Marco Balboni | Curriculum Vitae

Personal Data

Place and Date of Birth:	Faenza, Italy | 22 October 1997
Address:	Via Piero Gobetti 93/2, 40129, Bologna, Italy
ORCID:	0009-0001-3048-0020
email:	marco.balboni@inaf.it (marco.balboni.work@gmail.com)
Mother tongue:	Italian

Current position

11/2025–11/2027 Post-doc researcher (CdR)
University of Bologna
Supervisor: Prof. A. Bonafede

11/2024–10/2025 Post-doc researcher (AdR)
University of Bologna
Supervisor: Prof. A. Bonafede

Education

19/03/2025 PhD in Physics and Astrophysics
University of Insubria
Thesis: *A systematic study of thermal and non-thermal properties in galaxy clusters*
Supervisors: Dr. F. Gastaldello & Prof. A. Bonafede

11/2021–11/2024 PhD student in Astrophysics

29/10/2021 Master in Astrophysics and Cosmology
University of Bologna UNIBO
Thesis: *Constraints on magnetic fields and particle acceleration in the inter-cluster bridge A399-A401*
Grade: 110/110 cum laude
Supervisors: Prof. A. Bonafede, Dr. G. Bernardi

09/2019–10/2021 Master studies in Astrophysics and Cosmology

18/07/2019 Bachelor diploma in Astronomy
University of Bologna UNIBO
Thesis: *Equation of state in astrophysics*
Grade: 110/110 cum laude
Supervisor: D. Dallacasa

09/2016–07/2019 Studies of Astronomy at University of Bologna

30/06/2016 High School Diploma
Istituto di istruzione superiore "ARRIGO SERPIERI" - Bologna
Grade: 93/100

09/2011–06/2016 High School studies at IIS A. Serpieri

Publications

- *CHEX-MATE: New detections and properties of the radio diffuse emission in massive clusters with MeerKAT*
  Balboni, M. et al. 2026, in press.

- *CHEX-MATE: Scaling relations of radio halo profiles for clusters in the LoTSS DR2 area*
  Balboni, M. et al. 2025, A&A, V.695, id.A180

- *CHEX-MATE: A LOFAR pilot X-ray - radio study on five radio halo clusters*,
  Balboni, M. et al. 2024, A&A, V.686, id.A5

- *Constraints on magnetic fields in the inter-cluster bridge A399–A401*,
  Balboni, M. et al. 2023, A&A, V.679, id.A107,

- *Combined LOFAR-uGMRT analysis of the diffuse radio emission in the massive clusters Abell 773 and Abell 1351*
  Srikanth, K. S. L., Botteon, A., Cassano, R., Brunetti, G., Bonafede, A., Bruno, L., **Balboni M.** et al. accepted

- *In medio stat virtus: enrichment history in poor galaxy clusters*
  Riva G., Ghizzardi S., Molendi S., **Balboni M.** et al. 2025

- *Resurging from the ashes: A spectral study of seven candidate revived radio fossils in nearby low-mass galaxy clusters*
  Bruno L., Botteon A., Dallacasa D., Venturi T., **Balboni, M.** et al. 2025

- *MeerKAT L -band observations of the Ophiuchus cluster. Detection of synchrotron threads and jellyfish galaxies*
  Botteon, A., **Balboni, M.** et al. 2025

- *Deep Chandra observations of PLCKG287.0+32.9: a clear detection of a shock front in a heated former cool core*
  Gitti, M., Bonafede, A., Brighenti, F., Ubertosi, F., **Balboni, M.** et al. 2025

- *Understanding entropy in massive halos: The role of baryon decoupling*
  Molendi, S., **Balboni, M.** et al. 2025

- *Spherical bias in the 3D reconstruction of the ICM density profile in galaxy clusters*
  Veronesi, I., Bartalucci, I., Rasia, E., Molendi, S., **Balboni, M.** et al. 2025

- *CHEX-MATE: The intracluster medium entropy distribution in the gravity-dominated regime*
  Riva, G., Pratt, G. W., Rossetti, M., Bartalucci, I., Kay, S. T., Rasia, E., Gavazzi, R., Umetsu, K., Arnaud, M., **Balboni, M.**, et al. 2024

