

## Virginia Cuciti



### Title

Clash of giants: radio emission from merging galaxy clusters

### Abstract

Merging between galaxy clusters are the most energetic events in the Universe. Part of the energy released during these events is channeled into shocks and turbulence that accelerate particles in the Intra Cluster Medium (ICM) and produce diffuse cluster-scale radio emission. These sources have been studied for decades using observations at GHz-frequency, however, under many aspects, their origin remains unclear. Given the steepness of the spectrum of these sources, low frequency observations were the crucial, albeit missing, piece of the puzzle to understand these non-thermal phenomena. In this respect, the Low Frequency Array (LOFAR), recently opened a new frequency window (10-240 MHz) in the radio sky, which is the most promising window in this field. On one hand, this is leading to the discovery of new types of diffuse sources and physical interactions in the ICM, such as gently re-energised tails and even beyond the cluster-scale, such as bridges connecting pairs of galaxy clusters. On the other hand, thanks to the superior survey speed and sensitivity of LOFAR, we now have the possibility to analyse large samples of galaxy clusters, even in mass and redshift ranges that were previously inaccessible. In this talk, I will review some of the most important results that have been achieved in the past few years with LOFAR observations of galaxy clusters and I will discuss the ongoing and future work on the largest samples of clusters observed at low frequency.

# CURRICULUM VITAE

*Virginia Cuciti*

## PERSONAL INFORMATION

**Current Position:** Alexander von Humboldt fellow at the Hamburger Sternwarte, Hamburg, Germany

**Work Address:** Hamburger Sternwarte, Gojenbergsweg 112, 21029 Hamburg, Germany

**e-mail:** vcuciti@hs.uni-hamburg.de, virginiacuciti@gmail.com

**Birth date and place:** September 20, 1989 Montevarchi (AR), Italy

## RESEARCH INTERESTS

- Non thermal diffuse emission in galaxy clusters
- Physics of the Intra Cluster Medium
- Physics of radio galaxies
- Radioastronomy

## WORK EXPERIENCE

- **Apr 2020 – Present** Alexander von Humboldt fellow, Hamburger Sternwarte, Hamburg University, Hamburg, Germany  
Topic: A unified model for diffuse emission in galaxy clusters  
Main collaborators: Prof. M. Brüggen, Jr. Prof. F. de Gasperin
- **Nov 2018 – Mar 2020** Research associate, Hamburger Sternwarte, Hamburg University, Hamburg, Germany  
Topic: Galaxy clusters at Ultra-Low radio frequency  
Main collaborators: Jr. Prof. F. de Gasperin, Prof. M. Brüggen
- **Jan 2018 – Oct 2018** Post-doc researcher, Dipartimento di Fisica e Astronomia, Alma Mater Studiorum Bologna, Italy  
Topic: Statistical studies of radio halos in galaxy clusters  
Main collaborators: Dr. G. Brunetti, Prof. D. Dallacasa
- **2014** (April-June) Visitor at the University of Maryland, College Park, Maryland, USA.  
Topic: Searching for non-thermal diffuse radio emission in galaxy clusters with the GMRT  
Advisors: Dr. S. Giacintucci, Dr. M. Markevitch

## EDUCATION

- **2018** PhD title in Astrophysics at the University of Bologna.  
Thesis title: *Cluster-scale radio emission: analysis of a mass-selected sample of galaxy clusters*  
Advisors: Dr. G. Brunetti, Prof. D. Dallacasa
- **2016** (May-July) Visitor at the Harvard Smithsonian Center for Astrophysics, Cambridge, MA, USA with the Marco Polo grant from the University of Bologna  
Title of the project: *JVLA observations of diffuse radio emission in galaxy clusters*  
Advisor: R. van Weeren
- **2014** Master's degree in Astrophysics and Cosmology, University of Bologna, Italy  
Final grade: 110/110 *cum laude*  
Thesis title: *Radio Halos in a mass-selected sample of Galaxy Clusters*  
Advisors: Prof. L. Gregorini, Dr. R. Cassano, Dr. R. Kale

- **2011:** Bachelor Degree in Astronomy, University of Bologna, Italy  
Final grade: 108/110  
Thesis title: *The Milky Way structure and kinematic*  
Advisors: Prof. D. Dallacasa

