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Science Highlights

- First equatorial LOFAR deep images of a galaxy cluster (Abell 520)
- Thermal-noise, high-resolution images below 200 MHz for a galaxy cluster (the Sausage) nearby a $13k$ Jy source
- Discovery of the least powerful radio halo at 144 MHz in a low-mass galaxy cluster Abell 990 (as of May 15, 2021)
- Discovery of the most extended structure where cosmic rays are accelerated in a late state merging galaxy cluster (ClG 0217+70, as of May 15, 2021)

Research Interests

- My main research interest is to answer fundamental questions on the formation of diffuse radio sources in/between galaxy clusters. These studies will deepen our understanding on the physical mechanisms of particle acceleration and magnetic field amplification during the formation of large-scale structure. To do this, I make use of the most sensitive ground-based and space-based telescopes to observe radio and X-ray emission from merging galaxy clusters.

Employment History

Aug 2022 – present	**Postdoctoral researcher (DFG funded),** Hamburg Observatory, University of Hamburg (Germany).
Aug 2019 – Jul 2022	**Postdoctoral researcher (ERC funded),** Hamburg Observatory, University of Hamburg (Germany).
Apr 2014 – Oct 2018	**Doctoral researcher (ERC funded),** Leiden Observatory, Leiden University (Netherlands).
Sep 2012 – Feb 2014	**Research Assistant,** Institute of Astronomy and Astrophysics, Academia Sinica (Taiwan).
Feb 2011 – Aug 2012	**Researcher,** Department of Physics, International University - HoChiMinh City (Vietnam).
Aug 2004 – Dec 2007	**Teaching Assistant,** Department of Chemistry, University of Science - HoChiMinh City (Vietnam).
Apr 2004 – May 2004	**Research Assistant,** Institute of Applied Materials Science - HoChiMinh City (Vietnam).

Education

Apr 2014 – Jun 2019	**Ph.D. in Astronomy and Astrophysics, Leiden University (Netherlands)** Thesis: *Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters.* Supervisors: Prof. Huub Röttgering, Dr. Timothy Shimwell, Dr. Reinout van Weeren
Feb 2008 – Oct 2010	**M.Sc. in Physics, Stockholm University (Sweden)** Thesis: *Geometrically controlled evolution of four-qubit states.* Supervisor: Assoc. Prof. Hoshang Heydari
Sep 1999 – Aug 2003	**B.Sc. in Chemistry, University of Science - HoChiMinh City (Vietnam)** Thesis: *Theoretical study of Aldol-Tishchenko dimerization reaction.* Supervisor: Assoc. Prof. Bui Tho Thanh

Teaching Experience

Jan 2016 – Aug 2017	◇ **Leiden University (Netherlands)** Courses: *Physics experiments, Optics*. (in English)
Feb 2011 – Aug 2012	◇ **International University - HoChiMinh City (Vietnam)** Courses: *Physics 2B Lab (Electricity, Magnetism, Waves, and Modern Physics); Physics 3 Lab (Electricity and Magnetism)*. (in English)
Aug 2004 – Dec 2007	◇ **University of Science - HoChiMinh City (Vietnam)** Courses: *General Chemistry Lab A, Physical Chemistry Lab I, Physical Chemistry Lab II, Applications of Informatics in Chemistry*. (in Vietnamese)

Supervisory Experience

Jun 2021 – Aug 2021	◇ **Leiden University (Netherlands)**. Topic: *LEAPS (Leiden/ESA Astrophysics Program for Summer Students) research projects*. (in English)
Mar 2021 – Jul 2021	◇ **International University - HoChiMinh City (Vietnam)** Topic: *Research projects in radio astronomy*. (in English)
Jun 2016 – Aug 2017	◇ **Leiden University (Netherlands)** Topic: *LEAPS research project*. (in English)

Skills

Languages	◇ Fluently reading, writing and speaking competencies for English and Vietnamese (native).
Operating Systems:	◇ Linux, Windows, Mac, and standard packages therein.
High Performance Computing:	◇ TORQUE and SLURM queuing systems, large volume data processing (up to tens of Terabytes).
Programming Languages:	◇ Python, Matlab, Mathematica, C++, IDL.
Astronomical Software:	◇ LOFAR software, WSClean, CASA, CIAO, eSASS, SHERPA.

