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## **Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters**

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### **Citation**

Hoang, D. N. (2019, June 26). *Cosmic particle acceleration by shocks and turbulence in merging galaxy clusters*. Retrieved from <https://hdl.handle.net/1887/74441>

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**Issue Date:** 2019-06-26

## Curriculum Vitae

I was born on June 3, 1981 in Vietnam. When I was at high school, I realized that I was interested in doing a career in scientific research.

In 2003, I received my bachelor degree in chemistry from the University of Science - HoChiMinh City (US-HCMC). After graduation, I worked as a teaching assistant for laboratory courses on physical/computational chemistry at US-HCMC. I very much enjoyed doing chemistry experiments in the laboratory.

However, I was then more interested in physics and astronomy. In 2008, I decided to learn more about physics by attending a master program in physics at Stockholm University where I did my graduation thesis on theoretical quantum physics with my supervisor Prof. Hoshang Heydari. The thesis was about “geometrically controlled evolution of four-qubit states”.

After a short period of time working at International University - HoChiMinh City (VNU-HCMC-IU), I went to the Institute of Astronomy & Astrophysics, Academia Sinica (ASIAA) in Taiwan to learn about radio astronomy in 2012. At ASIAA, I joined the YTLA (Yuan-Tseh Lee Array, formerly AMiBA) group of Prof. Paul Ho. YTLA is a radio interferometer operating at 86 – 102 GHz and is built to observe the cosmic microwave background (CMB) radiation and the Sunyaev-Zel’dovich effect in galaxy clusters. In combination with radio observations at low frequency, the aim of my project was to search for the spatial correlation between the non-thermal (i.e. relativistic electrons, magnetic field) and thermal components in the intra-cluster medium (ICM).

In 2014, I was offered a PhD position in the group of Prof. Huub Röttgering at Leiden Observatory, Netherlands. My research focused on the particle acceleration mechanisms by large-scale shocks and turbulence in merging clusters of galaxies. To study the non-thermal components (i.e. relativistic electrons, magnetic field) in the ICM of merging galaxy clusters, I mainly used multi-frequency radio observations that were performed with the Low

Frequency Array (LOFAR), Karl G. Jansky Very Large Array (JVLA), Giant Metrewave Radio Telescope (GMRT), and Westerbork Synthesis Radio Telescope (WSRT). In addition, I also used X-ray data that were observed with X-ray satellites (i.e. Chandra, Suzaku). The results of my PhD research projects are presented in this thesis and are also published in international journals (i.e. Monthly Notices of the Royal Astronomical Society, *Astronomy & Astrophysics*). During my PhD study, I also attended/presented my research results at conferences in Beijing (China), Hamburg, Munich (Germany), Bologna (Italy), Assen, Dwingeloo, Leiden, Noordwijkerhout (Netherlands), Manchester (UK), California (US), and HoChiMinh (Vietnam).

After finishing my PhD study, I will move to Hamburg Observatory for a postdoctoral position in radio astronomy.

# List of publications

## First-author publications

1. Hoang, D. N. et al. Deep LOFAR observations of the merging galaxy cluster CIZA J2242.8+5301. 2017, MNRAS, 471, 1107 (Chapter 2)
2. Hoang, D. N. et al. Radio observations of the double-relic galaxy cluster Abell 1240. 2018, MNRAS, 478, 2218 (Chapter 3)
3. Hoang, D. N. et al. Radio observations of the merging galaxy cluster Abell 520. 2019, A&A, 622, A20 (Chapter 4)
4. Hoang, D. N. et al. Characterizing the radio emission from the binary galaxy cluster merger Abell 2146. 2019, A&A, 622, A21 (Chapter 5)

## Co-author publications

1. Shimwell, T. W. et al. (including Hoang, D. N.) The LOFAR Two-metre Sky Survey – II. First Data Release. 2019, A&A, 622, A1
2. Mandal, S. et al. (including Hoang, D. N.) Ultra steep spectrum emission in the merging galaxy cluster Abell 1914. 2019, A&A, 622, A22
3. Di Gennaro, G. et al. (including Hoang, D. N.) Deep Very Large Array observations of the merging cluster CIZA J2242.8+5301: Continuum and spectral imaging. 2018, ApJ, 865, 24
4. Botteon, A. et al. (including Hoang, D. N.) The spectacular cluster chain Abell 781 as observed with LOFAR, GMRT and XMM-Newton. 2019, ApJ, 622, A19