- *Mind the gap between A2061 and A2067: Unveiling new diffuse, large-scale radio emission*,
  G. V. Pignataro, A. Bonafede, G. Bernardi, **M. Balboni** et al. 2024

- *PSZ2 G282.28+49.94, a recently discovered analogue of the famous Bullet Cluster*,
  I. Bartalucci, I., Rossetti, R., Boschin, W., M. Girardi, M. Nonino, **Balboni, M.** et al. 2024

- *CHEX-MATE : turbulence in the ICM from X-ray surface brightness fluctuations*,
  Dupourqué, S., Clerc, N. , Pointecouteau, E., Eckert, D. , Gaspari, M., Lovisari, L. , Pratt, G. W. , Rasia, Elena , Rossetti, M. , Vazza, F., **Balboni, M.** et al. 2024

- *A 'MeerKAT-meets-LOFAR' study of the complex multi-component (mini-)halo in the*

extreme sloshing cluster Abell 2142,
Riseley, C. J. , Bonafede, A. , Bruno, L. , Botteon, A. , Rossetti, M. , Biava, N. , Bonnassieux, E. , Loi, F. , Vernstrom, T., **Balboni, M.** 2024

- *CHEX-MATE: Robust reconstruction of temperature profiles in galaxy clusters with XMM-Newton*,
Rossetti, M., Eckert, D., Gastaldello, F. , Rasia, E. , Pratt, G. W. , Ettori, S. , Molendi, S. , Arnaud, M., **Balboni, M.** et al. 2024

- *Metal enrichment: The apex accretor perspective*
Molendi, S. , Ghizzardi, S. , De Grandi, S., **Balboni, M.** et al.

- *A radio bubble shredded by gas sloshing?*,
Botteon, A., Gastaldello, F., ZuHone, J. A., **Balboni, M.** et al. 2024

- *CHEX-MATE: Constraining the origin of the scatter in galaxy cluster radial X-ray surface brightness profiles*,
I. Bartalucci, S. Molendi, E. Rasia, ..., **Balboni, M.** et al. 2023

Collaborations and Working groups

03/2025–now	Member of the **Evolutionary Map of the Universe (EMU) project**
12/2021–now	Member of the **LOFAR surveys key science project**
	Galaxy clusters working group
12/2021–now	Member of the **CHEX-MATE collaboration**
	Key project 6 - Thermal–non-thermal connection

Collaborations with research institutes:

11/2021–now	INAF – Istituto di Astrofisica Spaziale e Fisica Cosmica (IASF)
	Milan, Italy
11/2021–now	INAF – Istituto di Radioastronomia (IRA)
	Bologna, Italy
11/2021–now	INAF – Osservatorio di Astrofisica e Scienza dello Spazio (OAS)
	Bologna, Italy
09/2023–now	Leiden Observatory, Leiden University
	Leiden, The Netherlands

Talks at international conferences and meetings

November 2025	Talk on "New scaling relations for the galaxy cluster diffuse radio emission"
	Fifth National Workshop on the SKA (Bologna, Italy)
November 2025	Talk on "New scaling relations for the galaxy cluster diffuse radio emission"
	SPARCS XIII: Return of the Data (Cairns, Australia)
September 2025	Talk on "New Scaling Relations of Galaxy Cluster Radio Halos"
	LOFAR Family Meeting 2025 (Paris, France)
September 2025	poster on "Searching for new scaling relations of the cluster non-thermal component"

