# SYNCHRONY AND DESYNCHRONY IN NEURAL OSCILLATORS

## DISSERTATION

Presented in Partial Fulfillment of the Requirements for

the Degree Doctor of Philosophy in the Graduate

School of The Ohio State University

By

Shannon R. Campbell, B.S., B.S.

\* \* \* \* \*

The Ohio State University 1997

Dissertation Committee:

Dr. DeLiang Wang, Co-Adviser

Dr. Ciriyam Jayaprakash, Co-Adviser

Dr. Charles A. Ebner

Dr. David C. Andereck

Dr. Junko Shigemitsu

Approved by

Co-Adviser

Co-Adviser Department of Physics To my family

#### ACKNOWLEDGMENTS

I came to graduate school with the rather broad goal of doing original and interesting research. I had trouble finding funding in the Physics department, but fortunately, I met Dr. DeLiang Wang in the Computer and Information Science department. His research deals with complex dynamical systems - a rich and mathematically challenging topic. Beyond that, Dr. Wang's research is based on the brain, which is one of the most interesting mysteries on Earth.

Not only were the topics interesting, but Dr. Wang provided an inspiring and supportive atmosphere. He encouraged me to learn the basics and gave insightful guidance when I was struggling with confusing research problems. He is devoted to science and his students. I also appreciate the efforts of Dr. Jayaprakash, my physics adviser, who supported my somewhat unusual route to a Ph.D., and who also gave me invaluable advice as to how to approach problems. Both advisers deserve thanks for improving the quality of my research and of my writing. Special thanks go to Dr. Wang for his relentless correction of the logical, grammatical, and other errors that occurred in my writing.

I also want to thank several people who assisted my research and gave me useful suggestions - Dr. David Terman, Arthur Ralfs, Dr. Urbashi Mitra, Dr. Feng Zhao, Dr. Charles Ebner, Dr. David Stroud, Dr. Thomas Byers, and Dr. Kim Boyer. I would like to thank John Kolen, Veit-Anh Nguyen, and Ed Large for their insights into the fields of neural networks and artificial intelligence. I am also grateful for the comments and suggestions of my committee members, Dr. David Andereck, Dr. Greg Kilcup, and Dr. Junko Shigemitsu. I have also learned from conversations with Erdogan Cesmeli and Xuiwen Liu about research, science, and the goals of computer vision.

Without the financial support of several institutions, I would not have been able to perform research. I would like to thank the Physics department for the opportunity to teach. I am grateful to the Cognitive Science Dept. for the Summer Research Fellowship that supported me at an important time in my career (1993). I was also supported in part by an ONR grant (N00014-93-1-0335), NSF grants (IRI-9211419, CDA-9413962, and IRI-9423312), and an ONR Young Investigator Award (N0014-96-1-0676) to Dr. Wang.

I owe a multitude of thanks for the support and encouragement from the personal friends I have made here in Ohio. Many thanks to Dr. Dolena Ledee, Quyet Nguyen, Dr. John and Wendy Rusnak, Naeem Shareef, Erdogan Cesmeli, Yuping Yang, Dr. Gerald Wallweber, Xuiwen Liu, Dr. Ke Chen, Craig Stoneking, Chris Woodruff, Dr. Kwok Koo, Dr. Lon Beery, Dr. Albert Clairmont, Robert Chabot, Dave Golden, Joseph Ona, John Bowles, David Reisman, Tom Blackford, Dr. Mike Lomax, Pinky and the Brain. All have been friends and teachers.

### VITA

August 12, 1969	Born - Louisiana, U.S.A
1990	B.S. Physics, Math, Univ. of Calif. at Davis
1990-present	Graduate Teaching and Research Associate, The

Ohio State University

#### PUBLICATIONS

Campbell, S. R., and Wang, D. L. (in press) "Relaxation oscillators with time delay coupling", *Physica D*.

Campbell, S. R., and Wang, D. L. (1996) "Synchronization and desynchronization in locally coupled networks of Wilson-Cowan oscillators." *IEEE Trans. Neural Networks*, 7:541-554.

Campbell, S. R., and Wang, D. L. (1997) "Relaxation oscillator networks with time delays." *International Conference on Neural Networks*.

Campbell, S. R., and Wang, D. L. (1996) "Loose synchrony in relaxation oscillator networks with time delays." *International Conference on Neural Networks*.

Campbell, S. R., and Wang, D. L. (1996) "Loose synchrony in networks of relaxation oscillators with time delays." *World Congress on Neural Networks*.

Campbell, S. R. (1996) "Loose synchrony in relaxation oscillator networks with time delay." *Seventh Midwest Artificial Intelligence and Cognitive Science Conference*.

Campbell, S. R., and Wang, D. L. (1995) "Relaxation oscillators with time delay coupling." *World Congress on Neural Networks*.

Campbell, S. R., and Wang, D. L. (1994) "Synchronization and desynchronization in locally coupled Wilson-Cowan oscillators." *IEEE World Congress on Computational Intelligence*.

## FIELDS OF STUDY

Major Field: Physics

Secondary Field: Computer Science