Professional Activities

2020–present	◇ Reviewer for the time allocation of the GMRT.
2021–present	◇ Reviewer for the Publications of the Astronomical Society of Australia (PASA), New Astronomy, and Monthly Notices of the Royal Astronomical Society (MNRAS).
2011–present	◇ Member of Vietnamese Theoretical Physics Society.
2014–2018	◇ Galaxy cluster weekly meeting organizer (Leiden).

Research Publications

◇ *Total of 26 peer-reviewed papers and 3 conference proceedings*: including 8 first-author papers (incl. 1 in preparation), 4 third- and fourth-author papers, and 18 co-author papers. Total number of citations: 1374; h-index: 16 (as of September 9, 2022).

Journal Articles (First Author)

1 **Hoang**, D. N., Brüggen, M., Botteon, A., Shimwell, T. W., Zhang, X., Bonafede, A., … van Weeren, R. J. (2022). Diffuse radio emission from non-Planck galaxy clusters in the LoTSS-DR2 fields. *A&A, 665*, A60.
doi:10.1051/0004-6361/202243105

2. **Hoang**, D. N., Shimwell, T. W., Osinga, E., Bonafede, A., Brüggen, M., Botteon, A., … van Weeren, R. J. (2021). LOFAR detection of a low-power radio halo in the galaxy cluster Abell 990. *MNRAS*, *501*(1), 576–586. doi:10.1093/mnras/staa3581

3. **Hoang**, D. N., Zhang, X., Stuardi, C., Shimwell, T. W., Bonafede, A., Brüggen, M., … van Weeren, R. J. (2021). A 3.5 Mpc long radio relic in the galaxy cluster ClG 0217+70. *A&A*, *656*(41428), A154. doi:10.1051/0004-6361/202141428

4. **Hoang**, D. N., Koch, P. M., Bonafede, N., Brüggen, M., & Paul, H. (2021). A joint study of Sunyaev–Zeldovich and synchrotron emission from shock-heated plasma in the X-ray luminous galaxy cluster RX J1347.5–1145. *MNRAS*, *(in preparation)*.

5. **Hoang**, D. N., Shimwell, T. W., van Weeren, R. J., Brunetti, G., Röttgering, H. J. A., Andrade-Santos, F., … Stroe, A. (2019). Radio observations of the merging galaxy cluster Abell 520. *A&A*, *622*, A20. doi:10.1051/0004-6361/201833900

6. **Hoang**, D. N., Shimwell, T. W., Van Weeren, R. J., Röttgering, H. J., Botteon, A., Brunetti, G., … Stroe, A. (2019). Characterizing the radio emission from the binary galaxy cluster merger Abell 2146. *A&A*, *622*, 1–9. doi:10.1051/0004-6361/201834025

7. **Hoang**, D. N., Shimwell, T. W., van Weeren, R. J., Intema, H. T., Röttgering, H. J. A., Andrade-Santos, F., … White, G. J. (2018). Radio observations of the double-relic galaxy cluster Abell 1240. *MNRAS*, *478*(2), 2218–2233. doi:10.1093/mnras/sty1123

8. **Hoang**, D. N., Shimwell, T. W., Stroe, A., Akamatsu, H., Brunetti, G., Donnert, J. M. F., … White, G. J. (2017). Deep LOFAR observations of the merging galaxy cluster CIZA J2242.8+5301. *MNRAS*, *471*(1), 1107–1125. doi:10.1093/mnras/stx1645

Journal Articles (Third- and Fourth-Author)

1. Pasini, T., Brüggen, M., **Hoang**, D. N., Ghirardini, V., Bulbul, E., Klein, M., … Ramos-Ceja, M. (2022). The eROSITA Final Equatorial-Depth Survey (eFEDS). *A&A*, *661*, A13. doi:10.1051/0004-6361/202141211

2. Jones, A., de Gasperin, F., Cuciti, V., **Hoang**, D. N., Botteon, A., Brüggen, M., … van Weeren, R. J. (2021). Radio relics in PSZ2 G096.88+24.18: a connection with pre-existing plasma. *MNRAS*, *505*(4), 4762–4774. doi:10.1093/mnras/stab1443

3. Ghirardini, V., Bulbul, E., **Hoang**, D. N., Klein, M., Okabe, N., Biffi, V., … Williams, W. L. (2021). Discovery of a supercluster in the eROSITA Final Equatorial Depth Survey: X-ray properties, radio halo, and double relics. *A&A*, *647*, A4. doi:10.1051/0004-6361/202039554