	Magnetic Fields and Cosmic Rays across Diverse Scales: What's Next? (Center for Astrophysics, USA)
July 2025	poster on "Searching for scaling relations of the cluster non-thermal component" *Tracing Cosmic Evolution with Galaxy Clusters V* (Sesto, Italy)
March 2025	Talk on "Non-thermal properties of the CHEX-MATE sample" *CHEX-MATE workshop* (online)
December 2024	Invited talk on "Scaling relations of radio halo profiles" *LOFAR Cluster Working Group workshop* (Leiden, The Netherlands)
September 2024	Talk on "Radio-X study of CHEX-MATE radio halo clusters" *Cluster4 conference* (Trieste, Italy)
July 2024	Talk on "Radio-X study of CHEX-MATE radio halo clusters" *European Astronomical Society (EAS) Meeting 2024* (Padova, Italy)
July 2024	e-poster on "Constraints on the magnetic field in the intercluster bridge A399–A401" *European Astronomical Society (EAS) Meeting 2024* (Padova, Italy)
June 2024	Talk on "LOFAR-CHEXMATE study of radio halo clusters" *LOFAR Family meeting 2024* (Leiden, The Netherlands)
May 2024	Talk on "Thermal – non-thermal study of CHEX-MATE clusters" *ISSI meeting* (online and in presence, Bern, Switzerland)
May 2024	Talk on "Radio-X study of CHEX-MATE radio halo clusters" *SPARCS XII: Pushing Towards the Final Frontier* (Bologna, Italy)
February 2024	Talk on "Thermal – non-thermal study of ICM properties" *CHEX-MATE workshop* (online)
November 2023	Talk on "Thermal – non-thermal study of ICM properties" *ISSI meeting* (online and in presence, Bern, Switzerland)
June 2023	Talk on "Radio-X study of CHEX-MATE radio halo clusters" *The X-ray Universe* (Athens, Greece)
November 2022	*SPARCS XI:"Rise of the Sky Surveys"* (online)
November 2022	Talk on "Radio-X-ray correlations of a sample of 5 clusters with CHEX-MATE/LOFAR data and future outlook" *CHEX-MATE workshop* (online)
October 2022	Talk on "Radio-X study of CHEX-MATE-LOFAR radio halo clusters" *LOFAR Early Career Researcher conference* (Leiden, The Netherlands)
September 2022	Talk on "Radio-X study of CHEX-MATE radio halo clusters" *Cluster3 conference* (Bologna, Italy)
May 2022	Invited talk on "Magnetic field constraints in the A399-A401 cluster pair" *LOFAR Magnetism Key Science Project Mini-workshop* (online)

Professional formation

14/07/2025 - 18/07/2025	MeerKAT polarisation workshop (Bologna, Italy)
12/02/2024 - 14/02/2024	XRISM Science performance and data analysis workshop (Geneva, Switzerland)
19/06/2023 - 23/06/2023	Summer School of Astrostatistics in Crete (Heraklion, Greece)
3/04/2022 - 7/04/2023	Frontend research at low radio frequency Radio astronomy: Science and technical challenges (online)
May - June 2022	Insubria PhD Course on *Physics of deep learning: concepts, tools and theoretical framework* (Como, Italy)
7/02/2022 - 11/02/2022	DAWN Winter School for MSc and PhD students (online)
22/03/2021 - 26/03/2021	6th LOFAR Data School (online)

Study abroad program

15/09/2023 - 4/12/2023	Visiting period to Leiden University Supervisor: Prof R. van Weeren
6/08/2019 - 30/08/2019	English language school Hansa Language Centre, Toronto (CAN)

Competitive telescope time allocation

- **as PI** - MeerKAT, Cycle 6:
  "MeerKAT UHF follow-up of the most massive CHEX-MATE clusters" (97hr)
- **as PI** - MeerKAT, Cycle 5:
  "MeerKAT observations of the most massive CHEX-MATE clusters" (93hr)
- **as PI** - MeerKAT, Cycle 4:
  "MeerKAT observations of the most massive CHEX-MATE clusters" (45hr)
- **as PI** - MeerKAT, Cycle 3:
  "MeerKAT observations of the most massive CHEX-MATE clusters" (39hr)
- **as PI** - MeerKAT, Cycle 3:
  "High frequency study of a candidate Ultra-Steep radio halo" (12hr)
- **as PI** - uGMRT, Cycle 43:
  "Study of radio-halo spectral properties and X-ray correlations in CHEX-MATE clusters" (6hr)
- as co-I - XMM-Newton Large Program, AO25 (1070ks, C priority):
  "A Well-Defined Sample of Galaxy Groups: Tracing Gas Content Scatter" (99ks)
- as co-I - MeerKAT (Cycle 6):
  "Abell 2390: constraining the true nature of megahalos with high sensitivity observations" (8.8hr)
- as co-I - MeerKAT Extra-Large Proposal (Cycle 5):
  "Tracing magnetic field amplification during the process of structure formation" (128.5hr)
- as co-I - uGMRT, Cycle 47:
  "Revived fossil plasma in galaxy clusters: a uGMRT-LOFAR spectral study" (27hr)
- as co-I - XMM-Newton, AO23:
  "The merging dynamic of the new Planck bullet cluster PSZ2 G282.28+49.94" (99ks)

