scaling laws. I will describe the Planck survey, and review the Planck early results on clusters and discuss their implications. Such studies are pushing galaxy cluster science to more sophisticated and accurate modeling.

Speaker: **Shannon Patel (Leiden University)**
Title: **The Role of Environment at z>1: A Large Spectroscopic Sample from the 3D-HST Survey**

We present results from the 3D-HST survey pertaining to the properties of galaxies in various environments beyond z>1. The 3D-HST program utilizes a near-IR grism on HST/WFC3 and other deep multi-wavelength data in order to compile large spectroscopic, stellar-mass limited samples at high redshift. We take advantage of the superb redshift precision from the WFC3 spectroscopy in order to characterize various environments. We discuss how Hα derived SFRs and structural properties vary as a function of environment during these early times.

Speaker: **Irene Pintos-Castro (IAC)**
Authors: Irene Pintos-Castro, Miguel S·nchez-Portal, Bruno Altieri, the GLACE team and the Herschel High-z Clusters team
Title: **"Multiwavelength study of the galaxy population in the young cluster RXJ1257.2+4738 at z=0.866"**

"We present the first results of a study on the impact of the environment in the evolution of galaxies using a multiwavelength analysis of the young cluster RXJ1257.2+4738, from the optical to the far infrared, covering two virial radii. Our data set includes new observations of the GLACE survey - g',r',i',z'

bands with OSIRIS/GTC and J band with LIRIS/WHT- and PACS and SPIRE imaging photometry, along with existing MIPS and IRAC observations. We have processed GMOS spectra that confirm 24 cluster members, and calculated photometric redshifts for the rest. With our wide wavelength coverage we build spectral energy distributions, allowing us to determine total luminosities, stellar masses and star formation rates for the cluster members.
In addition, we are carrying out a mapping of the emission lines OII, OIII and Hbeta, with the tunable narrow-band filters at OSIRIS/GTC. These observations have been designed to measure stellar formation down to 2 $M_{\odot}$/yr, with nearly 2 magnitudes of extinction.

Speaker: **Felicia Ziparo (MPE)**
Title: **A star formation oasis in the middle of a cluster desert**

The level of star formation (SF) activity in galaxy systems is known to be suppressed relative to the field. According to the well known morphology-density relation (Dressler 1980) and the star formation rate (SFR)-density relation (Gomez 2003), in the local Universe high density regions, like groups and clusters, host mostly early type galaxies with lower SF level than field (mostly late-type) galaxies. The environmental dependence of galaxy SFR may change with redshift, as galaxies in systems undergo significant evolution. In higher-redshift clusters, the fraction of blue galaxies is higher ('Butcher-Oemler' effect, Butcher & Oemler 1978) and so is the fraction of infrared (IR) emitting galaxies ('IR Butcher-Oemler effect', e.g. Saintonge et al. 2008), where most of the IR emission is powered by SF. Given this evolution and the observed local relations, it is clear that a quenching of the star formation activity of galaxies in dense environments is required since z~1-2, and that this quenching process must act faster in galaxy systems than in the field.

Speaker: **Alessandro Rettura (Caltech/UCR)**
Title: **Evolution in the Structural Properties of Early-Type Brightest Cluster Galaxies over the past 10 billion years.**

We derive stellar masses and sizes of massive early-type Brightest Cluster Galaxies (BCG) drawn from the SpARCS cluster survey at $0.8 < z < 1.7$ and compare them with those measured in large, similarly selected samples of BCGs in the Local Universe ($0.04 < z < 0.3$). We find that, on average, the stellar mass of BCGs at fixed cluster mass grows by a factor of two between $z = 0.9$ and $z = 0.2$. On the other hand, the size of BCGs grows by a factor of five between the $z = 1.6$ and $z = 0.1$. We will present the results of our analysis and explain why these trends are most easily understood if early-type BCGs grew from many (dry) minor mergers. Only in such scenario can BCGs at z~0 be the descendants of our z~1.6 sample, as we demonstrates that major merging is not an important process in the late-time evolution of these systems.
In order to shed light on the role of the environment in regulating the star formation activity of galaxies, we follow the evolution of the galaxy population of a large sample of groups and clusters up to redshift ~2. In particular, we map with Herschel-PACS 8 clusters at $1.4 < z < 1.8$ for analysing the relation between star formation activity and environment at the epoch when clusters are assembling galaxies and galaxies are still undergoing their own formation process. The systems are all X-ray detected, spectroscopically confirmed and with large amount of multi-wavelength ancillary data. Our sample spans almost a decade in X-ray luminosity and dynamical mass, comprising relatively young systems and already old and relaxed clusters. This hetereogenity allows us to link the level of star formation activity to the global properties of the systems to shed light on which environmental process, if any, can affect the galaxy star formation activity.

Speaker: **Huub Rottgering (University of Leiden)**
Title: **Herschel and LOFAR observations and the study of proto-clusters.**

Understanding how massive black holes, galaxies and clusters of galaxies jointly emerged from inhomogeneities in the primeval Universe is one of the most compelling objectives of modern observational astrophysics. We have used SPIRE's excellent sensitivity and survey speed to study for the first time a significant sample of proto-clusters over the key redshift range $2 < z < 4$. This has been done through imaging of fields centered at the location of very luminous radio galaxies that are selected (i) to harbour the most massive black hole and/or (ii) are known to be located proto-clusters.
The LOFAR radio telescope is currently being commissioned and will constrain the spectra of starbursting galaxies down to 20 MHz. Combining radio and Herschel data on protocluster fields will yield good samples of protoclusters galaxies. During this talk the first LOFAR + Herschel results will be shown. The resulting data set allowed us to address key questions, including: (i) What fraction of the most luminous radio galaxies at $z > 2$ are located in the largest and most massive proto-clusters? (ii) What are the masses, sizes, and total star formation rates of the proto-clusters?

Speaker: **Gregory Rudnick (The University of Kansas)**
Title: **A Tale of Dwarfs and Giants: Using a z = 1.62 Cluster to Understand How the Red Sequence Grew Over The Last 10 Billion Years.**

A major topic in galaxy evolution is understanding how the passive galaxy population in clusters assembled over cosmic time. Key to this is the study of clusters at $z>1.5$, as it is at these epochs where present-day ellipticals experienced their last episode of major star formation. I will present the evolution in the luminosity function of passive cluster galaxies over the last 10 billion years. These results are based partly on new deep near infrared (NIR) observations with HAWK-I/VLT of a $z=1.62$ spectroscopically and x-ray confirmed cluster. Our observations probe the red sequence luminosity function (LF) (LF) to 2-3 magnitudes below L^* and allow us to constrain the physical processes regulating the growth of the cluster red sequence.
Our main observational results are that 1) the $z=1.62$ cluster red sequence has a large deficit of faint galaxies compared to its likely descendant clusters at $z<0.6$, 2) that this deficit of galaxies was present all they way down to $z=0.7$, and 3) that the cluster red sequence has grown by a factor of ~4 in stellar mass over the past 10 billion years. We explain this in the context of a simple model wherein the red sequence at $z>0.7$ grows by quenching of star formation and subsequent dry merging. With only a few mergers, we can accommodate the necessary stellar mass growth while keeping the shape of the LF unchanged. This picture is consistent with the direct evidence for an enhanced merger rate in red galaxies in our $z=1.62$ cluster from HST CANDELS observations. At $z<0.6$ the clusters enter a new phase of growth since they have become more massive and the galaxy merging cross-section decreases. As a result, the faint end is not depopulated via merging and the accretion of field galaxies results directly in an increase in the number of faint red cluster galaxies. Our results are consistent with a picture in which dissipationless merging plays an important role in shaping the evolution of the cluster red sequence at high redshift.
In addition to these findings, this cluster has significant amounts of obscured star formation in the massive galaxies of its core, despite the healthy red sequence. Therefore not even the massive cluster ellipticals have finished their formation. A crucial diagnostic for the last gasp of massive cluster galaxies will be direct measurements of the molecular gas, which we are currently measuring using completed CO(J=1-0) observations from the EVLA.