4. Donnert, J. M. F., Stroe, A., Brunetti, G., **Hoang**, D., & Roettgering, H. (2016). Magnetic field evolution in giant radio relics using the example of CIZA J2242.8+5301. *MNRAS*, *462*(July), 2014–2032. doi:10.1093/mnras/stw1792

Journal Articles (Co-Author)

1. Stuardi, C., Bonafede, A., Rajpurohit, K., Brüggen, M., de Gasperin, F., **Hoang**, D., … Vazza, F. (2022). Using the polarization properties of double radio relics to probe the turbulent compression scenario., *666*, A8. doi:10.1051/0004-6361/202244179

2. Pasini, T., Edler, H. W., Brüggen, M., de Gasperin, F., Botteon, A., Rajpurohit, K., … Riseley, C. J. (2022). Particle re-acceleration and diffuse radio sources in the galaxy cluster Abell 1550. *A&A*, *663*, A105. doi:10.1051/0004-6361/202243833. eprint: 2205.12281

3. Bulbul, E., Liu, A., Pasini, T., Comparat, J., **Hoang**, D. N., Klein, M., … Shen, Y. (2022). The eROSITA Final Equatorial-Depth Survey (eFEDS): Galaxy clusters and groups in disguise. *A&A*, *661*, A10. doi:10.1051/0004-6361/202142460

4. Liu, A., Bulbul, E., Ghirardini, V., Liu, T., Klein, M., Clerc, N., … Thibaud, Q. (2022). The eROSITA Final Equatorial-Depth Survey (eFEDS): Catalog of galaxy clusters and groups. *A&A*, *661*, A2. doi:10.1051/0004-6361/202141120

5. Sanders, J. S., Biffi, V., Brüggen, M., Bulbul, E., Dennerl, K., Dolag, K., … ZuHone, J. A. (2022). Studying the merging cluster Abell 3266 with eROSITA. *A&A*, *661*, A36. doi:10.1051/0004-6361/202141501
6. Botteon, A., Shimwell, T. W., Cassano, R., Cuciti, V., Zhang, X., Bruno, L., … de Gasperin, F. (2022). The Planck clusters in the LOFAR sky: I. LoTSS-DR2: New detections and sample overview. *A&A*, *660*(43020), A78. doi:10.1051/0004-6361/202143020
7. Di Gennaro, G., van Weeren, R. J., Rudnick, L., Hoeft, M., Brüggen, M., Ryu, D., … **Hoang**, D. N. (2021). Downstream Depolarization in the Sausage Relic: A 1–4 GHz Very Large Array Study. *ApJ*, *911*(1), 3. doi:10.3847/1538-4357/abe620
8. Brüggen, M., Reiprich, T. H., Bulbul, E., Koribalski, B. S., Andernach, H., Rudnick, L., … Marvil, J. (2021). Radio observations of the merging galaxy cluster system Abell 3391-Abell 3395. *A&A*, *647*, A3. doi:10.1051/0004-6361/202039533
9. Reiprich, T. H., Veronica, A., Pacaud, F., Ramos-Ceja, M. E., Ota, N., Sanders, J., … Vardoulaki, E. (2021). The Abell 3391/95 galaxy cluster system. *A&A*, *647*, A2. doi:10.1051/0004-6361/202039590
10. Wolf, J., Nandra, K., Salvato, M., Liu, T., Buchner, J., Brusa, M., … Williams, W. L. (2021). First constraints on the AGN X-ray luminosity function at $z \sim 6$ from an eROSITA-detected quasar. *A&A*, *647*, A5. doi:10.1051/0004-6361/202039724
11. Valentina, V., Shimwell, T., Perley, A. P., Govoni, F., Murgia, M., Feretti, L., … Wittor, D. (2021). Spectral study of the diffuse synchrotron source in the galaxy cluster Abell 523. *MNRAS, (submitted)*.
12. Zhang, X., Simionescu, A., Kaastra, J. S., Akamatsu, H., **Hoang**, D. N., Stuardi, C., … Brown, S. (2020). ClG 0217+70: A massive merging galaxy cluster with a large radio halo and relics. *A&A*, *642*, L3. doi:10.1051/0004-6361/202039028
13. Botteon, A., Shimwell, T. W., Bonafede, A., Dallacasa, D., Gastaldello, F., Eckert, D., … Wilber, A. (2019). The spectacular cluster chain Abell 781 as observed with LOFAR, GMRT, and XMM-Newton. *A&A*, *622*, A19. doi:10.1051/0004-6361/201833861
14. Shimwell, T. W., Tasse, C., Hardcastle, M. J., Mechev, A. P., Williams, W. L., Best, P. N., … Wilber, A. (2019). The LOFAR Two-metre Sky Survey. *A&A*, *622*, A1. doi:10.1051/0004-6361/201833559
15. Mandal, S., Intema, H. T., Shimwell, T. W., Van Weeren, R. J., Botteon, A., Röttgering, H. J., … Rafferty, D. (2019). Ultra-steep spectrum emission in the merging galaxy cluster Abell 1914. *A&A*, *622*, 1–11. doi:10.1051/0004-6361/201833992
16. Gennaro, G. D., van Weeren, R. J., Hoeft, M., Kang, H., Ryu, D., Rudnick, L., … Stroe, A. (2018). Deep Very Large Array Observations of the Merging Cluster CIZA J2242.8+5301: Continuum and Spectral Imaging. *ApJ*, *865*(1), 24. doi:10.3847/1538-4357/aad738
17. Botteon, A., Shimwell, T. W., Bonafede, A., Dallacasa, D., Brunetti, G., Mandal, S., … Venturi, T. (2018). LOFAR discovery of a double radio halo system in Abell 1758 and radio/X-ray study of the cluster pair. *MNRAS*, *478*(1), 885–898. doi:10.1093/mnras/sty1102
18. Shimwell, T. W., Röttgering, H. J. A., Best, P. N., Williams, W. L., Dijkema, T. J., de Gasperin, F., … Zwart, J. T. L. (2017). The LOFAR Two-metre Sky Survey. *A&A*, *598*, A104. doi:10.1051/0004-6361/201629313
19. Shimwell, T. W., Luckin, J., Brüggen, M., Brunetti, G., Intema, H. T., Owers, M. S., … White, G. J. (2016). A plethora of diffuse steep spectrum radio sources in Abell 2034 revealed by LOFAR. *MNRAS*, *459*(1), 277–290. doi:10.1093/mnras/stw661
20. Lin, K.-Y., Nishioka, H., Wang, F.-C., Huang, C.-W. L., Liao, Y.-W., Wu, J.-H. P., … Birkinshaw, M. (2016). AMiBA: cluster Sunyaev-Zel'dovich effect observations with the expended 13-element array. *ApJ*, *830*(2), 91. doi:10.3847/0004-637X/830/2/91

