Revealing the nature of new low-frequency radio source populations

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List of publications

First Author

Ultra-steep spectrum emission in the merging galaxy cluster Abell 1914
S. Mandal, H. T. Intema, T. W. Shimwell, R. J. van Weeren, A. Botteon, H. J. A. Röttgering, D. N. Hoang, G. Brunetti, F. de Gasperin, S. Giacintucci, H. Hoekstra, A. Stroe, M. Brüggen, R. Cassano, A. Shulevski, A. Drabent, D. Rafferty, A&A 622, A22 (2019).

Revived fossil plasma sources in galaxy clusters
S. Mandal, H. T. Intema, R. J. van Weeren, T. W. Shimwell, A. Botteon, G. Brunetti, F. de Gasperin, M. Brüggen, G. Di Gennaro, R. Kraft, H. J. A. Röttgering, M. Hardcastle, C.Tasse. A&A 634, A11 (2020).

Towards a sample of revived fossil plasma sources in Galaxy Clusters
S. Mandal, R. J. van Weeren, T. W. Shimwell, H. T. Intema, A. Botteon, F. de Gasperin, G. Di Gennaro, M. Grespan, G. Brunetti, M. Brüggen, M. Brienza, F. Gastaldello, M. J. Hardcastle, H. Röttgering, R. Kraft, R. Cassano, A. Drabent, M. Hoeft, D. Jung, L. K. Morabito, A. Shulevski, W. L. Williams, submitted to A&A.

Extremely deep 150 MHz Source Counts from the LoTSS Deep Fields
S. Mandal, I. Prandoni, M. J. Hardcastle, T. W. Shimwell, H. T. Intema, C. Tasse, R. J. van Weeren, H. Algera, K. L. Emig, H. J. A. Röttgering, D. J. Schwarz, T. M. Siewert, P. N. Best, M. Bonato, M. Bondi, M. J. Jarvis,

R. Kondapally, S. K. Leslie, V. H. Mahatma, J. Sabater, E. Retana-Montenegro, W. L. Williams, submitted to A&A.

Contributing Author

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G. Di Gennaro, R. J. van Weeren, G. Brunetti, R. Cassano, M. Brüggen, M. Hoeft, T. W. Shimwell, H. J. A. Röttgering, A. Bonafede, A. Botteon, V. Cuciti, D. Dallacasa, F. de Gasperin, P. Domínguez-Fernández, T. A. Ensslin, F. Gastaldello, **S. Mandal**, M. Rossetti & A. Simionescu, Nature Astronomy (2020)

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The Lockman Hole project: LOFAR observations and spectral index properties of low-frequency radio sources
E. K. Mahony, R. Morganti, I. Prandoni, I. M. van Bemmel, T. W. Shimwell, M. Brienza, P. N. Best, M. Brüggen, G. Calistro Rivera, F. de Gasperin, M. J. Hardcastle, J. J. Harwood, G. Heald, M. J. Jarvis, **S. Mandal**, G. K. Miley, E. Retana-Montenegro, H. J. A. Röttgering, J. Sabater, C. Tasse, S. van Velzen, R. J. van Weeren, W. L. Williams, G. J. White

Curriculum Vitae

I was born on the 17th of September 1992 in Purulia, a small town in the state of West Bengal, in India. Even though my family is full of medical doctors, I never had the interest to pursue that career path. I remember myself being very outdoorsy and passionate about adventures. I can trace back the first stimulation of my first interest in 'Astro' related things to the historic event of the Columbia Space Shuttle in 2003. I was really excited about the fact that the first woman from Indian origin, Kalpana Chawla was on board. The Columbia journey had ended with sad memories, however, it had given birth to a dream inside me to know more about space and celestial bodies.

