Report from the event supported by RadioNet

TITLE *THE EARLY STAGES OF GALAXY CLUSTER FORMATION:*

MERGERS, PROTOCLUSTERS, AND STAR FORMATION IN OVERDENSE ENVIRONMENTS

DATE: *17-21 JULY 2017*

LOCATION: *GARCHING B. MÜNCHEN, GERMANY*

MEETING WEBPAGE: *https://www.eso.org/sci/meetings/2017/GCF2017.html*

HOST INSTITUTE: *EUROPEAN SOUTHERN OBSERVATORY (ESO)*

RADIONET BENEFICIARY / NO: *ESO / 13*

Report:

1. SCIENTIFIC SUMMARY

The event brought together experts from across the electromagnetic spectrum studying the largest objects to form by the current epoch, galaxy clusters. Many other conferences and workshops have also come together to discuss galaxy clusters over roughly the 2nd half of the history of the Universe. What was unique here is that we also included an equal mix of scientists studying the precursors to galaxy clusters, which are called "proto-clusters", even earlier in the Universe and attempted to define precisely what distinguishes the two. Surprisingly, this may have been the first workshop of its kind, as those purely in the protocluster community have also met frequently in the absence of their lower redshift counterparts.

The evolution of a protocluster into a cluster is a continuous process, and often smaller clusters at high redshift on their way to joining other small clusters to form a massive cluster by the current epoch. As such, the definitions of each will always include a few ambiguous cases, but the interaction of theorists, observers, and instrumentation experts lent itself to a useful discussion. Rather than simply hearing the latest results from one's own field, many (including the conference organizers) felt they had learned something from the conference.

The RadioNet community will continue to play a prominent role in the study of protoclusters and clusters, as these objects are often discovered and characterized using radio, millimeter, and submillimeter facilities and surveys. At high redshift, ALMA and IRAM have been indispensable for studying the coldest and hottest gas in clusters and protoclusters, while at lower redshift, LOFAR and soon SKA have or will discover and characterize many merging systems.

https://www.eso.org/sci/meetings/2017/GCF2017.html

2. AGENDA OF THE EVENT

Monday

13:55 – 14:30 Monique Arnaud (invited): opening address

14:30 – 14:45 Yannick Bahe: The Hydrangea simulations: clusters with resolved galaxies

14:45 – 15:00 Marguerite Pierre: XMM-OWLS insights into cluster assembly at redshift 1 to 2

15:00 – 15:15 Nina Hatch: What distant clusters can reveal about galaxy evolution

15:15 – 15:30 POSTER SESSION

15:30 - 16:00 COFFEE & TEA BREAK

16:00 – 16:35 Gabriella de Lucia (invited): The build-up of galaxy clusters in a hierarchical Universe

16:35 – 16:50 Emanuele Contini: Semi-Analytic Model Predictions of the Galaxy Population in Proto-Clusters

16:50 – 17:05 Eda Gjergo: Simulating Galaxy Clusters with Dust Formation and Evolution

Tuesday

09:10 – 09:45 Nina Hatch (invited): Protocluster assembly: observations and theory

09:45 – 10:00 Audrey Galametz: A large-scale super-structure at z~0.65 in the UKIDSS ultra-deep survery field

10:00 – 10:15 Rafael Guzman: A spectroscopically confirmed rich proto-cluster at z 6.5

10:15 – 10:30 Mari Polletta: Multi-wavelength investigation of Planck high-redshift proto-clusters

10:30 – 10:45 Ryley Hill: Resolving with ALMA the nature of an early star-forming large-scale structure from PLANCK

10:45 – 11:15 COFFEE & TEA BREAK

11:15 – 11:30 Gael Noirot (presented by Audrey Galametz): The Densest Structures at z=1.4–2.8 from the CARLA Survey

11:30 – 11:45 David Clements: Starbursting Protoclusters from Herschel & Planck

11:45 – 12:00 Emmet Golden-Marx: The High-z Clusters Occupied by Bent Radio AGN (COBRA) Survey

12:00 - 12:30 Discussion

13:40 – 14:15 Marcus Bruggen (invited): Merging Clusters as Fundamental Physics Laboratories

14:15 – 14:30 Mariachiara Rossetti: Looking for merging clusters in SZ surveys

14:30 – 14:45 Kaustuv Basu: Shocks and cool cores: An ALMA view of cluster formation from outside and inside

14:45 – 15:00 Remi Adam: Probing the formation of distant clusters using NIKA SZ observations

15:00 – 15:15 Andrea Botteon: Non-thermal phenomena in El Gordo at z = 0.87

15:15 – 15:45 COFFEE & TEA BREAK

15:45 – 16:00 Gabriella DiGennaro: Deep in the (un)known: the Sausage Cluster

16:00 – 16:15 Matt Owers: The Cold Front Cluster Project: Probing the Impact of Hierarchical Growth on Cluster Galaxies

16:15 – 16:30 Michael Gregg: Observing Ram Pressure Stripping and Morphological Transformation in the Coma Cluster

16:30 – 16:45 Anshu Gupta: Survival of the fittest under the influence of ram pressure stripping!