Conference Proceedings

1. **Hoang**, N. D., & Heydari, H. (2011). Geometrically controlled evolution of four-qubit states. In G. Jaeger, A. Khrennikov, M. Schlosshauer, & G. Weihs (Eds.), *Advances in quantum theory* (Vol. 1327, pp. 329–333). doi:10.1063/1.3567455

2. Sezer, H. C., **Hoang**, N. D., & Heydari, H. (2011). Quantum entanglement properties of geometrical and topological quantum gates. In G. Jaeger, A. Khrennikov, M. Schlosshauer, & G. Weihs (Eds.), *Advances in quantum theory* (Vol. 1327, pp. 472–476). doi:10.1063/1.3567476

3. **Hoang**, N. D., & Heydari, H. (2010). Evolution of polynomial invariants of four-qubit systems controlled by local unitary operation. In I. Bengtsson, G. Björk, & M. Bourennane (Eds.), *International conference on quantum information and computation* (P1.34).

Observing Experience

Nov 2013 – Dec 2013 ◇ **Telescope operator,** Yuan-Tseh Lee Array for Microwave Background Anisotropy (AMiBA) at Mauna Loa Observatory (USA).

Feb 2013 – Mar 2013 ◇ (same as above)

Granted Observing Time

◇ **Radio**: **LOFAR** (190 hours awarded, including 181 hours PI projects); **GMRT** (123 hours awarded, including 29 hours PI projects); **VLA** (1384 hours awarded, co-PI); **IRAM/NIKA-2 (SZ)** (43.2 hours awarded, co-PI).
◇ **X-rays**: **Chandra** (80 hours awarded, 360 hours awaiting for decision, co-PI). **XMM-Newton**: 307 hours awarded (co-PI).

2022 ◇ xxxx Deep uGMRT observations of the shock-heated region of the merging galaxy cluster RX J1347.5–1145.
Telescope: GMRT. Request: 42 hours (awarded: 20 hours) (PI; **partly successful**).

◇ xxxx Deep uGMRT observations of the shock-heated region of the merging galaxy cluster RX J1347.5–1145.
Telescope: GMRT. Request: 42 hours (awarded: 20 hours) (PI; **partly successful**).

