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Machine learning for radio galaxy morphology analysis

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List of publications

First-author publications

1. *Unveiling the rarest morphologies of the LOFAR Two-metre Sky Survey radio source population with self-organised maps*
Rafaël I.J. Mostert, Kenneth J. Duncan, Huub J.A. Röttgering, Kai L. Polsterer, Philip N. Best, Marisa Brienza, Marcus Brüggem, Martin J. Hardcastle, Nika Jurlin, Beatriz Mingo, Raffaella Morganti, Tim Shimwell, Dan Smith, and Wendy L. Williams
A&A 645, A89 (2021)
[doi:10.1051/0004-6361/202038500](https://doi.org/10.1051/0004-6361/202038500)
2. *Radio source-component association for the LOFAR Two-metre Sky Survey with region-based convolutional neural networks*
Rafaël I.J. Mostert, Kenneth J. Duncan, Lara Alegre, Huub J.A. Röttgering, Wendy L. Williams, Philip N. Best, Martin J. Hardcastle, and Raffaella Morganti
A&A 668, A28 (2022)
[doi:10.1051/0004-6361/202243478](https://doi.org/10.1051/0004-6361/202243478)
3. *Finding AGN remnant candidates based on radio morphology with machine learning*
Rafaël I.J. Mostert, Raffaella Morganti, Marisa Brienza, Kenneth J. Duncan, Martijn S.S.L. Oei Huub J.A. Röttgering, Lara Alegre, Martin J. Hardcastle, and Nika Jurlin
A&A 674, A208 (2023)
[doi:10.1051/0004-6361/202346035](https://doi.org/10.1051/0004-6361/202346035)
4. *Constraining the giant radio galaxy population with machine learning-accelerated detection and Bayesian inference*
Rafaël I.J. Mostert*, Martijn S.S.L. Oei*, B. Barkus, Lara Alegre, Martin J. Hardcastle, Kenneth J. Duncan, Huub J.A. Röttgering, Reinout J. van Weeren, and Maya Horton
*These authors contributed equally to this article.
Submitted to A&A (2023)

Co-authored publications

1. *The LOFAR Two-meter Sky Survey: Deep Fields Data Release 1-III. Host-galaxy identifications and value added catalogues*
R. Kondapally, P.N. Best, M.J. Hardcastle, D. Nisbet, M. Bonato, J. Sabater, K.J. Duncan, I. McCheyne, R.K. Cochrane, R.A.A. Bowler, W.L. Williams, T.W. Shimwell, C. Tasse, J.H. Croston, A. Goyal, M. Jamroz, M.J. Jarvis, V.H. Mahatma, H.J.A. Röttgering, D.J.B. Smith, A. Wołowska, M. Bondi, M. Brienza, M.J.I. Brown, M. Brüggem, K. Chambers, M.A. Garrett, G. Gürkan, M. Huber, M. Kunert-Bajraszewska, E. Magnier, B. Mingo, R.I.J. Mostert, B. Nikiel-Wroczyński, S.P. O’Sullivan, R. Paladino, T. Ploeckinger, I. Prandoni, M.J. Rosenthal, D.J. Schwarz, A. Shulevski, J.D. Wagenveld, and L. Wang