16:45 – 17:00 Pascale Jablonka: SEEDisCS: how clusters form and galaxies transform in the cosmic web

Wednesday

09:10 – 09:45 Dominique Eckert (invited): The formation, evolution and chemical enrichment of the intracluster medium

09:45 – 10:00 Martin Bourne: Simulation of AGN jet feedback in galaxy clusters

10:00 – 10:15 Charutha Krishnan: Enhancement of AGN activity in a protocluster at z = 1.6

10:15 – 10:30 Rebecca Canning: AGN activity in massive cluster at z > 1

10:30 – 10:45 POSTER SESSION

10:45 – 11:15 COFFEE & TEA BREAK

11:15 – 11:30 Daniel Wik: Characterizing the First Galaxy Clusters at the Epoch of their Formation with STAR-X

11:30 – 11:45 Helmut Dannerbauer: Surprising existence of massive and large molecular gas reservoirs in a distant protocluster

11:45 – 12:00 William Forman: Anatomy of a Merger: A Deep Chandra Observation of Abell 115

12:00 - 12:30 Discussion

13:40 – 14:15 Nick Battaglia (invited): Cluster and Protocluster Mass Estimation and Determination of their Dynamical States

14:15 – 14:30 Chris Hayward: How well do submillimeter galaxies trace protoclusters?

14:30 – 14:45 Cristina Garcia Vergara: Protoclusters traced by high-redshift massive galaxies

14:45 – 15:00 Nobunari Kashikawa: High-z protocluster survey by Subaru/HSC

15:00 – 15:15 Hisakazu Uchiyama: Luminous Quasars Do Not Live in the Most Overdense Regions of Galaxies at z~4

15:15 – 15:45 COFFEE & TEA BREAK

15:45 – 16:00 Manuela Magliocchetti: High-redshift star-forming galaxies and proto-clusters: an insight from clustering studies

16:00 – 16:15 David Sobral: Large Hα surveys of field, filaments and (proto-)clusters at z 0.2–2.2: does the environment matter?

16:15 – 16:30 Yusei Koyama: The nature of Hα selected galaxies along the huge cosmic web across cosmic time with Subaru

16:30 – 16:45 Brian Lemaux: A Large Sample of Proto-clusters and Proto-Groups from the VIMOS Ultra-Deep Survey

16:45 – 17:00 Mark Brodwin: Epoch of Merger-Driven Star Formation and AGN in Galaxy Clusters

Thursday

09:10 – 09:45 Adam Muzzin (invited): The Evolution of Proto-Cluster Galaxies

09:45 – 10:00 Miguel Socolovsky: Excess of rapidly-quenched galaxies in distant galaxy clusters

10:00 – 10:15 Alessandra Beifiori: Tracing the evolution of passive galaxies at $1.4 \leq z \leq 1.8$ with KMOS

10:15 – 10:30 Pierluigi Cerulo: Galaxy Transformations in the Most Massive high-redshift Clusters

10:30 – 10:45 Veronica Strazzullo: Quiescent and star-forming galaxy populations in the core of ClJ1449+0856 at z = 2

10:45 – 11:15 COFFEE & TEA BREAK

11:15 – 11:30 Matteo Fossati: Witnessing the onset of environmental quenching at z~2. Results and implications from 3D-HST

11:30 – 11:45 Donald Lee-Brown: The Spectroscopic Ages of Passive Galaxies in a z = 1.62 Protocluster

11:45 – 12:00 Jeffrey Chan: The buildup and structural evolution of the cluster red sequence between redshift 1 to 1.5

12:00 - 12:30 Discussion

14:00 – 14:15 Masao Hayashi: Evolutionary phase of gas-rich galaxies in a galaxy cluster at z=1.46

14:15 – 14:30 Allison Noble: An ALMA Study of Gas-Rich Galaxies in z 1.6 Galaxy Clusters