5. Botteon, A. et al. (including Hoang, D. N.) LOFAR discovery of a double radio halo system in Abell 1758 and radio/X-ray study of the cluster pair. 2018, MNRAS, 478, 885
6. Donnert, J. M. F. et al. (including Hoang, D.) Magnetic field Evolution in Giant Radio Relics using the example of CIZA J2242.8+530. 2016, MNRAS, 462, 204
7. Kai-Yang, L. et al. (including Hoang, D. N.) AMiBA: Cluster Sunyaev-Zel'dovich Effect Observations with the Expanded 13-element Array. 2016, ApJ, 830, 91
8. Shimwell, T. W. et al. (including Hoang, D. N.) The LOFAR Two-metre Sky Survey I. Survey description and preliminary data release. 2016, A&A, 598, A04
9. Shimwell, T. W. et al. (including Hoang, D. N.) A plethora of diffuse steep spectrum objects in Abell 204. 2015, MNRAS, 459, 277

## Acknowledgements

It has been wonderful years of my life working as a PhD student at Leiden Observatory in the little city of Leiden, Netherlands. I would not have become who I am today without the help and support of many people.

Special thanks to my supervisors Huub Röttgering, Timothy Shimwell, and Reinout van Weeren. Huub: Thank you for accepting me as one of your students, for giving me the freedom to choose my own research and for providing support/guidance during my PhD study. Tim: Thank you for being my daily supervisor and a friend of mine. You are always very nice and helpful. Reinout: Thank you very much for helping me from the beginning to the end of my PhD study. Working with you is always prolific and fun.

I would also like to thank former/current members of the Huub's group who I have been closely work with and learn a lot from. Many thanks to Andra (CfA), Julius (INAF-IRA), Huib (CIRA), Francesco (Universität Hamburg), Wendy, Jit, Josh, Gabriella, Raymond (ASTRON), Leah (University of Oxford), Edwin, and Pedro.

It was a great opportunity for me to work with people in the LOFAR collaboration as well as collaborators of collaborators. Thank you Gianfranco (INAF-IRA), Marcus (Universität Hamburg), Matthias (Thüringer Landessternwarte), Annalisa (INAF-IRA), Rossella (INAF-IRA), David (University of Manchester), David (Universität Hamburg), Andrea (INAF-IRA), Gabriella (CfA), Emanuela (ASTRON), Roberto (ASTRON), Glenn (The Open University), George, Chiara (CNRS), Krzysztof (Jagiellonian University), Torsten (Max Planck Institute for Astrophysics), Julie (Université de Montréal), and Marie-Lou (Université de Montréal).

Many thanks to the X-ray people (i) who helped me with X-ray aspects of the galaxy clusters: Hiroki (SRON), Liyi (SRON), and Felipe (CfA) and (ii) who organized regular seminars on cluster studies: Francois (MTA-Eötvös University) and Igone (SRON).

My PhD time would not be easy and pleasant without the help from the Sterrewacht and Leiden University staff. I would like to thank Alexandra, Els, Evelijn, Caroline, Marjan, Monica, Anita, Debbie, Liesbeth, David, Evdkraan, Erik, Kelly, Saskia, and Yvonne.

I would like to take this opportunity to thank my pre-doctoral supervisors for helping/guiding me through the initial steps of radio astronomy: Patrick (ASIAA) and Paul (ASIAA). Also thanks to anh Ngoc (a colleague of mine at VNU-HCMC-IU) for supporting me during this period of time.

This thesis is dedicated to my family, my father, my father-in-law, my mother, my mother-in-law, my brothers, my brother-in-law, my sisters, my sisters-in-law, and my beloved wife. Thank you very much for loving me unconditionally, always being supportive and believing in me. I always feel warm in my heart when thinking of you. Last but not least, lovely thanks to my wife, Ly, for always being by my side and being the best soulmate of mine in the Universe.