Speaker: **Miguel Sanchez-Portal (ESAC)**
Title: **A Herschel far-infrared view of the Spiderweb proto-cluster**

We present new far-infrared (FIR) imaging data of the proto-cluster region around the radio-galaxy PKS 1138-262 at z=2.2 (the so-called Spiderweb galaxy), obtained with the PACS and SPIRE instruments on-board the Herschel Space Observatory (HSO). The Spiderweb shows properties of a cD galaxy progenitor (e.g. its stellar mass is ~ 10^{12} $M_{\odot}$, i.e. one of the most massive galaxies at z>2) and it is surrounded by Hα and Lyα emitters at the same redshift.
The acquired photometric maps of ~ 10x10 arcmin at 100 and 160 μm and ~ 30x30 arcmin at 250, 350 and 500 μm, centred on the radio-galaxy, were used to produce band-merged multi-wavelength catalogue, supplemented with publicly available mid-infrared photometric data from Spitzer. Best match spectral energy distributions (SEDs) with Herschel templates are derived for all sources that are detected at high signal-to-noise ratio, including 4 spectroscopically confirmed members. Based on the SED and the overall FIR spectral shape we identify a sample of candidate proto-cluster members. The SEDs are then used to derive the total FIR luminosities, star formation rates and dust masses. To quantify statistically the overdensity of the IR galaxies associated with the Spiderweb proto-cluster, we calculate the source counts in both PACS and SPIRE and the two-point angular correlation function (2p-ACF).

Speaker: **Federico Sembolini (UAM)**
Title: **Exploring the SZE brightness of MUSIC proto-clusters to calibrate Y-M scaling law**

The power of the Sunyaev-Zel'dovich Effect (SZE) to perform deep cosmological investigations lies in avoiding the dimming result usual in observations of emitted radiation. The proto-clusters, objects typically at redshift higher than 1, are suitable candidate to be investigated by the inverse Compton scattering of the IntraCluster Medium with CMB photons. We propose for the first time to extend the study of the scaling law linking the object total mass, M, with the SZE brightness, Y, to proto-clusters. Due to the total lack of available observational data, we take advantage of MUSIC, the largest dataset of high resolution gasdynamical simulated galaxy clusters. More than 700 objects, extracted from two large cosmological N-body simulations (MareNostrum and MultiDark), are simulated with radiative and non-radiative physics, including radiative cooling, UV photoionization, star formation and supernova feedback. For each present cluster we can study the evolution back in time of all the member particles. Under the assumption to define a proto-cluster as the only largest progenitor present at a specific redshift, we are able to estimate the spherical thermal component of SZE, integrated inside the virial radius, and similarly the total mass. To this purpose we consider only objects present in the redshift range from z=1 and z=4. The Y-M scaling law is checked and it shows an increasing of the slope in the log-log fit with the redshift emphasizing a departure from a self-similarity approach. The scatter of the data behaves a similar trend. The self similarity, expected in the case of objects in hydrodynamic equilibrium, isothermal and spherical symmetric, has been previously verified in the case of massive MUSIC galaxy clusters (Sembolini, 2011-2012), while it is not expected to be satisfied by proto-clusters. Forecast of observations of proto-clusters by the SZE are reported in the case of large, and so high angular resolution, telescopes, like C-CAT.

Speaker: **Nick Seymour (CASS/CSIRO) / Dan Stern (JPL)**
Title**: The Impact of High-z Radio on Their Environments**

High redshift radio galaxies are unique markers of the coeval formation of massive galaxies and their central black holes at the centre of peaks of dark matter over-densities within the early Universe. As such they are important laboratories for studying the formation of massive galaxies containing active galactic nuclei and how this activity affects their environment. I shall present results from `Projet HeRGE', a systematic study of 71 high redshift radio galaxies (z>1, L_500MHz>10^{26} W/Hz) using Spitzer and Herschel photometry. From these data we are able to constrain the stellar mass, the AGN power and the SFR of these sources and, hence obtain a measure of the overall evolutionary state of the system. By

comparing the current state of the system with the richness of the over-density we shall examine the impact of the central galaxy on its proto-cluster environment.

Speaker: **Francesco Shankar (Observatoire de Paris)**
Title: **Probing the evolution of massive spheroidal galaxies via halo occupation distribution and semi-analytic models.**

One of the still mostly debated topics in Cosmology is the formation and evolution of massive, spheroidal galaxies, for which galaxy evolution models sometimes offer disparate conclusions.
In my talk I will present results from a new code that evolves massive galaxies via a hybrid approach.
The basic idea of our modelling is to follow the hierarchical merger histories of haloes, and at each timestep during the evolution, ìpaintî galaxies onto haloes via Halo Occupation Distribution (HOD) techniques. The latter rely on tuning the median monotonic (sub)halo mass-stellar mass relation (including its scatter) that fully satisfies the constraints of stellar mass function and galaxy clustering properties at all redshifts. A galaxy inside the main progenitor branch of a tree is then at each time-step initialized until a merger occurs, then all its structural and photometric properties are updated following recipes inspired by the results of numerical simulations of several galaxy mergers. HOD models have the virtue that they do not require full ab initio physical recipes to grow galaxies in dark matter haloes, as in full semi-analytic models. This in turn allows to by-pass the still substantial unknowns about, e.g., star formation and feedback in galaxy evolution models. By comparing with a variety of new statistical, structural, photometric, and clustering data sets, such as the size-stellar and color-mass relations, I will show how we can successfully break degeneracies in the models and constrain galaxy evolution models. In particular, during my talk I will discuss the hot topic of the size evolution of early type galaxies, the role of environment versus mergers, the origin of the highly non-linear color-mass relation recently inferred in SDSS, and conclude with the clustering properties, all topics of extremely relevance for the large and deep ongoing and future surveys such as BOSS and EUCLID.

Speaker: **Lee Spitler (Swinburne University)**
Title: **The discovery of a galaxy cluster with passive galaxies at redshift z=2.2**

Deep wide-field near-infrared imaging from the new FourStar camera on the Magellan telescope has revealed a compact (R ~ 750kpc) clustering of ~30 galaxies at redshift z=2.2. The cluster was discovered using novel medium-band filters that allow us to measure galaxy redshifts to ~2% at z=2. With these kind of accuracies we can now directly probe large-scale structures at these redshifts and correlate environment with galaxy evolution in the early Universe. I will describe the discovery of the cluster, its spectroscopic confirmation and highlight early results from our extensive observational follow-up campaign with Magellan, Keck, Gemini and the VLT.

Speaker: **Brian Stalder (Harvard-CFA)**
Title: **Massive Clusters at z>1 from the South Pole Telescope SZ Survey**

Several galaxy clusters have been identified at z>1 in the SPT-SZ survey after extensive optical and near-infrared follow up. In addition to their use for cosmological analyses, these systems are excellent case studies for galaxy formation and evolution in dense environments. For example, the massive (5x1014 M_sun) galaxy cluster, SPT-CL J0205-5829, currently has the highest spectroscopically confirmed redshift, z=1.322, in the SPT survey. The most luminous galaxies in this cluster have evolved stellar populations and low rates of star formation; this by the time the universe was <5 Gyr old.

