

Preface

This monograph represents the culmination of a long journey upon which I first embarked a decade ago in 1997. It was after the first term of my junior year at California Institute of Technology that I realized that my true passion was in theoretical physics and not in chemistry or medicine. I switched to becoming a physics major instead, and I had the good fortune of having John Schwarz as my new undergraduate advisor. Given how I first became fascinated with physics after reading a copy of *Hyperspace* by Michio Kaku way back in high school, I could not wait to jump on the chance then of taking Ph 205 and Ph 239 on Quantum Field Theory and General Relativity as a brand-new, wide-eyed physics major.

My love for independence took me to the University of Pennsylvania on the east coast for graduate school. There I had the good fortune of meeting my graduate thesis advisor Randall Kamien who taught me about beautiful things that abound in “soft” systems. I had a feeling of truly coming in full circle at the end, when I defended my dissertation on geometrical methods in soft-condensed matter physics, the research behind which combined the use of my prior background in biology and chemistry with my love of mathematics and theory.

This monograph represents an extension of my original thesis and includes a more thorough discussion on the concepts and mathematics behind my research works on the foam model, as applied to studying issues of phase stability and elasticity for various non-closed packed structures found in fuzzy and colloidal crystals, as well as on a renormalization-group analysis regarding the critical behavior of loop polymers upon which topological-constraints are imposed. The common thread behind these two research works is their demonstration of the importance and effectiveness of

utilizing geometric and topological concepts for modeling and understanding soft systems undergoing phase transitions.

Giving credit where it is due, my thesis advisor Randy Kamien first used the brilliant idea of the foam model in explicating the observed non-close packed structures in fuzzy colloidal systems. Together with Primoz Zihlerl, Randy and I extended the foam model in studying elasticity of these fuzzy systems, while at the same time investigated the phase properties in charged colloidal crystals. Most notably, we were all fascinated with the particular A15 lattice structure that first found attention elsewhere in the related mathematical topic of minimal surfaces. It was during my collaboration with Randy when I first appreciated the fact that beautiful ideas from geometry and topology have their natural settings not only in such esoteric subjects as string theory but also in the much more hands-on field of soft physics wherein we can readily see, smell, or even touch the underlying physical systems that we are studying.

For that newfound appreciation as well as the complete freedom afforded me to explore physics and the sciences in general during my years at Penn, I am forever grateful to Randy who is one of the most upstanding and passionate physicists I have met — not to mention being the best science teacher from whom I have had the privilege of learning. Among the other mentors who have deeply shaped me as a scientist during my academic career, I would like to acknowledge my special gratitude to Sunny I. Chan at Caltech for allowing me opportunities to explore my interests in chemistry as well as for giving me numerous sound advice about life when I needed them. I would also like to thank Barry Simon at Caltech for agreeing to be my SURF mentor and granting me a summer of “smelling the roses” in the wild fields of mathematics. I would like to thank Kip Thorne at Caltech for sharing his experience on the importance of ethics in the national and international enterprises of scientific research. In the same vein, I am grateful to my postdoctoral advisor Monica Olvera de la Cruz at Northwestern University for setting a good example in balancing life and science as well as restoring my hope and faith in the latter. Above all, I am indebted to all of them, as well as my dearest friend Alan G. Roche and others too many to mention, for genuinely having my best interest in their hearts.

Last but not least, this monograph also documents, in a way, my growth and progress in this very personal life-learning journey of mine during the past decade. As such, I thank World Scientific Publishing for the opportunity of publishing this research monograph. Of course, I would not be here

without my family. And I gladly dedicate this work to my brother David as well as to my parents for their continual and unquestioning support in all my endeavors.

William Kung
Chicago, Illinois
2008