2021 ◇ Deep uGMRT observations of the shock-heated region of the merging galaxy cluster RX J1347.5–1145.
Telescope: GMRT. Request: 42 hours (awarded: 20 hours) (PI; **partly successful**).

◇ Is there any systematic difference between the spectral properties of double or single radio relics?
Telescope: GMRT. Request: 160 hours (40 hours awarded) (co-PI; **partly successful**).

◇ A systematic spectral study of double radio relics with the uGMRT and LOFAR.
Telescope: GMRT. Request: 66 hours (30 hours awarded) (co-PI; **partly successful**).

◇ Clusters with Extreme GCBs in the eROSITA Final Equatorial-Depth Survey.
Telescope: Chandra. Request: 220 ks (co-PI; **awaiting for results**).

◇ Exploring the large scale shock – radio halo connection.
Telescope: Chandra. Request: 120 ks (co-PI; **awaiting for results**).

◇ CL0217+70: A late stage galaxy cluster merger and its tell-tale radio halo.
Telescope: NuSTAR. Request: 180 ks (co-PI; **successful**).

2020 ◇ Deep uGMRT observations of pre-merging galaxy clusters and their filaments.
Telescope: GMRT. Request: 34.6 hours (9 hours awarded) (PI; **partly successful**).

◇ Follow up observation of the spectacular radio relic in A2256: spectral and curvature analysis.
Telescope: GMRT. Request: 12 hours (co-PI; **successful**).

◇ Uncovering the origin of an underluminous relic residing in the low-mass galaxy cluster CIZA J0649.3+1801.
Telescope: GMRT. Request: 18 hours (12 hours awarded) (co-PI; **partly successful**).

◇ Chandra Study of the Double-Bullet cluster MACS J1752.0+4440.
Telescope: Chandra. Request: 80 ks (co-PI; **unsuccessful**).

◇ X-ray shock characterization in the double radio relic cluster MACS J1752.0+4440.
Telescope: XMM–Newton. Request: 122 ks (co-PI; **successful**).

Granted Observing Time (continued)

- ◇ Follow-up XMM observations of the first supercluster discovered by eROSITA.
  Telescope: XMM–Newton. Request: 185 ks (co-PI; **successful**).
- ◇ Deep tSZ and kSZ imaging of a triple-merger system within a supercluster.
  Telescope: IRAM/NIKA-2. Request: 43.2 hours (co-PI; **successful**).

2019
- ◇ LOFAR coverage of the eROSITA eFEDS field.
  Telescope: LOFAR. Request: 104 hours (PI; **successful**).
- ◇ Cosmic shocks under the magnifying glass.
  Telescope: VLA. Request: 40 hours (co-PI; **successful**).
- ◇ Cosmic shocks under the magnifying glass.
  Telescope: VLA. Request: 26 hours (co-PI; **successful**).
- ◇ J-BooDeeS: the JVLA Bootes Deep Survey – X-Proposal.
  Telescope: VLA. Request: 1240 hours (co-PI; **successful**).

2018
- ◇ Formation of extended radio emission in double-relic galaxy clusters (re-submission).
  Telescope: LOFAR. Request: 42 hours (PI; **successful**).
- ◇ Cosmic shocks under the magnifying glass.
  Telescope: VLA. Request: 58 hours (co-PI; **successful**).

2017
- ◇ Formation of radio halos in double-relic galaxy clusters.
  Telescope: LOFAR. Request: 42 hours (PI; **unsuccessful**).
- ◇ LOFAR observations of the merging galaxy cluster Abell 2146.
  Telescope: LOFAR. Request: 17 hours (PI; **successful**).
- ◇ A Direct test of Cosmic Ray re-acceleration at galaxy cluster shocks with LOFAR.
  Telescope: LOFAR. Request: 8.3 hours (co-PI; **successful**).
- ◇ A Direct test of Cosmic Ray re-acceleration at galaxy cluster shocks with LOFAR (additional proposal).
  Telescope: LOFAR. Request: 8.3 hours (co-PI; **unsuccessful**).
- ◇ Cosmic tsunamis: testing modern cluster radio relic models with observations.
  Telescope: VLA. Request: 20 hours (co-PI; **successful**).

2016
- ◇ Intergalactic shock-fronts and their relations to radio relics.
  Telescope: LOFAR. Request: 8.6 hours (PI; **successful**).

2015
- ◇ LOFAR observations of the Sausage cluster.
  Telescope: LOFAR. Request: 9.6 hours (PI; **successful**).

References

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