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Acknowledgments

When I receive a thesis from a colleague of mine, I always start with acknowledgments and usually end with them :) This is not only because their work is not interesting to me but also because acknowledgments are the best part in their theses to see their personalities. Keeping this in mind, I decided to write not only about the list of people I am grateful but also about myself so that the readers can get more information about me. So this is longer than usual acknowledgments in Ph.D. theses and rather informal and filled with personal thoughts. I hope you can enjoy reading it.

To those who are also interested in mathematical parts of this thesis: The rest is formal and does not contain any personal thing. So please do not worry about being fed up with reading about my personality and enjoy the rest!

I first thank my father who introduced mathematics to me. When I was a kid, I was good at calculations (not anymore) and was eager to encounter difficult problems. When I entered some special private school for the exams of private junior high schools, they gave me lots of math problems I could not solve and I would often ask my father how to solve them (even when he was sleeping, I often woke him up and asked). Although he was not the best teacher in my life, he is the first person who taught me how to think in mathematics and since then, mathematics is not just a calculation to me and that led me to decide to become a mathematician when I was 10.

Secondly, I am grateful to Kurt Gödel for proving Incompleteness Theorems (the first and the second) which excited me a lot when I was a high school student. Although there was no person around me (including me) who knew about the precise statements of the theorems, they got me into foundations of mathematics and made me to study mathematical logic in my bachelor. Of course his work is much more than Incompleteness Theorems and it has been affecting my academic life even now, but this is the part of his work which changed my life the most.

I would like to thank Paul Cohen for inventing forcing and proving the independence of the Continuum Hypothesis from ZFC. After learning Gödel's Incompleteness Theorems, I got into axiomatic set theory thanks to the nice lectures of a professor in mathematical department and started to read a book in axiomatic set theory. In the last part of the book, it mentions the independence of CH from ZFC and I still remember how much I was shocked at it. While the Gödel sentence is a rather artificial statement to be independent from a suitable axiom system, CH seemed very natural to me and I wondered how on earth one could prove such statement to be independent, which led me to become a set theorist.

I am grateful to W. Hugh Woodin for developing such a beautiful connection between determinacy and large cardinals. When I was a senior undergraduate student, I was reading a book in set theory and found his theorem that the existence of a supercompact cardinal implies $AD^{L(\mathbb{R})}$, which was stunning to me and made me wonder how come such large objects could have strong effect on the world of real numbers. This had been a big mystery to me until I got into inner model theory and learned further results on determinacy and large cardinals and this is why I decided to major in descriptive set theory.

So after finishing my bachelor, I went to Nagoya, a city in Japan between Tokyo and Kyoto, to study set theory. I am indebted to Yo Matsubara, Yasuo Yoshinobu, and Sakaé Fuchino for their constant and patient support during my stay in Nagoya. Without their encouragement, I would not be able to imagine going abroad for my study. Besides them, I am also grateful to Tadatoshi Miyamoto, Hiroshi Sakai, and Toshimichi Usuba for arranging a warm atmosphere and for being always eager to teach me set theory and listen to me. Especially I have learned a lot from Sakai and Usuba by an enormous amount of discussions with them. I often recall the days when we talked about set theory until midnight (sometimes with alcohol), which is a precious memory to me.

I would like to thank Joan Bagaria for giving a mini course on forcing absoluteness in Kobe in 2005. Through his lecture, I got interested in forcing absoluteness and wrote a master's thesis on this topic. (The work in Chapter 2 is also the continuation of the work in my master's thesis.) He has been always quick to respond to my e-mails and always helpful to me, which also made me consider studying in Barcelona.