Speaker: **Veronica Strazzullo (CEA Saclay)**
Title: **Galaxy population properties in high-redshift clusters**

Massive galaxies in cluster central regions up to at least z~1 consistently appear as generally evolved systems with respect to their structure as well as stellar populations. Their tight red sequence points toward a rapid, remarkably synchronous episode of massive star formation occurring at redshift z≥2. By observing galaxies in clusters at z~1.5 and beyond, we are thus finally able to approach this formation epoch, and to directly witness this active evolutionary phase. Several studies have indeed shown a significant diversity in the massive galaxy populations of z ≥1.5 clusters, this result being extended to the most distant cluster galaxies by our recent observations of Cl1449+0856 at z~2. Cluster-to-cluster differences might also become more marked than at lower redshifts, depending on the mass and individual early evolution of different systems, as suggested by the comparison of our results on galaxy population properties in the very massive XMMU J2235-2557 at z~1.4 with other studies of less evolved clusters at similar epoch. I will specifically discuss some of our recent results on the structure and stellar population properties of high redshift cluster galaxies, and how the comparison with lower redshift clusters as well as field studies at similar redshift may tell us about galaxy evolution in dense environments at early times.

Speaker**: Martin Stringer (Observatoire de Paris)**
Title: **Massive galaxies at high redshift: rare or impossible?**

The most massive collapsed regions in the universe are particularly sensitive probes of the underlying physics. With the rapid decline at high mass in the number density of halos predicted by LCDM, even small changes in the observed number or estimated mass of these regions will stretch the current standard cosmology. To examine this potential conflict in more detail, we study the galaxy populations that would be contained in such massive collapsed halos according to hierarchical formation theory, explaining some counter-intuitive effects of feedback and infall on galaxies when they are contained in a cluster environment, and illustrating the break down in correlation between galaxies and their host halos at these largest mass scales, as more and more of the total baryonic mass is contained in substructure. We then use the flexibility of these models to identify the underlying physical limits whose effect dominates the emergent high redshift cluster population, and thus address the question of whether massive galaxies in the early universe are merely improbable in the context of the standard hierarchical picture, or if they are - even under the most generous assumptions - impossible.

Speaker: **Ken-ichi Tadaki (University of Tokyo)**
Title: **MAHALO-Subaru project: the accelerated growth of massive, star-bursting galaxies at z>2**

In the present universe, the morphologies and properties of galaxies exhibit a bimodal distribution, which is caused by the environmental dependence. Early-type galaxies are red, massive and quiescent, while late-type galaxies are blue, less massive and active in star formation. It is found that such bimodality persists at least up to z~2. For understanding the galaxy transition from blue galaxies to red massive ones, it is critical to map out and examine actively star forming galaxies at z>2 in the various environments from clusters to general field. With such a motivation, we have been conducting ``MAHALO-Subaru'' project (MApping HAlpha and Lines of Oxygen with Subaru). This is the wide and deep H-alpha or [OII] emitter surveys with the custom-made narrow-band filters on Subaru telescope, targeting 8 known clusters/protoclusters at 1.5<z<2.5, and general field.
We present the H-alpha emitter surveys at z=2.2 and 2.5 in the SXDF-CANDELS field, where the high resolution near-infrared and optical images by WFC3/ACS on HST are both publicly available. This field is also unique because of its wealth of deep multi-wavelength data sets from X-ray to radio as well as submm data by ASTE and Herschel. We found that the star formation rate of massive H-alpha emitters in the field environment are as high as that in protocluster cores at z>2. Interestingly, it is found that most of them show red rest-frame optical colors. Their morphologies tend to be obviously clumpy or disturbed compared to the blue, less massive emitters. By the analysis of the resolved color, we found that the

nuclei of galaxies are redder than the clumps superposed on the underlying disk. This suggests three possible interpretations: nuclear starburst by merger events, inside-out growth or inward clump migration. Although current our observations can not discriminate among these scenarios, they are likely the key populations in the transitional phase, which would then eventually evolve into present-day massive, early-type galaxies. We are witnessing their progenitors when the Universe was most active in star formation.

Speaker: **Masayuki Tanaka (IPMU, University of Tokyo)**
Title: **Quiescent early-type galaxies in z>1.5 groups**

We present recent results from our on-going work on z>1.5 galaxy groups and clusters. We are conducting an X-ray search of distant clusters in deep fields and we have identified a few z>1.5 systems so far. We briefly summarize our discoveries and then focus on a system at z=1.61. Its mass inferred from X-rays is only 3.10^{13} $M_{\odot}$, making it the lowest mass group ever confirmed at z>1.5. The group is likely a progenitor of a present-day cluster of a typical mass. Based on the deep HST/WFC3 data from CANDELS, we find that the group galaxies form a surprisingly prominent red sequence. Detailed SED fits based on deep multi-wavelength photometry show that most of the group members are indeed quiescent galaxies. Furthermore, their morphological parameters derived from the WFC3 data show that they have early-type morphology. The group thus appears strikingly similar to those in the local universe. The only difference is its high AGN fraction (~40%), which might indicate a role of AGNs for quenching.
At z>2, there are a number of known 'proto-clusters'. In parallel to the X-ray survey, we are conducting deep near-IR spectroscopy of proto-clusters and we present our recent observation of PKS1138 at z=2.16. The PKS1138 proto-cluster hosts a large number of star forming galaxies, but we spectroscopically confirm for the first time that quiescent galaxies populate in the proto-cluster environment. Our results on the z=1.6 and z=2.2 systems might suggest that the environmental dependence of galaxy properties observed today is imprinted at high redshifts, possibly during the first gravitational collapse of clusters.

Speaker: **Paolo Tozzi (INAF - Osservatorio Astronomico di Trieste)**
Title: **Search and characterization of high-z, massive clusters: recent results from Chandra and Swift/XRT**

We present results from the most recent deep Chandra observations of high redshift clusters (namely XMM2235 and WARPS1415) showing that high S/N, high resolution observations can put strong constraints on the large scale structure of the Universe, on the physics of the Intra Cluster Medium, on the chemical enrichment from cluster galaxies, and on the nature of the feedback acting in the cluster cores. We also present new results from the Swift X-ray Cluster Surveys based on Swift/XRT archival data, with more than 200 newly discovered X-ray clusters. This survey, combined with serendipitous discovery in Chandra and XMM deep fields, indicate that the expected number of massive ($M>10^{14}$ $M_{\odot}$), high-z clusters is larger than previously thought, and this can put strong constraints on the standard LambdaCDM and Quintessence models, paving the way to possible new physics. Thanks to these results, it is possible to find the optimal strategy to design future X-ray missions capable to create a breakthrough in this field.

Speaker: **Hideki Umehata (Institute of Astronomy, The University of Tokyo)**
Title: **Submillimeter Galaxies in the SSA22 Protocluster at z=3.1**

We present the results of counterpart identification of submillimeter galaxies (SMGs) detected in the SSA22 protocluster, which is traced by Lyα emitting galaxies (LAEs) at z = 3.1 and discuss the relationship between SMGs and the large scale structure.

112 SMGs were uncovered in this field with a significance of over 3.5σ by a 1.1mm deep survey with AzTEC camera mounted on the Atacama Submillimeter Telescope Experiment (ASTE) .
We searched counterparts for these SMGs using the following three methods; radio(1.4GHz) , MIPS ch1(24μm), and IRAC color(3.6μm, 4.5μm, 5.8μm, and 8.0μm) diagnostics. As a result we identified 48 SMGs with at least one counterpart. Furthermore we extract 34 SMGs from those with counterpart and observed by IRAC 4 channels and derive their photometric redshifts with photometric data from optical to mid-infrared wavelength (at most 13 bands). Finally we identify seven SMGs as candidates of z=3.1 protocluster member.
Two point angular correlation function between LAEs and these SMGs shows that there are significant spatial correlation, which indicates SMGs are correlated with the large scale structure. We also detect individually X-ray emission in three SMGs around the core of the protocluster, suggesting that these harbor luminous AGNs ($Lx_{0.5\text{-}8.0\ keV} \sim 10^{44}$ ergs s^{-1}). These results indicate that high density regions at the high redshift universe are the site of SMG/AGN formation. This picture is consistent with predictions from the standard model of hierarichical structure formation.