- A&A 648, A3 (2021)
[doi:10.1051/0004-6361/202038813](https://doi.org/10.1051/0004-6361/202038813)
2. *The best of both worlds: Combining LOFAR and Apertif to derive resolved radio spectral index images*
 R. Morganti, T.A. Oosterloo, M. Brienza, N. Jurlin, I. Prandoni, E. Orrù, S.S. Shabala, E.A.K. Adams, B. Adebahr, P.N. Best, A.H.W.M. Coolen, S. Damstra, W.J.G. De Blok, F. De Gasperin, H. Dénes, M.J. Hardcastle, K.M. Hess, B. Hut, R. Kondapally, A.M. Kutkin, G.M. Loose, D.M. Lucero, Y. Maan, F.M. Maccagni, B. Mingo, V.A. Moss, R.I.J. Mostert, M.J. Norden, L.C. Oostrum, H.J.A. Röttgering, M. Ruiters, T.W. Shimwell, R. Schulz, N.J. Vermaas, D. Vohl, J.M. Van Der Hulst, G.M. Van Diepen, J. Van Leeuwen, and J. Ziemke
 A&A 648, A9 (2021)
[doi:10.1051/0004-6361/202039102](https://doi.org/10.1051/0004-6361/202039102)
 3. *The application of ridgelines in extended radio source cross-identification*
 B. Barkus, J.H. Croston, J. Piotrowska, B. Mingo, P.N. Best, M.J. Hardcastle, R.I.J. Mostert, H.J.A. Röttgering, J. Sabater, B. Webster, and W.L. Williams
 MNRAS 509, Issue 1, (2022)
[doi:10.1093/mnras/stab2952](https://doi.org/10.1093/mnras/stab2952)
 4. *The LOFAR Two-metre Sky Survey-V. Second data release*
 T.W. Shimwell, M.J. Hardcastle, C. Tasse, P.N. Best, H.J.A. Röttgering, W.L. Williams, A. Botteon, A. Drabant, A. Mechev, A. Shulevski, R.J. van Weeren, L. Bester, M. Brüggen, G. Brunetti, J.R. Callingham, K.T. Chyży, J.E. Conway, T.J. Dijkema, K. Duncan, F. de Gasperin, C.L. Hale, M. Haverkorn, B. Hugo, N. Jackson, M. Mevius, G.K. Miley, L.K. Morabito, R. Morganti, A. Offringa, J.B.R. Oonk, D. Rafferty, J. Sabater, D.J.B. Smith, D.J. Schwarz, O. Smirnov, S.P. O’Sullivan, H. Vedantham, G.J. White, J.G. Albert, L. Alegre, B. Asabere, D.J. Bacon, A. Bonafede, E. Bonnassieux, M. Brienza, M. Bilicki, M. Bonato, G. Calistro Rivera, R. Cassano, R. Cochrane, J.H. Croston, V. Cuciti, D. Dallacasa, A. Danezi, R.J. Dettmar, G. Di Gennaro, H.W. Edler, T.A. Enßlin, K.L. Emig, T.M.O. Franzen, C. García-Vergara, Y.G. Grange, G. Gürkan, M. Hajduk, G. Heald, V. Heesen, D.N. Hoang, M. Hoeft, C. Horellou, M. Iacobelli, M. Jamrozy, V. Jelić, R. Kondapally, P. Kukreti, M. Kunert-Bajraszewska, M. Magliocchetti, V.H. Mahatma, K. Małek, S. Mandal, F. Massaro, Z. Meyer-Zhao, B. Mingo, R.I.J. Mostert, D.G. Nair, S.J. Nakoneczny, B. Nikiel-Wroczyński, E. Orrù, U. Pajdosz-Śmierciak, T. Pasini, I. Prandoni, H.E. van Piggelen, K. Rajpurohit, E. Retana-Montenegro, C.J. Riseley, A. Rowlinson, A. Saxena, C. Schrijvers, F. Sweijen, T.M. Siewert, R. Timmerman, M. Vaccari, J. Vink, J.L. West, A. Wołowska, X. Zhang, and J. Zheng
 A&A 659, A1 (2022)
[doi:10.1051/0004-6361/202142484](https://doi.org/10.1051/0004-6361/202142484)
 5. *A machine-learning classifier for LOFAR radio galaxy cross-matching techniques*
 L. Alegre, J. Sabater, P. Best, R.I.J. Mostert, W.L. Williams, G. Gürkan, M.J. Hardcastle, R. Kondapally, T.W. Shimwell, and D.J.B. Smith
 MNRAS 516, Issue 4, (2022)

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6. *The LOFAR Two-Metre Sky Survey (LoTSS): VI. Optical identifications for the second data release*

M.J. Hardcastle, M.A. Horton, W.L. Williams, K.J. Duncan, L. Alegre, B. Barkus, J.H. Croston, H. Dickinson, E. Osinga, H.J.A. Röttgering, J. Sabater, T.W. Shimwell, D.J.B. Smith, P.N. Best, A. Botteon, M. Brüggen, A. Drabent, F. de Gasperin, G. Gürkan, M. Hajduk, C.L. Hale, M. Hoeft, M. Jamrozy, M. Kunert-Bajraszewska, R. Kondapally, M. Magliocchetti, V.H. Mahatma, R.I.J. Mostert, S.P. O’Sullivan, U. Pajdosz-Śmierciak, J. Petley, J.C.S. Pierce, I. Prandoni, D.J. Schwarz, A. Shulewski, T.M. Siewert, J.P. Stott, H. Tang, M. Vaccari, X. Zheng, T. Bailey, S. Desbled, A. Goyal, V. Gonano, M. Hanset, W. Kurtz, S.M. Lim, L. Mielle, C.S. Molloy, R. Roth, I.A. Terentev, and M. Torres.

