

## (A) Project Summary

**Title:** Dynamics in Many Dimensions  
**Principal Investigator:** Predrag Cvitanović  
**Institution:** Georgia Institute of Technology

This IGERT proposal addresses a critical need of today's science and engineering education, namely to train a new generation of young researchers who can overcome traditional disciplinary barriers in problems that share a common basis of nonlinearity and many dimensions (or degrees of freedom) in both the physical and biological sciences. To meet this grand challenge, a group of 25 faculty are joining together in a campus-wide effort with five international faculty participants. Our IGERT program will implement a new curriculum that combines innovative courses, co-advised thesis research, international internships, and efforts to promote diversity on campus.

**Intellectual Merit:** Nonlinear science deals with systems whose behavior cannot be understood by knowing how separate components behave in isolation: a nonlinear system is *not* just “the sum of its parts.” By identifying and analyzing features that are common to widely different systems, advances in nonlinear science continue to have a fundamental impact on many disciplines in the natural sciences and engineering. We believe that new scientific breakthroughs will require researchers who can investigate across departmental barriers. For example, bifurcation theory, originally developed in physics to study coherent pattern formation in various systems with many interacting degrees of freedom, has been used to understand intricate couplings between fluid mechanics and biology in both theoretical and experimental contexts. We propose the creation of an integrated, cross-disciplinary graduate training program which emphasizes fundamental concepts common to various academic disciplines and can provide the impetus and structure for initiating, stimulating, and sustaining the cross-disciplinary research required to progress in this field. The essential elements of our IGERT activities combine interdisciplinary coursework to provide students with a common toolkit in nonlinear science with individual and team research (co-advised by faculty members with complementary perspectives) to train them in the discovery of new knowledge. Also seminars, workshops and international internships will broaden their perspectives and expand their horizons.

**Broader Impact:** Our goal is to prepare a diverse group of graduate students for the rapidly evolving professional environment of the future. In addition to courses, research, seminars and internships, the IGERT activities include a student-run seminar series, annual retreats, regional workshops, international nonlinear summer schools, and a visiting scientist program. These activities are designed to provide a stimulating graduate experience which emphasizes cross-disciplinary thinking, communication skills and student community. Institutional support including matching graduate student support, collaborative recruitment, common IGERT lab and office space, and experts in the campus Office of Assessment will ensure that our program meets its goals. Furthermore, our faculty team is committed to promoting a diverse student body through outreach initiatives such as research exchange opportunities between students at Atlanta area minority colleges and Georgia Tech.

**Keywords:** nonlinear science, physical sciences, engineering, mathematical biology