Speaker: **Bram Venemans (MPIA Heidelberg)**
Title: **Proto-clusters searches and studies**

High redshift progenitors of local clusters of galaxies, so-called proto-clusters, are important laboratories to study the evolution of galaxies in dense environments and to trace the formation of large scale structure. In this talk, I will give an overview of various projects and methods that have successfully identified proto-clusters at redshifts z > 2. I will then highlight the results obtained by detailed studies of these proto-clusters and their galaxies.

Speaker: **Joel Vernet (ESO)**
Title: **The Spitzer view of the environment of 70 powerful high redshift radio galaxies at 1<z<5**

Powerful radio galaxies (RGs) at high redshift have long been suspected to lie at the centre of assembling clusters, or at the very least, at a cross-road of large scale filamentary structures. They have the requisite properties to evolve into the brightest cluster galaxies and indeed, the average environment of such RGs at low redshift is that of an Abell 0 cluster. I will present the results of a systematic study of the environment of 70 powerful RGs between z=1 to beyond z=3 both in terms of active galaxies (star-forming and AGN) selected at 24 μm with Spitzer/MIPS (Mayo et al. 2012, A&A 539, 33) and passive galaxies selected in the Spitzer/IRAC bands (Galametz et al. 2012. ApJ 749,169). Both studies consistently confirm the very high density of these fields compared to blank fields (eg. SWIRE) but also reveal an interesting spread in the ratio of passive to active galaxies that can be related to variations in the evolutionary state of those proto-clusters. Trends with redshift and RG luminosity are also investigated.

Speaker: **Jon Willis (University of Victoria)**
Title: **Distant clusters in the XMM Large Scale Structure survey**

Distant galaxy clusters provide important tests of the growth of large scale structure in addition to highlighting the process of galaxy evolution in a consistently defined environment at large look back time. We present a sample of 22 distant (z>0.8) galaxy clusters selected from the 9 square degrees footprint of the overlapping X-ray Multi Mirror (XMM) Large Scale Structure (LSS), CFHTLS Wide and Spitzer SWIRE surveys. Clusters are selected as extended X-ray sources with an accompanying overdensity of galaxies displaying optical to mid-infrared photometry consistent with z>0.8. Nine clusters have confirmed spectroscopic redshifts 0.8<z<1.2 and a further 13 have up to 10 band photometric redshifts 0.8<z<2.2. Each cluster displays a red sequence galaxy population, determined either individually or via a stacking analysis, whose colour is consistent with the expectation of an old, coeval stellar population

observed at the cluster redshift. We also compare the observed X-ray emission to the flux expected from a suite of model clusters and find that the sample displays an effective mass limit ~ 10^{14} $M_{\odot}$ with all clusters displaying masses consistent with M<5 10^{14} $M_{\odot}$. In addition to presenting the cluster sample we highlight a number of follow-up programs such as deep Chandra and SZ observations.

Speaker: **Dominika Wylezalek (ESO)**
Title: **The mid-infrared environments of radio-loud AGN**

Powerful high redshift radio-loud AGN, are known to preferentially lie in overdense fields and are therefore promising beacons for identifiying large-scale structure at high redshift and to search for galaxy (proto)-clusters. A dozen of (proto)-clusters has been confirmed to date at z>1.2 in the fields of radio-loud AGN - in particular radio galaxies. However, due to the relatively small number of confirmed clusters, it is still challenging to draw a clear picture of formation and evolution in high redshift clusters. It is still also under debate whether the cluster environment depends on the type of targeted radio-loud AGN (e.g. radio-loud quasars, radio quiet quasars, powerful radio galaxies etc.). We present the first results of our large Spitzer snapshot program, CARLA (Clusters Around Radio-Loud AGN; P.I.: D. Stern), that is currently targeting over 400 radio-loud AGN (~200 radio galaxies and ~200 radio-loud quasars) at 1.3<z<3.2 (15min in 3.6um and 35min in 4.5um) for a total of more than 300hours of Spitzer/IRAC time and that for the first time allows to systematically study the fields of a large sample of powerful radio-loud sources over a wide redshift range. We first isolate high redshift galaxies using IRAC colors and then search for potential overdensities of the IRAC-selected sources around the targeted AGN. CARLA is also ideal to investigate how the environment depends on the radio-loud AGN properties like redshift, radio-power and AGN classification and to test models that try to explain the apparent difference in the environments of radio-loud AGN and radio galaxies. More than 200 fields were observed so far. The data are reduced and currently under analysis. Some very exciting cluster candidates at z>1.4 have already been standing out of the sample and scheduled for follow-up. We expect that at least a hundred more fields will be at our disposal by September.

Speaker: **Andrew Zirm (Dark Cosmology Centre)**
Title: **Towards Building Robust (Photometric) Density Maps at z~2**

Recent results have suggested that galaxies in overdense regions at z>1.5 follow the same mass-size relation as local galaxies (Zirm et al. 2012, Papovich et al. 2012). In the field at the same redshifts (1 < z < 2), many quiescent galaxies have much smaller sizes at fixed mass. Using archival data and new imaging from the ultraVISTA survey we have constructed a galaxy density map around z=2 to observe the trend of galaxy sizes over a range of environmental densities. The density maps are based on the full photometric redshift probability distributions for the individual galaxies along with a 2D Voronoi analysis. We have constructed a set of maps via Monte Carlo to assess the statistical robustness of the calculated densities. Finally, we have measured galaxy sizes from the ground-based data and the HST/WFC3 data from CANDELS where possible. We find that galaxy sizes do indeed follow a continuous trend with environmental density such that at a fixed mass the galaxies in overdense regions are larger. We interpret this observed density-size relation in terms of a model in which initial galaxy size depends on formation redshift and the size changes via mergers.

Posters

Kaustuv Basu (AlfA, University of Bonn)
Title: **A Sunyaev-Zel'dovich take on cluster radio halos**

Giant radio halos in galaxy clusters provide the best evidence that ultra-relativistic particles (cosmic rays) and magnetic fields exist over Mpc scales. Despite being critical for a complete understanding of the ICM and its evolution, their powering mechanism remains unclear. Theoretical models of radio halo origin have so far been based on X-ray selected cluster samples, with X-ray luminosities being used as a proxy for cluster mass. In this poster I show what happens when clusters are selected based on their Sunyaev-Zel'dovich (SZ) effect instead, which provides a relatively unbiased mass estimate based on the total thermal energy content. The result is a more precise scaling of the radio power with radio halo mass and the total cluster mass, which can be used to differentiate between simple theoretical models. In addition, the segregation between radio halo and radio quiet systems becomes much less pronounced. I discuss the implications for this weak/non-existent "bi-modality" in radio halo clusters, and some implications for this work in light of the upcoming deep radio surveys like the ASKAP/EMU.

Rafael Barrena (IAC)
Title: **The faint end luminosity function of non virialized galaxy clusters.**

We will expose results of studies on the bright part of the luminosity function (LF) of a sample of very unrelaxed clusters ("DARC" clusters showing evidence of major, recent mergers) and compare them to a reference sample of relaxed clusters that span a comparable mass and redshift range. Our analysis is based on the SDSS DR7 photometric data and we consider r' band LFs of ten massive and X-ray luminous clusters ($0.2<z<0.3$), always considering physical radii (R_{200} or its fractions). We show that DARC and relaxed clusters give similar LF parameters and blue fractions. The two samples differ in their content of bright galaxies BGs, $Mr'<-22.5$. Relaxed clusters have fewer BGs, in particular when considering the outer cluster region $0.5R200 < R < R200$ (by a factor two).
However, the cumulative light in BGs is similar for relaxed and DARC samples.
In conclusion, BGs grow in luminosity and decrease in number as the parent clusters grow hierarchically, which agrees with a BG formation by merging with other luminous galaxies.