During the early years of my school life, I started developing interest in scientific subjects, especially in Maths and Physics. I also started taking participation in national level competitive examinations. During the last year of my high school in 2010, I qualified in the Indian Institute of Technology Joint Entrance Examination (IIT-JEE) and chose to pursue an integrated masters degree in Physics from one of the premier institutes in India: the Indian Institute of Technology, Kharagpur. During my 1st year of my undergraduate studies, I was selected to represent my institute in an academic camp called 'Vijyoshi', that was organised by the Indian Institute of Science, Bangalore. In that camp, renowned scientists presented lectures on Astronomy and Astrophysics and that triggered my childhood interests to know about the universe. From that time onwards, I was determined to pursue my study in Astronomy and Astrophysics. Our department did not offer many astronomy related courses. But, I started to work with Prof. Somnath Bharadwaj, a faculty at IIT Kharag-

pur, on short term projects and gradually started developing interest in radio astronomy. Following this, I gathered several research experiences in the field of radio astronomy. I worked as a summer student at NCRA-TIFR under the supervision of Prof. Jayaram Chengalur where I was involved with the process of upgrading the Ooty Radio Telescope (ORT). Later, in 2014, I was selected for a summer internship at the Leiden Observatory, under the supervision of Dr. Timothy Shimwell to work on Westerbork Synthesis Radio Telescope (WSRT) observatins of proto-clusters. During my masters' thesis, I worked on theoretical modelling of magneto-convection under the supervision of Prof. Krishna Kumar. I graduated with a masters degree in Physics in the August of 2015.

In September 2015, I started a position as a PhD candidate at the Leiden Observatory under the supervision of Dr. Huib Intema and Prof. dr. Huub Röttgering. During the first year of my PhD, I was involved in the development of LOFAR calibration pipelines and collaborated with a lot of scientists at the Netherlands Institute for Radio Astronomy (ASTRON). This experience allowed me to appreciate the huge amount of technological advancements that have been made in this field and to familiarize with big data problems. In the later years, I started to work on diffuse radio emission in galaxy clusters. During my PhD, I mostly focused to study revived fossil plasma sources in galaxy clusters and used LOFAR data to derive the deepest radio source counts at 150 MHz, ever obtained. These two aspects of the thesis, blend the technical side of radio astronomy with the scientific prospects of the field. I was fortunate enough to travel around the world and present my scientific results in international conferences (India, USA, China, Italy, Germany, France) and visit collaborators (USA, Italy) to work with. It has been a great learning experience to communicate with such a large and diverse audience in so many countries. In Leiden, I have been a teaching assistant for the bachelor course "Astronomical Observing Techniques" and the masters course "Radio Astronomy". I also have been a co-supervisor for one of the summer students during LEAPS 2018. I also worked as one of the editors for the Annual Report of the Leiden Observatory in 2017. In addition, for 3 years (until 2019) I was a member of the social committee and helped in the organisation of annual events at the Observatory such as Sinterklaas, Christmas lunch and the summer barbecue.

Working at the Leiden Observatory has truly been an enriching experience, both professionally and personally. In future, I wish to use my experience and continue to do research in the field of space science and technology.

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My PhD journey in Leiden has been a wonderful experience. I was very fortunate to have such a friendly, welcoming and international environment at the Leiden Observatory. Coming all the way from India to a foreign country was not an easy choice, but I am very glad that I took this leap. Being a part of the LOFAR group has been a great learning experience. Huib, I learnt a lot from you; not just in academic matters but also in tackling many other challenges. Thank you for the guidance in this journey. Tim, you are one of the nicest colleagues that anyone could wish to work with. Starting from your supervision during my summer internship to all these years, I had a great time working with you on so many different projects; thank you for everything. Fra(ncesco), I always valued your opinions and suggestions. You always demonstrated how to think pragmatically and tackle things in a rational way. I am very lucky to have worked with so many excellent scientists in the LOFAR collaboration. Amongst them, I am particularly grateful to Isabella and Gianfranco. You always allowed me to visit in Bologna to work with you. Thank you very much for the support. Xander, thank you so much for your encouraging words and support, especially in the last few months, I really appreciate it.