- as co-I - XRISM, AO1:
  "An atlas of motion in A2142 at high spectral resolution with XRISM" (100ks)
- as co-I - uGMRT, Cycle 45:
  "Re-energising fossil plasma in galaxy clusters" (35hr)
- as co-I - MeerKAT, Cycle 4:
  "The first systematic study of magnetic field in galaxy clusters using a uniform radio and X-ray sample: a pilot study" (31hr)
- as co-I - LOFAR, Cycle 20:
  "Radio Megahalos in galaxy clusters" (105.3hr)
- as co-I - uGMRT, Cycle 42:
  "A candidate relic in PSZ2G282.28+49.94, the Planck bullet" (18hr)
- as co-I - XMM-Newton, AO22:
  "In medio stat virtus: iron abundance in intermediate mass galaxy clusters" (212 ks)

Scholarships and Awards

December 2021	Merit-based scholarship for one of the best thesis project at UNIBO Physics Department (DIFA) in the academic years 2019-2021
May 2018	Merit-based scholarship for worth students University of Bologna UNIBO

Languages

Italian	Native
English	Advanced (C1 Level, IELTS certificate 2025)

Data Reduction and Computing Skills

Programming languages:	Python, Fortran90, Bash, R, IDL (basic)
OS Platforms:	Linux, Windows
X-ray data:	XMM-Newton, Chandra
Radio data:	MeerKAT, LOFAR, uGMRT, VLA

Peer Review

- Publications of the Astronomical Society of Australia (PASA)
- Journal of Cosmology and Astroparticle Physics (JCAP)

Thesis Supervising

F. Campolucci	"Magnetic fields properties in the galaxy clusters PSZ2G243.15-73.84" Master thesis, University of Bologna, 2025, co-supervisor
B. De Stefanis	"Multiwavelength analysis of the CHEX-MATE cluster MACSJ0600.1-2008" Master thesis, University of Milano Statale, 2025/26, co-supervisor

Research activity

My past and current research activity regards the study of galaxy clusters' environment, through radio and X-ray observations with the aim of providing a complete picture of their properties. My main focus is the complex interplay between thermal and non-thermal baryonic diffuse components, but I am also working on the cluster plasma physics.
Specifically, I exploit X-ray and radio observations as they provide complementary information on the Intra-Cluster Medium (ICM). The former, on the ICM thermal emission and its thermodynamic quantities (density, temperature, pressure and entropy), and the latter, on non-thermal, cosmic ray electrons (GeV energies) and μG magnetic fields on Mpc-scales. With such a multiwavelength coverage, it is possible to obtain a comprehensive view of the clusters' history and the ongoing physical processes.
In my research I mainly make use of the CHEX-MATE sample (CHEX-MATE Collaboration 2021), which provides a well selected sample of objects with a high-quality X-ray (XMM-Newton) and radio (LOFAR, MeerKAT) data coverage. My research focuses on the study of the relations between thermal and non-thermal cluster components (e.g. throughout the whole cluster extension, in correspondence of discontinuities, etc...) and use them to infer cluster properties, e.g. origin of diffuse radio emissions, the ICM magnetic field strengths.
Currently I am working on integrating spatially resolved radio and X-ray analyses with polarisation data. In particular, I am using L-band observations made with the MeerKAT radio telescope to derive the magnetised properties of the ICM. This is done by combining Faraday Rotation Measure analyses of compact polarised sources, with the resulting gas density profiles derived from X-ray observations. One of the mail goals of this analysis is to constraint the large scale magnetic fields at different epochs, in order to determine its origin and amplification mechanism over the Universe evolutionary history.

Other activities

- Since 2022 - Collaboration to the Open day for students at IASF-Milan
- June 2023 - Outreach activity at "Giovanni Falcone" elementary shcool, Funo di Argelato, Bologna