Pierluigi Cerulo (Swinburne University of Technology)
Title: **The Build-up of the Red Sequence in High Redshift Galaxy Clusters**

I present the results of a detailed analysis of the galaxy properties in an X-ray detected cluster at z=0.98. I will show how galaxy morphology and size depend on the location on the red sequence, suggesting different evolutionary paths for the cluster members according to their morphology. I will also present the results of my investigation of galaxy stellar ages and star formation rates as a function of stellar mass on the red sequence. I will show how the study of differences between the brightest and faintest red sequence members and comparison with their counterparts in the local universe provides important new clues to the links between galaxy and cluster formation as well as the different physical processes responsible for the build-up of the red sequence in clusters.

Lauriane Delaye (GEPI - Observatoire de Paris - Universite de Paris D. Diderot)
Title: **Size evolution in high redshift clusters**

We study the effect of environment in the size growth of massive ($\log(M/M_{\odot})>10$) red sequence early-type galaxies (ETGs) between z=0.8 and z=1.5.
We analyze the mass-size relation of 468 massive ETGs in 9 rich clusters from the HAWK-I cluster survey (hcs.obspm.fr). For all clusters we have deep HST rest-frame B-band imaging to compute sizes together with 4 bands photometry (including VLT/NIR) to estimate stellar masses through SED fitting.
Our sample contains the richest and most distant clusters known up to date and it is therefore the best sample available to study the mass assembly of ETGs leaving in extreme environments. Results are then compared to a field population at the same redshifts.
Between z=1.5 and z=0.8, we find that the sizes of cluster ETGs are approximately increased by a factor of ~1.6. However, at these redshifts, the effect of internal properties of the galaxies such as morphology and stellar mass seems to have a significant effect in the size evolution as the environment.

A. Fritz (INAF IASF Milano), A. Iovino (INAF OA Brera), O. Cucciati (INAF OA Trieste), M. Scodeggio (INAF IASF Milano), and the VIPERS Team
Title: **The VIPERS project: Galaxy Groups and Clusters in VIPERS**

We will present first results on our analysis of galaxy groups and clusters using sample of ~50,000 galaxies in the redshift range 0.5<z<1.2 drawn from the ongoing VIMOS Public Extragalactic Redshift Survey (VIPERS) project (Guzzo et al. 2012). We present our cluster search techniques to identify ~40 overdense structures (N_mem>5) up to z~1 in two different sky regions covering a total area of ~12sq.deg. Our results are compared to realistic mock simulations to understand the success rate, observational selection effects and limitations of our cluster search algorithms. For the identified cluster candidates, we construct colour-magnitude diagrams and analyse the build-up of the red-sequence in clusters and groups. Using stacked spectra of cluster/group members, we explore the global spectral properties and the stellar populations of these galaxies in order to constrain their evolutionary history. Our results are compared to our identified XXL cluster catalog and to other cluster search algorithms from the literature. These findings allow for the first time to get an understanding of the impact of cosmic variance and to re-fine previous results of cluster and group studies up to z~1.2.

Marisa Girardi (Dipartimento di Fisica - Univ. di Trieste - Italy)
Title**: Merging Clusters of DARC Sample: studying the formation of galaxy systems**

Extended, diffuse radio emissions (halos and relics) embedded in galaxy clusters are rare phenomena. Here I present a few results of the DARC program, aimed to study the internal Dynamics Analysis of "Radio"-Clusters mainly based on a TNG program (spectroscopic data for 20 clusters at z=0.1-0.3). The study of kinematics of member galaxies show that DARC clusters are examples of very substructured systems and allow us to detect and weight the intervening subclusters as well as to determine their relative motions and projected geometry. The observational scenario, often reinforced by X-ray data too, is generally well interpreted with DARC clusters being in the phase of formation through a major merger, just observed few Gyr after the core passage. I will discuss some interesting examples and discuss the global kinematical and dynamical properties we obtain with radio properties presented in the literature.

Inger Jorgensen (Gemini Observatory)
Title: **The Gemini/HST Galaxy Cluster Project: The end of passive galaxy evolution for early-type galaxies**

We present an analysis of stellar populations and evolutionary history of early-type galaxies in three similarly rich galaxy clusters MS0451.6-0305 (z=0.54), RXJ0152.7-1357 (z=0.83), and RXJ1226.9+3332 (z=0.89). The clusters are part of our 15-cluster sample making up the database for the Gemini/HST Galaxy Cluster Project. The data consist of high S/N optical spectroscopy from Gemini/GMOS-N and imaging from HST/ACS.
We have established the Fundamental Plane (FP), the size-mass relation, and scaling relations between absorption line indices and velocity dispersions. The main results are: (1) The data show no significant evolution of sizes or velocity dispersions with redshift at a given galaxy mass. (2) The FP slope depends on the redshift and is steeper at z=0.8-0.9 than at z=0, indicating that the formation redshift for the low mass galaxies is smaller than that of the high mass galaxies. (3) The scaling relations for the line indices in general show less evolution with redshift than found from the FP, and therefore cannot easily be interpreted together with the FP within the model of passive evolution.
Based on the absorption line indices and recent stellar population models from Thomas et al. we find that (1) MS0451.6-0305 has a mean metallicity [M/H] approximately 0.2 dex below that of the other clusters and our low redshift sample, and (2) RXJ0152.7-1357 has mean abundance ratio [alpha/Fe] approximately 0.3 dex higher than that of the other clusters. These differences are not consistent with a passive evolution scenario for early-type cluster galaxies over the redshift interval studied. Low-level star formation is needed to bring the metallicity of MS0451.6-0305 in agreement with the low redshift sample, while we speculate whether galaxy mergers may be able to explain how the abundance ratios can change with redshift.

Eugene Kang (korea astronomy & space science institute (KASI))
Title: **Overabundance of massive structures of galaxies at high redshift**

We searched and studied massive structures of galaxies (MSGs) at 0.6 < z < 4.5 in the areas of two GOODS fields. These MSGs are identified by running top-hat filters on the two dimensional spatial distribution of galaxy sample - a K-band limited, photometric redshift sample, which is supplemented by dropout galaxies in a z-band limited sample at high redshift part. Here photometric redshifts are derived from multi-wavelength data ranging from U-band through 8 micron band of the Spitzer. We find 59 MSGs with significances of 3.5-8 sigma. The derived masses found to be a > 10^{13} $M_{\odot}$ with the comoving number density of a few \times$10^{-6}$ Mpc^{-3} at z ~ 3. In order to test the LCDM prediction, we carried out an analysis of MSGs using the mock galaxy catalog based on Millennium simulation selected in the same way as the analysis of the observational data. We find that the observed number density of the massive structures deviates strongly at z > 2 from the simulation results based on the LCDM universe. We further discuss implications of our results.

Minsun Kim (Korea Astronomy and Space Science Institute)
Co- Authors: Eunhyeuk Kim
title : **X-ray Point Sources in Galaxy Clusters**

We study X-ray point sources in galaxy clusters to investigate the density environmental effects on physical properties of X-ray point sources. We have used the Chandra archival observations of galaxy clusters, containing ~58,000 X-ray point sources in ~800 Chandra ACIS observations of ~600 galaxy clusters. It covers an intermediate flux range of Fx=10^{-15} -10^{-13} erg sec^{-1} cm^{-2} in the 0.3-8 keV. We present the source counts, fluxes, hardness ratios, and X-ray colors of the X-ray point sources in galaxy clusters and compare to those of typical fields. We have performed extensive Monte-Carlo simulations to utilize the X-ray point source properties. In addition we have calculated the detection probability of the X-ray point sources in galaxy clusters and compared to that of typical fields.