14:30 – 14:45 Gregory Rudnick: The molecular gas properties of z = 1.62 proto-cluster galaxies

14:45 – 15:00 Rosemary Coogan: The molecular gas content of star-forming galaxies in a z 2 cluster as seen by JVLA and ALMA

15:00 – 15:15 Mehdi Walji: The topology of the Spider's web

15:15 – 15:45 COFFEE & TEA BREAK

15:45 – 16:00 Elizabeth Cooke: A mature galaxy cluster at z = 1.58 around the radio galaxy 7C1753+6311

16:00 – 16:15 MinJu Lee: Insights of environmental effect in high-z galaxy evolution from radio and (sub)mm perspectives

16:15 – 16:30 Mariko Kubo: Bimodal morphologies of massive galaxies at the core of a protocluster at z = 3.09

16:30 – 16:45 Chao-Ling Hung: The role of galaxy mergers and molecular gas in the early phase of galaxy cluster assembly

16:45 – 17:00 Eelco van Kampen: Dust and gas in distant cluster galaxies with ALMA

Friday

09:10 – 09:45 Megan Donahue (invited): Lessons Learned from Multiwavelength Studies of Low Redshift Clusters of Galaxies

09:45 – 10:00 Tadayuki Kodama: Enhanced Lyα depletion in the proto-cluster cores at z = 2.5

10:00 – 10:15 Zheng Cai: MApping the Most Massive Overdensity Through Hydrogen (MAMMOTH)

10:15 – 10:30 Ken Mawatari: Mapping of HI absorption structure in the SSA22 protocluster at z=3.1

10:30 – 10:45 Toma Badescu: Discovery of a Protocluster Associated with a Lyα Blob Pair at z=2.3

10:45 – 11:15 COFFEE & TEA BREAK

11:15 – 11:30 Alessandro Rettura: Mass-Richness relation for X-ray and SZE-selected clusters at z<0.4

3. PARTICIPANTS

We had 8 invited speakers, of which 4 were female and 4 were male. Half of them represented European institutions, and the other half was from North America. None of the invited speakers received RadioNet support.

Attendees came from 5 continents (all but Africa & Antarctica), with the percentages:
54% Europe (Germany, Italy, France, UK, Switzerland, Turkey, Spain, The Netherlands)
23% North America (US, Canada)
15% Asia (Japan, South Korea, India, China)
5% South America (Chile, Brazil)
3% Australia

35% of talk submissions were from women, and 35% of talk allocations were awarded to women. The talk selection was done blindly, so we conclude there was no measurable bias in how we graded talk abstracts.

Concerning young researchers & students, we had ~25% students, ~30% postdoctoral researchers, and 45% tenure-track or tenured faculty of the ~100 participants.

Attendee list is in the Annex I.

4. RADIONET FINANCIAL CONTRIBUTION

We used the support from RadioNet to subsidize the travel of several students and postdocs attending the workshop, in addition to waiving their registration fees using internal ESO funding. This was to maximize participation of junior, underrepresented scientists.

Those we chose for support are: Charutha Krishnan (Indian, working in UK), Vajiheh Sabzali (Iran), Süleyman FiŞek (Turkish), Reju Sam John (Indian), Tai-An Cheng (Chinese, working in UK), Eda Gjergo (Albanian, working in Italy), Alessandro Rettura (Italian, working in the USA)

ANNEX I – Participant's List

Participants

Quick links

- Group picture :-)
- Home
- SOC/LOC
- Invited Speakers
- Programme **PDF** - [Zenodo]
- Abstract booklet
- Poster Papers
- Participants
- Accommodation

Last name	First Name	Home Institution
Alis	Sinan	Istanbul Univeristy
Andreani	Paola	ESO
Arnaud	Monique	CEA
Arrigoni Battaia	Fabrizio	ESO
Babazaki	Yasunori	Nagoya University
Bădescu	Toma	Argelander Institut für Astronomie
Bahe	Yannick	MPA Garching
Basu	Kaustuv	University of Bonn
Battaglia	Nick	
Beifiori	Alessandra	USM/MPE
Botteon	Andrea	IRA-INAF
Bourne	Martin	IoA/KICC, University of Cambridge
Brodwin	Mark	University of Missouri-Kansas City
Brüggen	Marcus	University of Hamburg
Cai	Zheng	UCO/ Lick Observatory
Canning	Rebecca	KIPAC/ Standford University
Cappi	Alberto	INAF - Osservatorio Astronomico di Bologna
Casey	Caitlin	
Castignani	Gianluca	Observatory of Paris, LERMA
Cerulo	Pierluigi	Universidad de Concepcion
Chan	Jeffrey	University of California, Riverside
Cheng	Tai-An	Imperial College London
Clements	David	Imperial College London
Contini	Emanuele	Yonsei University
Coogan	Rosemary	University of Sussex
Cooke	Elizabeth	Durham University
Dannerbauer	Helmut	Instituto de Astrofisica de Canarias
Day	Tiffany	Macquarie University
De Breuck	Carlos	ESO
De Grandi	Sabrina	INAF-Brera
De Lucia	Gabriella	INAF
Di Gennaro	Gabriella	Harvard-Smithsonian Center for Astrophysics
Di Mascolo	Luca	Max Planck Institute for Astrophysics

