# Acknowledgments

I would like to thank Toshifumi Futamase for his support for my undergraduate and graduate studies. He has taught me about inflation, generalized gravity theory, and quantum field theory in curved spacetime, which have always fascinated me, and continue to do so. In addition, he has opened up the CMB world to me, which has been and continues to be my main research field. I will never forget his kind and constant support for my student life; especially, for sending me to Princeton University, which has benefited my research life more than ever.

I would like to thank David N. Spergel for his genuine support and constant encouragement during the last two years of my graduate student life in Princeton University. He is not only a CMB professional, but also a superb theoretical astrophysicist. He has always intrigued and stimulated me through invaluable discussions on various topics. I greatly appreciate his suggestion that I work on the CMB non-Gaussianity; I am really enjoying the pursuit of CMB non-Gaussianity, hence the title of this thesis. I also wish to thank him for involving me in the *MAP* project. Joining the *MAP* project, has been my dream since I was an undergraduate student. I also appreciate his remarkably generous support for assisting my wife and myself in adjusting to life in the United States.

The work in chapter 5 and 6 has been accomplished in collaboration with Benjamin D. Wandelt, Anthony J. Banday, and Krzysztof M. Górski. Ben's outstanding knowledge of mathematics and statistics has helped me in completing the work in many ways. I also appreciate his constant encouragement. The collaboration started when Ben and I attended the CMB meeting held at the Institute for Theoretical Physics (ITP), the University of California, Santa Barbara. I am very grateful for this chance meeting and for the work which we have done together.

Licia Verde has taught me about the bispectrum. Through many discussions on the higher-order moment statistics with her, I have been able to improve the work in chapter 4 substantially. Licia also attended the ITP CMB meeting, after which she came to Princeton University (good for me!). I appreciate the meeting which provided me with the opportunity to meet these distinguished people.

The discussions on global topology of the universe with Taro K. Inoue have benefited the work in chapter 6 and appendix D. His remarkable, well-organized Ph.D. thesis (Inoue, 2001b) has enabled me to calculate the angular trispectrum in a closed compact hyperbolic universe, even though I am just an amateur in topology.

In addition to the supervisors, collaborators, and colleagues who have directly contributed to this thesis work, my research life has been supported by many many generous, warm-hearted people, without whom I could not have accomplished the thesis. I would like to thank them here.

Naoshi Sugiyama has helped me in learning the basic physics of CMB. I have attended his lectures on CMB twice: the first was when I was a first-year graduate student beginning serious work on CMB, and the second was when I was a fourth-year student finishing one of the thesis projects. The lectures have triggered my interest in CMB explosively, and encouraged me to pursue the CMB studies more and more. I also sincerely appreciate his generous efforts which have been indispensable for me to be accepted at Princeton University.

Yasushi Suto has (implicitly) taught me how to pursue the research. I have learned about the Sunyaev–Zel'dovich (SZ) effect through the observational project (the SZ project) led by him (Komatsu et al., 1999, 2001c). This project has affected my research life dramatically, and broadened my field-of-view by many orders of magnitude. I also appreciate his generous recommendation for me to be accepted at Princeton University.

Makoto Hattori has assisted me with my undergraduate and graduate studies. I still remember very clearly many of our discussions which took place at midnight; they were always a lot of fun. He has taught me the physics and X-ray properties of clusters of galaxies, which eventually led me to study the clusters with the SZ effect. Also, I would like to thank him for involving me in the SZ project; this involvement made my research world inflate exponentially.

Hiroshi Matsuo taught me the basics of radio observations through the SZ project. The observations with him at the Nobeyama Radio Observatory were so joyful, as have been many interesting and stimulating discussions — which often took place with drink. The tips on radio observations that I have learned from him are invaluable treasures for my research life.

I have been benefited by the collaboration with Tetsu Kitayama through the SZ project as well as the project on the CMB fluctuations induced by the cluster SZ effect (Komatsu and Kitayama, 1999). I took advantage of collaborating with him to learn about the statistical treatment of the clusters of galaxies. I also appreciate his warm friendship and encouragement.

Through the collaboration with Uroš Seljak (Komatsu and Seljak, 2001), I have learned about the physics of dark matter halos. He has expanded my understanding of clusters of galaxies substantially. The discussions with him have always stimulated me, and also encouraged me very much. I really appreciate his constant warm-hearted encouragement.

I am indebted to Kentaro Nagamine for his generous help with my early life in the United States, without which I could not have survived until now, seriously. I am grateful to all the people and colleagues in the Department of Astrophysical Sciences, Princeton University, for the warm hospitality and the exciting academic environment.

I would like to thank my English tutor, Ms. Lila Lustberg, not only for teaching me English, but also for wonderful friendship with my wife and myself. I also sincerely appreciate her constant encouragement.

I have spent six years in Tôhoku University as an undergraduate and a graduate student. Throughout my school life, I have been benefited by many wonderful fellows in the Astronomical Institute. I would like to thank them here.

I would like to thank Yousuke Itoh for friendship throughout our undergraduate and graduate school days, and his remarkably generous help with the paperwork necessary to continue my research abroad. Yousuke and I have attended the weekly cosmology seminar guided by our common supervisor, Futamase-sensei, when we were undergraduate students. Futamase-sensei's seminar has been known as one of the "hardest" student seminars in our institute, and it is really true. (One day I suffered from appendicitis when preparing for the seminar!) Yousuke is genuinely smart, and has always influenced me through the seminar. This seminar was literally my starting point as a cosmologist, and if he were not attending, I could not have made it.

I am deeply appreciative of the tremendous amount of discussions that I had with Masahiro Takada. He and I have studied CMB together through the other seminar guided by Futamase-sensei, and he has helped with my understanding of CMB significantly. I am grateful to the colleagues in our outstanding cosmology group: Shijun Yoshida, Takashi Hamana, Etienne Pointecouteau, Keiichi Umetsu, Jun'ichi Sato, Izumi Ohta, Yoshihiro Hamaji, and Nobuhiro Okabe, as well as to the fellows in the same year: Hiroshi Akitaya, Ken'ichiro Asai, Yuji Ikeda, Motoki Kino, and Naohiro Yamazaki, and to all the people in the Astronomical Institute. Especially, I would like to thank Takashi Murayama and Takahiro Morishima for their remarkably generous efforts to maintain our outstanding computer environment in the institute.

I acknowledge financial support from the Japan Society for the Promotion of Sciences, which has enabled me to study abroad and to concentrate on the research activity without being concerned about the living expenses. This financial support has been a crucial factor for me to accomplish the thesis work.

I would like to send my best thanks to my mother, Hideko, father, Hidenori, and two sisters, Natsuko and Mikiko, for their every support for my long student life as well as for their understanding of my pursuing academic research. Finally, I would like to thank my wife, Midori, who is my deepest love of all in the universe. She is the center of my universe.