During the final stage of my master, I was more or less determined to study abroad and the first place I had in mind was California, which is the best place for studying the connection between determinacy and large cardinals. But since I had never been abroad at that time, my English was pretty poor and I would not be able to be a teaching assistant, which is a usual job to earn on their living for graduate students in the States. So I decided to try to find a position in Europe and I met Benedikt Löwe, who is my supervisor, the person whom I am most indebted to during my Ph.D. When I found an advertisement of Ph.D. positions in GLoRiClass project, I contacted him and after a few e-mails, he strongly encouraged me to apply for the position. Since then, he has been always

helpful for me not only mathematically but also non-mathematically. Without his encouragement, I would not be able to study in Amsterdam and overcome many problems which happened to me during my Ph.D. He has been always patient to me no matter how lazy I am about my work and sometimes he gave me certain amount of pressure on my mathematical & non-mathematical work, which was very calm and not irritating at all. He always let me do whatever I wanted to do and watched me from a certain distant position, which I truly appreciate because it is one of the most difficult things to do for supervisors worrying about their students. Without his encouragement and patience, I would not be able to finish this thesis. Also, whenever I need help from him, he is always quick to respond and does his best for me, which is a surprising amount of work for him. I am very happy to have such a great academic father.

At the beginning of my Ph.D., I sometimes considered leaving Amsterdam as a Ph.D. student because it seemed hard to study inner model theory in Amsterdam, which was one of the main reasons why I decided to study abroad. That led Benedikt to introduce Ralf Schindler to me, who is my second supervisor, and I am really happy to have met him. His point of view so-called “Everything must come from mice” has changed my set theory lifestyle a lot as you see the cover of this thesis. When he talked to me about inner model theory, I often felt that mice are really living their lives in set theory since he treats them as if they were ‘creatures’, which was a nice experience and I have learned a lot from him especially about intuitions and pictures he has in mind on inner model theory. I am also grateful for his warmful hospitality in Münster for one and a half years and for taking care about me for such a long time. I thank him and people in Münster for introducing Hefeweizen and Skat to me, both of which I enjoy a lot even after my stay in Münster.

I am grateful to Jouko Väänänen for treating me as a good set theorist, for informing me a lot of events in mathematical logic, and for encouraging me to organize several events in set theory in Amsterdam. Without his encouragement, I would not have applied for the fall semester program in Mittag-Leffler and would not be able to enjoy such a wonderful semester with world-wide researchers in set theory and model theory. Also, without his suggestion, I would not have organized a series of seminars on Σ_1^2 forcing absoluteness and would not have given talks, which led me to understand the connection between saturations of ideals on ω_1 and forcing absoluteness and the strong impact of Martin’s Maximum on modern set theory.

I would like to thank Johan van Benthem and Yde Venema for sharing their knowledge with me and being open to me to discuss mathematical logic. Both of them are very energetic about their work, which attracted me to work on some problems in fixed point logics that you can see in Chapter 6 of this thesis. Thanks to them, I have not felt so isolated as a set theorist at ILLC.

Jörg Brendle was always helpful to me when I asked questions in set theory and he was very patient and careful to respond to my e-mails. Some of his responses

are included in the work of Chapter 2 of this thesis.

I thank W. Hugh Woodin once again for discussing Blackwell determinacy, determinacy, and large cardinals. His great insights on the above topics were very inspiring and I often gained more motivation and ideas from him.

When I came to Amsterdam, I needed to adjust myself to an European culture and it took me some time and energy to manage it. During the beginning of my life in Amsterdam, many people have helped me for surviving and enjoying life here. Among them, Ioanna Dimitriou, Stefan Bold, Jakub Szymanik, Andreas Witzel, Karol Osowski, Ichiro Hasuo, Clemens Kupke, Fenrong Liu, Nick Bezhanishvili, Olivier Roy, Merlijn Sevenster, Aline Honingh, Leigh Smith, Ulle Endriss, Ingrid van Loon, Tanja Kassenaar, Jessica Pogorzelski, Marjan Veldhuisen, and Rene Goedman have been very helpful and I am grateful to all of them. Especially Jakub and Andi have been nice to me while we had difficult time during the first year of GLoRiClass project and I am glad that I had both of them as the same fellows.