Mariko Kubo (Astronomical Institute, Tohoku university)
Title: **The formation of the massive galaxies in the SSA22 z=3.09 protocluster**

We present the studies of the SSA22 proto-cluster at z=3.09 with Subaru MOIRCS (Multi-Object Infrared Camera and Spectrograph) JHK band deep and wide imaging. The SSA22 protocluster is known to be one of the most outstanding structure at high redshift. We studied the population of the proto-cluster galaxies with U, B, V, R, i, z, J, H, K and Spitzer IRAC and MIPS 24μm multiwavelength photometries.
First we selected the candidate of the proto-cluster galaxies with K_{AB}<24 (S/N=5) and z_{phot}=2.6-3.6 by using photometric redshift. There are the overdensity of the K-selected galaxies in the proto-cluster. Especially those selected as Distant Red Galaxies (DRGs, $J-K_{AB} > 1.4$) or those detected with MIPS 24μm show higher density excess. The limiting flux of the MIPS 24 μm in the SSA22 region corresponds to SFR_{IR} ~ 1000 $M_{\odot}$/yr for z~3 galaxies, suggesting the enhancement of the very obscured starbursts.
Then we investigated the stellar population of the K-selected galaxies from the rest-UV to NIR color. Most of the red K-selected galaxies have the color consistent with the dust obscured galaxies. On the other hand, we found that some of the red K-selected galaxies have the color consistent with the passively evolving galaxies. They already have the stellar mass of $10^{10.5}$-10^{11} $M_{\odot}$/yr and their number density is much larger than that in the field at same redshift. Furthermore the passive galaxies, 24μm detected galaxies and X-ray detected galaxies are all concentrated at the density peak of the proto-cluster. It may be the first time to find the density excess and the clustering of the passive galaxies at z=3 distant universe. Our results support the rapid formation and evolution of the massive galaxies in the high-density region which predicted from the hierarchical formation scenario of the galaxies in the CDM cosmology.

Jong Chul Lee (Korea Astronomy and Space Science Institute)
Title**: Cluster effects on galaxy activity in local Universe**

Based on ~100 Abell clusters (<z>~0.1) from the Sloan Digital Sky Survey (SDSS) data release 7 with a large number of spectroscopically confirmed member galaxies, we investigate the star formation (SF) and nuclear activity in cluster environments in contrast with the field.
We find that the number ratio of active galactic nuclei (AGN) to SF galaxies in the clusters is lower than that in the field as well as it is found that SF and AGN fractions decrease with decreasing cluster-centric distance, implying that nuclear activity (rather than SF activity) is more strongly suppressed by galaxy-cluster interactions. Using the Wide-field Infrared Survey Explorer (WISE) all-sky data, we also find that brightest cluster galaxies (BCGs) show mid-infrared excess compared to early-type cluster galaxies with a similar mass range, supporting that host clusters play a role in the enhancement of BCG activity.
The galaxy activity seems to be really affected by not only neighbor galaxies but also the host cluster in the sense that it is dependent on cluster properties such as velocity dispersion, X-ray luminosity, cluster-centric distance of BCG, and dominance degree of BCG. The implications of these findings will be discussed more in the presentation.

Elvira Leonardo (CAAUL Lisbon)
Title: **Clustering properties of extreme bulgeless galaxies: the massive and the AGN population**

We are carrying out a systematic study of bulgeless systems at intermediate redshifts ($0.4 < z \leq 1.0$) using data from four of the largest, deepest multi-wavelength surveys: COSMOS, AEGIS, GOODS-S/GEMS, and GOODS-N. Amongst ~19000 bulgeless galaxies, we identified ~250 high mass objects (M>10^11 M_sun), and few of them also host X-ray detected AGN.
Massive galaxies with an AGN pose a challenge to the current picture of galaxy formation, because, in principle, they require a hierarchical growth to reach such large
masses and to efficiently feed the central engine. However bulgeless galaxies are commonly found in low density environments, and indeed theoretical models predict that they evolve in isolation, i.e. infrequent or inefficient interactions.

We present here the study of the environmental properties of these extreme bulgeless galaxies, based on ACS/HST and deep ground based ULTRAVISTA surveys.

Rossella Licitra (GEPI - Observatoire de Paris - Universite de Paris D. Diderot)
Title **High redshift galaxy clusters detected in deep Megacam multi-wavelength images**

We present recent results on the stellar evolution in cluster galaxies from z~1 to present from the Next Generation Virgo Cluster Survey. Our survey covers 104 sq. deg. centered on the Virgo cluster with deep CFHT/Megacam imaging in five band passes. We detect background clusters with dedicated methods based on the search of red galaxy and photometric redshift overdensities. We analyse galaxy stellar population evolution in clusters from z~1 to present using scaling relations, such as the color-magnitude relation.

Ken Mawatari (Tohoku University)
Title: **Characterization of the distribution of the Ly-alpha emitters in the 53W002 proto-cluster region at z = 2.4**

We present the results of our wide-field narrow band imaging of the field around the radio galaxy 53W002 with Subaru/Suprime-Cam. We observed the 31'x24' area using a custom made filter NB413 centered at 4140 Å with the width of 83 Å, and detected 204 Lyα emitters (LAEs) at z = 2.4 with a rest frame equivalent width larger than 25 Å to the depth of 26 AB mag (in NB413). Four Lyα blobs (LABs) were also detected, one of which is newly discovered. We identify a significant high density region (53W002F-HDR) that spreads over ~ 5'x4' near 53W002 where the LAE number density is nearly four times as large as the average of the entire field. As more objective indicator of the significance of the structure than just density, we introduce a new quantity, rareness probability, which represents the probability of finding given structure at given redshift. We also tested the usefulness of rareness probability using simulations to confirm that the new quantity enables us to make comparison with proto-cluster regions at other redshift more objectively. The rareness probability of the 53W002F-HDR is estimated to be $0.9^{+2.4}_{-0.62}$%, which corresponds to the moderately rich structure. No notable environmental dependency at the comoving scale of 10 Mpc is found for the distributions of the Lyαequivalent width and luminosity in the field, which is also confirmed in other fields at z = 3.1. On the other hand, the four LABs are all found to be located in the rims of high density regions.

Mohammad Mirkazemi (Max Planck Institute for Extraterrestrial Physics)
Title: **CODEX: A large sample of most massive among distant galaxy clusters**

Formation of the large-scale structure of the Universe results in ever increasing mass of the massive clusters. Yet, sufficient volume necessary to find the clusters requires both large areas and high redshifts for clusters. Large area intermediate redshift surveys therefore hold the key to studies of massive clusters. I will present a new effort in obtaining such a sample within the SDSS-III survey, using identification of X-ray sources in RASS data. This sample, called CODEX (COnstrain Dark Energy with X-ray clusters), includes a very large sample of 300 massive galaxy clusters with mass > 5 10^{14}. I will present the on-going results of spectroscopic identification, weak lensing calibration and high-precision mass proxy measurements for this sample.

Ivelina Momcheva (Yale University)
Title: **New Results on IRC0218**

Still one of only a handful of z>1.5 clusters, IRC0218A (z = 1.62) is becoming the poster child for high-redshift high-density environments. I will present results from new WFC3 grism observations of the

cluster, trying to paint a complete picture of star-formation and AGN activity. Comparison to the properties of coeval galaxies in the field in the 3D-HST survey will provide clues to the role of the environment in the early evolution of clusters.