Donahue	Megan	MSU
Eckert	Dominique	University of Geneva
Fisek	Suleyman	Istanbul University
Forman	William	CfA
Fossati	Matteo	MPE Garching
Galametz	Audrey	MPE
Garcia Vergara	Cristina	Leiden Observatory
Gian Luigi	Granato	INAF-OATS
Girardi	Marisa	University of Trieste
Gjergo	Eda	Universita' di Trieste, Dipartimento di Fisica
Golden-Marx	Emmet	Boston University
Gregg	Michael	University of California, Davis
Gupta	Anshu	Australian National University
Gupta	Suhani	Indian Institute of Science Education and Research
Guzman	Rafael	University of Florida
Hatch	Nina	University of Nottingham
Hayashi	Masao	National Astronomical Observatory of Japan
Hayward	Chris	Flatiron Institute
Hill	Ryley	University of British Columbia
Hung	Chao-Ling	The Universitz of Texas at Austin
Jablonka	Pascale	EPFL
John	Reju Sam	Pondicherry engineering college, Pondicherry University
Kang	Xi	Purple Mountain Observatory
Kaothekar	Sachin	Mahakal Institite of Technology, Ujjain
Kashikawa	Nobunari	NAOJ
Kodama	Tadayuki	Astronomical Insitute, Tohoku University
Koyama	Yusei	Subaru Telescope
Krishnan	Charutha	University of Nottingham
Kubo	Mariko	NAOj
Lee	Minju	The University of Tokyo
Lee-Brown	Donald	University of Kansas
Lemaux	Brian	University of California, Davis
Luo	Yu	Purple Mountain Observatory
Magliocchetti	Manuela	IAPS-INAF
Manilla-Robles	Ariadna	ESO
Manrique	Alberto	ICCUB. Universitat de Barcelona
Maurogordato	Sophie	Nice
Mawatari	Ken	Osaka Sangyo University
Menéndez-Delmestre	Karin	Valongo Observatory, Federal University of Rio de Janeiro
Mitsuishi	Ikuyuki	Nagoya University
Molendi	Silvano	INAF/IASF-Milano
Mroczkowski	Tony	ESO
Muzzin	Adam	York University
Nantais	Julie	Universidad Andres Bello
Noble	Allison	MIT
Owers	Matt	Macquarie University and Australian Astronomical Observatory
Pierre	Marguerite	IRFU CEA
Polletta	Mari	IRAP
Ragone-Figueroa	Cinthia	IATE-Argentina INAF-Trieste
Rémi	Adam	Laboratoire Lagrange (OCA)
Rettura	Alessandro	Caltech/IPAC
Rosetti	Marichiara	IASF-Milano INAF
Rudnick	Gregory	University of Kansas, Department of Physics and Astronomy
Salvador-Solé	Eduard	ICCUB. Universitat de Barcelona
Schellenberger	Gerrit	Smithsonian Astrophysical Observatory
Sobral	David	Lancaster University
Socolovsky	Miguel	University of Nottingham
Strazzullo	Veronica	LMU
Stroe	Andra	ESO
Sunyaev	Rashid	Max-Planck Institut fuer Astrophysik
Tamura	Takayuki	ISAS, JAXA
Terni de Gregory	Beatrice	IRA-INAF Bologna

Uchiyama	Hisakazu	Sokendai/ NAOJ
van Kampen	Eelco	ESO
Walji	Mehdi	School of Physics SCHOOL OF PHYSICS AND ASTRONOMY, UNIVERSITY OF NOTTINGHAM
Warmels	Rein	ESO
West	Michael	Lowell Observatory
Wik	Daniel	NASA GSFC
Yelkenci	Fuat Korhan	Istanbul University
Zhang	Fenghui	YNAO