After getting used to life in Amsterdam before going to Münster, I have further met many nice people at ILLC such as Yurii Khomskii, Herman Stel, Brian Semmes, Jacob Vosmaer, Amélie Gheerbrant, Gaëlle Fontaine, Olivia Ladnig, Nina Gierasimczuk, Tikitu de Jager, Jonathan Zvesper, Lena Kurzen, Raul Leal Rodriguez, Joel Uckelmann, Sara Uckelmann, Maria Alina, Joost Joosten, Fan Yang, Thomas Icard, Christian Kissig, Balder Ten Cate, Yanjing Wang, Michael Franke, Eric Pacuit, Levan Uridia, and Petter Remen. Among them, I especially thank Joost for being a nice colleague and teaching me a lot about teaching assistants and also for helping me some formal issues in the Netherlands while I was staying in Münster.

After one year in Amsterdam, I went to Münster for half a year to study inner model theory. Benjamin Claverie, Philipp Doebler, Gunter Fuchs, Philipp Schlicht, Daniel Busche, Thilo Volker Weinert, Christoph Duchhardt, and Giulia Uckelmann have been very nice friends and I had a nice time with them. I have been especially close to Ben, Philipp Doebler, and Philipp Schlicht and I am grateful to them. I also thank people in the boat house (Andi, Olivia, and Tikitu) for hosting me from time to time when I visited Amsterdam.

After coming back to Amsterdam, I met many new people at ILLC such as Jarmo Kontinen, Lauri Keskinen, Juha Kontinen, Marc Staudacher, Cédric Dégrement, Yun Qi Xue, Inés Crespo, Ivano Ciardelli, Hideto Kamei, Thomas Quella, Fernando Velazquez-Quesada, Stefan Minica, Karin Gigengack, and Peter van Ormondt. I especially remember hanging out with Jakub, Nina, Jarmo, Lauri, Jonathan, Maria, and other people playing poker or drinking and discussing something, which is a nice memory to me. I also thank Dick de Jongh for working together on problem sessions in the course of basic logic. It was nice for me to look at him and see how he deals with students.

After one year in Amsterdam, I went back to Münster and stayed there for 11 months. This time I stayed at a house with German speaking people for the

whole year, which was a unique experience to me. Tomasz Samek, the house owner, is a very frank & cheerful person. He travels a lot and always brings nice alcohol as a souvenir. Jan Peltzer and Emre Burma have been always helpful and we often had fun with drinking alcohol or doing barbecue together. It was nice to talk with Tchelet Ram about Jewish cultures and art. Besides living in a German culture, it was a pleasure to chat with Ben about Japanese cultures and French cultures. It was also nice to meet new people at Universität Münster such as Philipp Lücke, Dominik Adolf, Lars Scheele, and Antongiulio Fornasiero.

After the second stay in Münster, I stayed at Institut Mittag-Leffler for 3.5 months to attend the semester program in model theory and set theory, where many famous researchers gathered and worked together. It was really an experience and nice to talk with such great people and work together. Besides the academic benefit, since we lived in the same institute, we had many opportunities to have parties and enjoy sightseeing. I really had a nice time with Jana Flašková, Vadim Kulikov, Philipp Schlicht, Marcin Sabok, Teppo Kankaanpää, Agatha C. Walczak-Typke, Benno van den Berg, Andrés Villaveces, Natasha Dobrinen, Meeri Kesälä, and Kaisa Kangas. I would like to thank Jouko and Juliette Kennedy for organizing such a great semester and great meetings with Saharon Shelah, W. Hugh Woodin, Stevo Todorcevic, and Menachem Magidor.

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I am so absent-minded and lazy that it has become one of the main ways to get close to people that I bring some troubles, they try to help me, and we get close each other. Certainly, at least some secretaries in academia should be mentioned here: Ingrid, Karin, Peter, Tanja, Marco Vervoort, Thés Smeets, Marie-Louise Koskull, Martina Pfeifer, and Alexander Koponen. The more they feel close to (or annoyed with) me, the more I owe them my gratitude.

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Amsterdam, April 2010,
Daisuke Ikegami