Rogerio Monteiro-Oliveira (University of Sao Paulo - Brazil)
Title: **A multi-technique analysis of the merging cluster Abell 1758**

We present here the velocity measurements of ~150 galaxies members of the cluster Abell 1758 from Gemini-GMOS data and a dynamical analysis. This cluster shows strong observational evidence of having undergone recent event of a collision between their substructures. Previous studies both by us and others authors based on the comparison of the mass distribution obtained by weak gravitational lensing with spatial distribution of the intracluster X-ray emitting gas show that in one of those substructures a detachment of the gas in relation to the galaxies and dark matter, alike the bullet cluster, while in the other substructure the position of all those elements coincide, at least in the projected space. A fundamental element towards a more complete understanding of the dynamics of this cluster is the determination of the amount of momentum perpendicular to the plane of the sky. This information is not accessible by x-ray nor gravitational lenses, and hence the relevance of the analysis the dynamics of this complex system.

Gustavo Morales (Pontificia Universidad Catolica de Chile)
Title: **The Atacama Cosmology Telescope: An independent data analysis.**

The Atacama Cosmology Telescope (ACT) is a radio telescope in Chile located in the desert at 5200 meters over the sea level that has been able to measure the CMB fluctuations up to arcminute angular scales. It also has proven to be a prolific experiment both from an astrophysical and cosmological perspective, owing to three essential design features: arcminute resolution matched to the size of clusters, degree-scale field of view for efficient surveying, and the relatively unprecedented sensitivity of 1000-element bolometric detector arrays. The analysis of the ACT data conducted by the Princeton team required the development of a new data-reduction pipeline based on a detailed understanding of the telescope's properties and systematics. Here in PUC, I am currently working with Rolando Dunner in an independent analysis of the new ACT data release to be published soon, in collaboration with the ACT team in Princeton. My goal is to characterize and exploit such maps by writing a pipeline which generates a catalog with all point and extended sources detected by doing astrometry and calculating fluxes (which for the case of clusters translates into a Compton parameter estimation), noise distribution and so on. Following Marriage et al. (2011) prescriptions, my algorithm involves the calculation of an optimal filter to maximize the SNR and highlight any particular profile we are interested in. In this regard, such relative flexibility could also be useful in incoming experiments like ACTPol, the new polarization-sensitive receiver for the ACT still in development. Here I present our method, partial results and some consistency checks with Princeton's studies.

Alessandro Nastasi (MPE)
Title: **Exploring the distant galaxy cluster population with the XMM-Newton Distant Cluster Project**

Galaxy clusters are the most massive bound systems in the Universe and extremely sensitive probes to trace the growth of the cosmic large-scale structures and to test cosmological models. They are also excellent laboratories for studying the formation and evolution of galaxies and the role of environment, merging and AGN feedback in this process.
In my poster I will summarize the results obtained with the XMM-Newton Distant Cluster Project (XDCP) which is specifically designed to discover and characterize, with multi-wavelength follow-up, the most distant X-ray luminous galaxy clusters. I will also present a new semi-automatic pipeline for the reduction

of FORS2 spectra, whose efficiency enabled us to push the limit of the optical spectroscopic confirmation up to z~1.6, beyond the boundary of the so called "redshift desert".

Viral Parekh (University of Cape Town)
Title: **Substructure in Galaxy Clusters identification through Morphology parameters**
Co-Author: **Kurt van der Heyden**

Abstract: Recent spectral and spatial X-ray observations of galaxy clusters suggests subclustering and merging in many clusters. Hence Galaxy Clusters can be grouped into two categories; relaxed and non-relaxed clusters. We have investigated the use of Morphological parameters (Gini, Asymmetry,M20, Concentration, Ellipticity, Smoothness and Gini 2nd order) to differentiate between relaxed and non-relaxed scenarios. We initially simulated different relaxed and non-relaxed morphologies with multiple beta profiles. Finally, we applied our method to a different redshift sample of clusters from the Chandra archive and studied correlation between parameters and X-ray gas properties. In this poster I will show the promising results from the morphological parameter calculations and its possible application to study morphology of radio halo and relic clusters.

Valentina Presotto (University of Trieste - Dept. of Physics)
Title: **ICL properties in MACSJ1206 cluster from ground based multi-band images**

Constraining the origin of the intra cluster light (ICL) is a promising way to understand the mechanisms occurring in galaxy clusters as well as their assembly history. The advent of modern CCDs allowed to perform studies of the properties of the ICL, but there is still no general consensus on the amount of baryonic light captured in the ICL and on its formation. Furthermore only few studies have been performed at $z > 0.3$.
In this talk I will present the method of ICL detection and measurement and the results I have obtained from ground-based images of MACSJ1206, one cluster in the CLASH sample. The CLASH survey comprises 25 massive clusters of galaxies in the redshift range $0.2 < z < 0.8$. Among these, 14 have been selected for spectroscopic follow-up at the VLT. At completion, both photometric and dymanical properties of each cluster will be available allowing the study of ICL and its connection to cluster properties. Using deep multi-band images from SUBARU we studied the colors and the morphology of the ICL in MACSJ1206, as well as its connection to cluster substructures.

Joana S. Santos (ESAC)
Title: **Far-infrared star-formation in XMMUJ2235.3-2557, a massive galaxy cluster at z=1.4**

Star-formation in the galaxy populations of massive clusters is known to be less pronounced with respect to field galaxies, and also tends to be suppressed in the core region, although indications of a reversal of the star-formation-density relation have been observed in a few z>1.4 clusters.
Using deep imaging in the range 100-500um from PACS and SPIRE onboard Herschel, we study the total infrared emission of 7 cluster members and several cluster candidates of XMMUJ2235, one of the most massive, distant, X-ray selected cluster galaxies at z=1.393. The total rest-frame L(8-100um) is obtained by fitting the spectral energy distributions, with which we derive galaxy star-formation rates.

Ana Cecilia Soja (University of Sao Paulo - Brazil)
Title: **Weak lensing analysis of the galaxy cluster RXC J1504-0248**

In this work we studied the galaxy cluster RXC J1504-0248, at z=0.215, from images in the bands r', g' and i' obtained with Gemini South telescope. The photometric calibration was performed by comparison

with field objects identified in the Sloan Digital Sky Survey (SDSS). From the analysis of color-color and color-magnitude diagrams, galaxies in the field were then divided into cluster members, background and foreground objects. We determined the PSF using the IM2SHAPE program (Bridle et al. 1998). These results enabled us to obtain the cluster projected mass distribution through a weak lensing analysis performed with the LENSENT program (Marshall et al. 2002). We also shown that the cluster luminosity distribution and the X-ray emission are consistent with the mass map. Using a SIS model, we estimated the mass of the cluster, obtaining 1.3 10^{15} $M_{\odot}$, consistent with the mass obtained in a previous X-ray analysis, 1.7 10^{15} $M_{\odot}$, by Bohringer et al. (2005).

Daniel Stern (JPL/Caltech), Allan Hornstrup (DTU-Space), Silvano Molendi (INAF), Fiona Harrison (Caltech) and the NuSTAR Team
Title: **High Energy Observations of Galaxy Clusters with NuSTAR**

On June 13, 2012, the Nuclear Spectroscopic Telescope Array (NuSTAR) launched into low-Earth orbit, becoming the first true imaging hard X-ray mission. NuSTAR, which operates in the 5-80 keV band, has a range of Galactic and extragalactic objectives. I will discuss NuSTAR plans for observing galaxy clusters. The motivation for such observations are two-fold. First, NuSTAR should detect and characterize the controversial non-thermal component emerging from galaxy clusters at high energies. Such observations will provide direct measures of the mean cluster magnetic field strength and density of relativistic electrons, which, in turn, are valuable for obtaining a detailed description of the processes in intracluster gas and the origin of magnetic fields Second, NuSTAR will characterize the hot thermal emission in the vicinity of shock fronts.