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Curriculum vitae

Rafaël Inayat Jacobus Mostert, born in Delft on the 6th of November 1993, was raised in Monster, a village enclosed by hydroponic greenhouses and the North Sea. In high school, the Dalton in the Hague (VWO) from 2006 to 2011, he enrolled in the Dutch-English bilingual program. He was part of the debate team, and a member of the participation council. He received the Leiden Advanced Pre-university Programme for Top students certificate for Astronomy in 2009 and for Physics in 2010.

From 2011-2015 he was enrolled in the Physics & Astronomy bachelor at Utrecht University with a minor in computer science. His bachelor thesis about modelling heat- and vapour fluxes inside a crop-filled greenhouse was written during an internship at the horticulture department of TNO — the Netherlands Organization for Applied Scientific Research. From 2014-2017 Rafaël chaired the board of the JWG, the Dutch youth association for astronomy with over 500 members.

At Leiden University from 2015-2018, he pursued an Astronomy Master's program with a focus on data and computer science. His first research project concerning wide-field spectral polarimetry was completed under the supervision of Dr.ir. F. Snik and his second research project concerning the exploration of radio-interferometric images using self-organising maps was completed under the supervision of Dr. K.J. Duncan and Prof.dr. H.J.A. Röttgering.

A contributed talk at the AstroInformatics conference at the Heidelberg Institute for Theoretical studies was the kick-off for his PhD. From 2018-2022, under the supervision of Prof.dr. H.J.A. Röttgering at Leiden University and Prof.dr. R Morganti at ASTRON — the Dutch institute for radio astronomy, his research focused on the application of computer vision and machine learning to the images produced by the LOFAR (radio telescope) Two-metre Sky Survey. During his PhD, he co-organised the European Astronomical Society annual conference which hosted more than 1700 participants, he assisted in teaching two Master's and one Bachelor's course, and he supervised five Master's students for their master research project.

Next, he aspires to keep on learning about machine learning and artificial intelligence as a senior specialist data consultant at Valcon. After years of looking up, he now contributes to solutions for enhancing life on earth, starting with a computer vision project at ProRail — a Dutch government body responsible for the national railway network infrastructure, the allocation of rail capacity, and controlling rail traffic.

Acknowledgements

Pursuing a PhD felt like rowing across a sea of unknown size. Fortunately, I was able to regularly encounter or call upon other boats. Some boats like mine, easy to blow off course, crewed by a single PhD student, sometimes a nimble sailing craft crewed by a postdoc, or occasionally the larger steadfast vessels crewed by permanent staff members.

I am thankful that I was regularly able to lay anchor next to the ships of my supervisors, Huub Röttgering and Raffaella Morganti and that of Ken Duncan, my PhD mentor. As my decision to start on the traverse that is a PhD hinged on whether I enjoyed my Master's research project, I can say that Ken, my daily supervisor for the master project, played an important role in that decision. Ken introduced me to inspiring collaborators in Heidelberg (Kai Polsterer) and Hatfield, which kindled my interest in pursuing a PhD. This PhD is the most complex project I embarked on so far in my life — the ramifications of the global COVID-19 pandemic made it even more challenging — and Huub and Raffaella were able to support and guide me until the very end.

During my PhD, jointly funded by ASTRON, Leiden Observatory and LIACS, I got to know many more fun and inspiring people. The members of the LOFAR group, the members of the international LOFAR collaboration, the scientists working at ASTRON, fellow astronomy PhD-colleagues and others working at the Leiden Observatory. I thank the Leiden Observatory support staff and the IT department specifically for enabling my research. I am also grateful for Thomas Bäck and Hao Wang, who gave me the opportunity to visit their Natural Computing Research group meetings. I enjoyed conversations and dinner with Martijn and Frits, convened on the eleventh floor of the Huygens with Olivier, enjoyed bouldering, dancing and going out with Aniek, Erik, Roland and Sarah in Turin and Cologne, meeting Nika at ASTRON and conferences, conversations with Lara in Edinburgh, enjoyed wine and classical music with Dilovan. I will cherish the fleeting conversations with smart and caring people at workshops and conferences. Writing my final article together with Martijn gave me the necessary joy and motivation for the final leg of the PhD.

On the shore, a territory that can feel distant when you are out at sea for long, my friends and family were always there for me, whichever way the wind blew. Throughout my time in high school, my physics teacher Marcel and volunteers at the JWG kindled my passion for physics and astronomy. Throughout my time at university, my housemates kept me young and my horizon wide. Most of all, I was glad that I could share my ups and downs with my favourite pirate, Elise.

Now onwards I go, on a journey that attempts to alternate traversal on land and on sea. I hope that many of our trajectories will cross again someday.