National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Subject: Unsolicited proposals to the Dynamical Systems program in the Division of Civil, Mechanical and Manufacturing Innovation (ENG) and the Applied Mathematics program in the Division of Mathematical Sciences (MPS) addressing crosscutting topics in theory and application of dynamical systems

Dear Colleague:

The field of dynamical systems is one of the fundamental research areas that has enabled advances in many fields of science and engineering. Recent "research needs" workshops, panel discussions at professional meetings and research trends have pointed at several specific topics that merit further attention by the dynamical systems research community. Significant potential advances can be expected by new interdisciplinary research addressing application areas in science and engineering.

The Dynamical Systems program in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI) in the Directorate of Engineering (ENG) and the Applied Mathematics program in the Division of Mathematical Sciences (DMS) of the Directorate for Mathematical and Physical Sciences (MPS) of the National Science Foundation (NSF) recognize the opportunities posed by a closer collaboration by the two programs in the field of dynamical systems. They encourage the submission of unsolicited research proposals to the CMMI Dynamical Systems program and the DMS Applied Mathematics program addressing cross-cutting topics in one or more aspects of the following special topics:

- *Fundamentals of complex systems.* The hallmark of a complex system is its potential to adapt, self-organize, and support emergent behavior. Decomposing a complex system and analyzing its component parts may not necessarily give a clue to the behavior of the system as a whole. What can dynamical systems research contribute to our understanding of complex systems in nature or to the design of complex engineered systems?
- *Model reduction.* The fundamental laws of nature (conservation laws, Newton's law, etc.) provide the logical framework for mathematical models of physical phenomena. When the phenomena are complicated, a compromise must be found between completeness and simplicity, and some form of aggregation must be applied. What can dynamical systems research contribute to model reduction methods that preserve the characteristic features of the phenomena being modeled, especially those that are "large-scale" or nonlinear, yet are amenable to analysis and design?

- *Long-term behavior.* In his studies of weather and climate, Lorentz identified the existence of a strange attractor as a fundamental limiting factor for our ability to make long-term forecasts. What can dynamical systems research contribute to the accurate numerical simulation of large-scale nonlinear systems (such as the Earth's climate) possibly beyond the limits imposed by a strange attractor?
- *Infinite-dimensional systems.* Most research in dynamical systems has been concerned so far with finite-dimensional systems (ordinary differential equations). However, many phenomena in science and engineering are modeled as infinite-dimensional systems (partial differential equations, or "abstract" differential equations in function spaces). What can dynamical systems research contribute to our understanding and design of the dynamics of infinite-dimensional systems?
- *Discrete dynamical systems.* Large networks are ubiquitous in science and engineering (supply chains, biological networks, chemical pathways, the Internet, control systems, numerical methods, etc.). What can dynamical systems research contribute to a unified approach to discrete dynamical systems and, in particular, to our understanding of the interplay between structure and dynamics of such systems?
- *Uncertainty.* A mathematical model of an evolving physical system must account for some degree of uncertainty; either the data are uncertain or incomplete, or there is uncertainty in the model because initial or boundary conditions cannot be specified exactly, or the model is one of an ensemble of multiscale models. What can dynamical systems research contribute to the estimation of uncertainty in nonlinear stochastic dynamical systems?

Proposals addressing any of the above special topics can be submitted to either the CMMI Dynamical Systems program or the DMS Applied Mathematics program for joint consideration. Such proposals will be managed by a team consisting of program directors in CMMI and DMS.

Proposals should be commensurate with levels of effort typical in unsolicited proposals entertained by these programs. PIs are encouraged to contact the appropriate program director to discuss the research idea and research effort prior to submitting the proposal. Proposals with levels of effort that are typical for Focused Research Groups (FRG) activities in DMS are not appropriate for this focused topic area and should be submitted to the next round of the FRG competition.

Proposals must be submitted in accordance with the deadline and proposal window specified for unsolicited proposals for CMMI/Dynamical Systems and DMS/Applied Mathematics, respectively; see the NSF web site http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13574&org=CMMI and http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5664&org=DMS. They must be identified by the words "DynSyst_Special_Topics:" at the beginning of the proposal title.

Primary Contacts:

Dr. Hans G. Kaper, Applied Mathematics Program, Division of Mathematical Sciences, Directorate for Mathematical and Physical Sciences, 703-292-4859, hkaper@nsf.gov

Dr. Eduardo A. Misawa, Dynamical Systems Program, Division of Civil, Mechanical, Manufacturing and Innovation, Directorate of Engineering, 703-292-5353, emisawa@nsf.gov

Sincerely,

Dr. Adnan Akay
Division Director
Division of Civil, Mechanical
Manufacturing and Innovation
ENG

Dr. Peter March
Division Director
Division of Mathematical Sciences
MPS