## PUBLICATIONS

1. *Radio halos in a mass-selected sample of 75 galaxy clusters. I. Sample selection and data analysis*, CUCITI, V. et al., 2020, A&A, accepted
2. *Radio halos in a mass-selected sample of 75 galaxy clusters. II. Statistical analysis*, CUCITI, V. et al., 2020, A&A, under review
3. *New giant radio sources and underluminous radio halos in two galaxy clusters*, CUCITI, V. et al., 2018, A&A, 609, 61
4. *Occurrence of radio halos in galaxy clusters - Insight from a mass-selected sample*, CUCITI, V., et al., 2015, A&A, 580, 97
5. *Fast magnetic field amplification in distant galaxy clusters*, di Gennaro, G. et al., 2020 NatAs.tmp, 226D
6. *LOFAR observations of galaxy clusters in HETDEX*, van Weeren, R. et al., 2020, 2020 arXiv201102387V
7. *LOFAR Detection of a Low-Power Radio Halo in the Galaxy Cluster Abell 990*, Hoang, D. et al., 2020, MNRAS.tmp, 3373H
8. *The great Kite in the sky: A LOFAR observation of the radio source in Abell 2626*, Ignesti A., et al., 2020, A&A, 643A, 172I
9. *Reaching thermal noise at ultra-low radio frequencies. Toothbrush radio relic downstream of the shock front*, de Gasperin, F., et al., 2020 A&A, 642A, 85D
10. *A giant radio bridge connecting two galaxy clusters in Abell 1758*, Botteon, A., et al., 2020 MNRAS, 499L, 11B
11. *The Beautiful Mess in Abell 2255*, Botteon, A., et al., 2020, ApJ, 897, 93B
12. *LOFAR observations of X-ray cavity systems*, Birzan, L., et al., 2020, MNRAS, 496, 2613B
13. *Cassiopeia A, Cygnus A, Taurus A, and Virgo A at ultra-low radio frequencies*, de Gasperin, F., et al., 2020, A&A, 635A, 150D
14. *Particle acceleration in a nearby galaxy cluster pair: the role of cluster dynamics*, Botteon, A., et al., 2019, A&A, 630A, 77B
15. *LOFAR Discovery of a Radio Halo in the High-redshift Galaxy Cluster PSZ2 G099.86+58.45*, Cassano, R., et al., 2019, ApJ, 881L, 18C
16. *Expanding the Sample of Radio Minihalos in Galaxy Clusters*, Giacintucci, S., et al., 2019, ApJ, 880, 70G
17. *A LOFAR study of non-merging massive galaxy clusters*, Savini, F. et al., 2019, A&A, 622, 24
18. *Evolutionary phases of merging clusters as seen by LOFAR*, Wilber, A. et al., 2018, A&A, 622, 25
19. *First evidence of diffuse ultra-steep-spectrum radio emission surrounding the cool core of a cluster*, Savini, F. et al., 2018, MNRAS, 478, 2234
20. *On the absence of radio halos in clusters with double relics*, Bonafede, A. et al., 2017, 470, 3465
21. *KAT-7 observations of an unbiased sample of mass-selected galaxy clusters*, Bernardi, G. et al., 2016, MNRAS, 456, 1259 B
22. *The Extended GMRT Radio Halo Survey II. Further results and analysis of the full sample*, Kale, R. et al., 2015, A&A, 579, 92

23. *Radio halos in galaxy clusters: insight from a mass-selected sample*, CUCITI, V., Proceedings of “The many facets of extragalactic radio surveys: towards new scientific challenge” (EXTRA-RADSUR2015)
24. *Radio halos in a mass-selected sample of Galaxy clusters*, CUCITI, V., et al., 2014, ASI Conference Series, 13, 215C

## TALKS & SEMINARS

I presented the results of my research at more than 20 international conferences. I have been invited to give seminars and colloquia in more than 5 Institutes, including the NASA’s Goddard Space and Flight Centre (Maryland, USA), the Centre for Astrophysics (Massachusetts, USA) and the Hamburger Sternwarte (Hamburg, Germany).

## OBSERVATIONAL PROPOSALS

I am PI and co-I of several observational proposals at many of the principal radio interferometers in the world: LOFAR, MeerKAT, GMRT and JVLA. I obtained a total of  $\sim 250$  hours at the LOFAR, GMRT and JVLA as PI.

## AWARDED GRANTS

- **2020** Alexander von Humboldt Fellowship. I obtained a two years fellowship to work at the Hamburger Sternwarte, Hamburg.

Title of the project: “A unified model for diffuse emission in galaxy clusters”

- **2016** Marco Polo grant from the University of Bologna. I obtained a total of €3135 for a three months visit at the Harvard Smithsonian Center for Astrophysics in Cambridge (MA).

Title of the project: “JVLA observations of diffuse radio emission in galaxy clusters”

Advisor: Dr. Reinout van Weeren.

## TEACHING AND SUPERVISING

I am currently supervising the PhD candidate Alex Jones at the Hamburger Sternwarte in Hamburg. PhD project: Galaxy clusters at low and ultra-low radio frequencies.

**2019** Radioastronomy laboratory class at the Physics department of the University of Hamburg.

**2019** Introduction to astronomy exercise class at the Physics department of the University of Hamburg.

## WORKING GROUPS AND COLLABORATIONS

I am a member of the LOFAR Survey Key Science Project (SKSP) Collaboration and I am leading a project aimed at performing the first statistical analysis of the diffuse emission in clusters at low radio frequency.

I am a member of the D-MeerKAT consortium. Specifically, I am part of the “MeerKAT imaging and signal processing” working group.

Hamburg, 17 December 2020

Virginia Cuciti