For my PhD research, I used a lot of computing resources and it would not have been possible without the help from the Sterrewacht computer group. Erik, Aart, David, Eric and Leonardo, thank you so much for your prompt responses for all the helpdesk tickets I submitted. I would also like to thank Evelijn, Alexandra, Marjan, Caroline, Monica and all the other secretaries for making the official work so smooth; I never had to worry about those aspects.

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During all these years, I have met so many wonderful people at the Sterrewacht. Christos and Tommaso, you are not only two of my closest friends, but are like my brothers. You guys thought about everything, haha. Thank you for countless awesome memories. The PhD journey would have been significantly different without you guys and I have been very lucky to share this path with friends like you. Grazie alla mia famiglia (quasi tutta) italiana: Valeriya (favourite office-mate ever), MariCri, Gabriella and Eleonora: thank you for all the nice memories, the honorary citizenship and always making me feel like home. To the Maastricht 2019 group: Anna, Mantas, Fraser, Kirsty, Pooneh, Anniek & Arthur: spending holiday season far from home is not easy, but you all made it super fun and enjoyable. Thank you for all the fun times. To all the other people from the Sterrewacht (or in connection with): Andrea (Manrique), Andrej, Alberto, Bas, Clément (I hope you still have the ladle), Dario, Dilovan, Emanuele, Francois (Grande man!), Gaby, Marco, Davide, Igone, Lammim, Lýdka, Lorenzo, Luke, Omar, Mieke, Marta, Matteo, Martinella, Pedrito, Salvatore, Santiago and anyone else that I might have missed; thank you for the time spent together and all kinds of social activities.

In my experience, having a good work life balance also depends on the interaction one makes outside the workplace. I am very glad that I had been surrounded by so many wonderful people during this time who made a direct or indirect contribution for the completion of this thesis. Elenita, I cannot thank you enough, it's IMPOSSIBLE. The emotional support and the friendship that I had from you, are unparalleled and I am so happy to have you in my life. And of course, thank you for the amazing cover and abstaining (==saving) people from getting the glimpse of my art skills! Ireth, my Costa Rican sister; thank you so so much for listening to me all the time and helping me out in the hard times. I am so happy that all these years we managed to"keep in touch" and I

hope to do the same in future ;). Vince, my friend, my housemate, thank you for everything. Without your constant support, this journey would have been much harder. Thanks a lot also for all the food and teaching me so many Italian cuisine. Nicandro and Flavio, thank you for being such amazing friends, I could always count on you! No one taught (some people would use the word 'impose') me the concept of Italian cuisine more scientifically than you two! Marta and Federica, grazie belle, from the bottom of my heart! Your words and support meant a lot. Andrea (rocca): Maaaan! we shared A LOT of memories together (of course, also the birthday) and thank you for everything. Hopefully 8a+ at some point in near future ;). Noemi, thank you for your support during the last year and being positive about things in general; it helped a lot! Aurelio, Piermarco, Tilbe, Lieslore and Liuba: thank you for all the nice discussions and fun memories. Frédérique, thank you for being such an amazing, cool and positive person! You always listened to me and made me feel better. Thank you to my fellow PhDs (mostly): Helena, Anna Prydatko, Uditendu, Alexandru, Chris, Lavinia, Leonardo, Miriam, Erik, Claudiu, Swantje, Yan, (little) Tim, Natacha, Aleksandrina; for all the happy moments, discussions that we shared over these years.

The sport of climbing is known to attract people with an analytic mind because it involves solving a 'problem'. However, for me climbing has not just been a sport, it has been my safe place where I could learn my capabilities, re-energise my brain and motivate myself to improve the quality of life. During this activity, I met many people and big cheers to all those friends: Arthur, Lise, Pablito, Filippo (allez ha!), Aurelio, Piermarco, Andrea, Christos, Liuba, Christiane, Lieslore, Federico, Chloé, Harish, Hugo, Raúl, Ander, Jelle, Daragh, Evan and anyone else who I might have missed.

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