Kenta Suzuki (Institute of Astronomy, University of Tokyo)
Title**: Large Dust and CO in Hα emitting galaxies associated with the proto-cluster around 4C~23.56 at z=2.48**

We present the results of millimeter-wave observations of the proto-cluster region around the radio galaxy 4C23.56 at z=2.48, where a significant over density of Hα emitting galaxies (HAEs) is reported (Tanaka et al. 2011, PASJ, 63S, 415). Our AzTEC/ASTE 1.1~mm observation yielded a map covering 170 $arcmin^2$ field with a noise level of 0.6 - 1.0~mJy (1σ), which is one of the largest deep millimeter-wave maps taken in a region centered on a high-redshift radio galaxy.
We detected 35 submm galaxies (SMGs) with the deboosted fluxes ranging from 1.5 to 9.8~mJy. Corresponding FIR luminosities are 10^{12-13} $L_{\odot}$ and the star formation rates (SFRs) of these SMGs are 700 - 3500 $M_{\odot}yr^{-1}$ if the SMGs are indeed lying at high redshift (2<z<7). We compared the spatial distribution and SFRs of SMGs with HAEs detected by Subaru / MOIRCS narrow band survey (7x4 $arcmin^2$ field of view). We found a significant spatial coincidence of 1.1 mm emission with HAEs. Although the AzTEC/ASTE beam size is too large to compare directly, overlapping of HAEs and SMGs implies that at least some of the detected SMGs are associated with HAEs at z=2.5, and they are dust-obscured, growing star-bursting galaxies in the proto-cluster at z=2.5. This view is also supported by the fact that most of HAEs have IRAC band colors which are consistent to those in SMGs at z~2.5. A tentative detection of positive signals in the two point angular cross correlation function between the positions of the HAEs and SMGs is also consistent to the proposed view.
During the course of the interferometric follow up observations of the AzTEC sources in this region, we detect the redshifted CO(5-4) emission line at 1.8 mm (165~GHz) from one of HAEs. This HAE is associated with one of the AzTEC sources and shows SMG like IRAC colors. Therefore, this HAE is also identified as a SMG. The CO(5-4) emission shows a broad line shape (FWHM > 1000 km s^{-1}), implying that this could be a multiple or merging system. The detected CO(5-4) luminosity corresponds to the molecular gas mass of 2.9 10^{10} $M_{\odot}$ if we assume the CO(5-4)/CO(1-0) brightness temperature ratio of 0.3 and a ULIRG-like CO-to-H_2 conversion factor. This results in a star formation efficiency (SFE) ~ L_{IR} / L'_{CO} of 144 $L_{\odot}$ (K km s^{-1} pc^2) $^{-1}$, suggesting that this HAE shows an intermediate SFE between quasars/SMGs (``starburst sequence'') and gas-rich star-forming galaxies (i.e., ``disk-mode sequence'').

Jun Toshikawa (The Graduate University for Advanced Studies)
Title: **A Primitive Clustering Structure Probed by Wide-field Imaging**

We report the discovery of a protocluster at z~6 containing at least eight protocluster members with spectroscopic confirmations in the wide-field image of the Subaru Deep Field. The overdensity of the protocluster is significant at the 6 sigma level, based on the surface number density of i'-dropout galaxies. The overdense region covers ~36 sq. arcmin, and includes 30 i'-dropout galaxies. Follow-up spectroscopy revealed that 15 of these are real z~6 galaxies. Of these 15, eight are clustering in a narrow redshift range (5.98<z<6.03), corresponding to a seven-fold increase in number density over the average in redshift space. We found no significant difference in the observed properties between the eight members and the seven non-members. The velocity dispersion of the eight members is 647 km/s, which is about three times higher than that predicted by the standard cold dark matter model. This discrepancy could be attributed to the distinguishing three-dimensional distribution of the eight members. We discuss two possible explanations for this discrepancy: either the protocluster is already mature, with old galaxies at the center, or it is still immature and composed of three subgroups merging to become a larger cluster. In either case, this concentration of z=6.01 galaxies may be one of the first sites of formation of a galaxy cluster in the universe.

Remco F.J. van der Burg (Leiden Observatory)
Co-authors: Adam Muzzin, Henk Hoekstra, Chris Lidman, Alessandro Rettura, Gillian Wilson, Howard K.C. Yee
Title: **The stellar mass function of 6 rich galaxy clusters at z ~ 1**

We present the stellar mass function of galaxies in 6 rich clusters from the Gemini Cluster Astrophysics Spectroscopic Survey (GCLASS) in the redshift range 0.86 < z < 1.20 and compare our results with field measurements at similar redshifts. We find a significant difference in the shape and normalization of the stellar mass function between the clusters and the field sample. We distinguish between star-forming and quiescent galaxies using the rest-frame U-V versus V-J diagram, and find that the best-fitting Schechter parameters for those separate galaxy types is independent of environment. Therefore, the difference in the shape of the total stellar mass function is a reflection of the increased fraction of quiescent galaxies in high density environments.

Stefano Zarattini (IAC)
Title: **Fossil groups of galaxies: Clues through their luminosity functions.**

Fossil groups (FGs) are extreme structures in the Universe. They are characterized by a large magnitude gap (at least 2 magnitudes in the r-band) between the two brightest galaxies of the system. The Fossil Groups Origins (FOGO) is a large observational program with the aim to carry out a systematic, multiwavelenght study of a sample of 34 FGs selected from the Sloan Digital Sky Survey (Santos et al. 2007). Recently, we have obtained unprecedented deep r-band images of the entire sample using the NOT and INT telescopes (La Palma, Spain) which allow us to reach the faint end of the luminosity function of these systems. Here, we will present the LFs for the whole sample of FGs and their comparison with that of other clusters such as Virgo and Coma.

Felicia Ziparo MPE
Co-Authors: P. Popesso, A. Biviano, A. Finoguenov, D. Wilman, and the PEP team.

Title: **The role of environment in the evolution of the SF activity up to z~1.6**

The observed properties of galaxies have long been known to depend on the environment. The level of star formation (SF) activity in galaxy systems is known to be suppressed relative to the field. According to the well known morphology-density relation (Dressler 1980) and the star formation rate (SFR)-density relation (Gomez 2003), in the local Universe high density regions, like groups and clusters, host mostly early-type galaxies with lower SF level than field galaxies.
In order to better investigate the quenching of galaxies as a function of density and redshift, we follow the evolution of the star formation activity in structures through the different phases of the structure formation. For this purpose, we build a catalogue of X-ray selected groups at $0 < z < 1.6$ in the ECDFS, COSMOS, and GOODS regions for which are available very deep Herschel PACS and Spitzer MIPS observations. We use the deep PACS and MIPS data to get an accurate, estimate of the star formation activity of the group galaxies. In addition we derive an estimate of star formation rate (SFR) and of the galaxy stellar mass (M*) using the SED fitting technique (SFR_SED).
In order to understand differences and similarities of group and field galaxies, we study their location in the SFR-M* plane in four redshift bins up to z~1.6. We use the distribution of the residuals in the SFR-M* plane with respect to the so-called Main Sequence to show that the SFR-density relation is well established already at z~1.
We also investigate the relation between the mean SF activity, mean mass and mean specific SFR in group galaxies with respect to the distance from the group centre and the galaxy velocity within the system. We observe at any redshift a significant mass segregation towards the group centre. However, we see an increase of the level of SF activity towards the group outskirts up to z~1 and a rather constant level at any location within the group at higher redshift. To analyse the same aspect from a different point of view, we finally investigate the evolution of SFR-density relation. We observe a mild anti-correlation up to z~1 and a flattening at higher redshift, z~1.6.