ARIZONA STATE UNIVERSITY

November 18, 2003

To whom it may concern:

I am pleased to recommend Dr. Mukeshwar Dhamala for a position in your department. I was his Ph.D. advisor.

Mukesh did research on Nonlinear Dynamics and Chaos with me from 1997-2000 at both University of Kansas and Arizona State University. He was a top student in Kansas. He had a broad and solid background in nonlinear dynamics and in physics in general. He understood that dynamics provides a natural vehicle for interdisciplinary outreach. On research, he was enthusiastic about his work. He had a thorough understanding of the scientific issues pertinent to his research. Most problems on which he worked were conceptually and numerically challenging. To understand the issues involved, a lot of detailed reasoning, sophisticated derivations, and original computer techniques were necessary.

Mukesh's first research project was to devise a scheme, based on measured time series, to control transient chaos in deterministic flows. By examining the return maps obtained from time series, he proposed a control strategy to restore sustained chaotic motion for almost all initial conditions in the phase-space region of interest. The implementation of the control algorithm involved many fundamental concepts in chaotic dynamics such as chaotic saddles, fractal measures, and return maps. He proved his strategy effective by demonstrating its applicability to three problems: (1) voltage collapse in electrical power systems; (2) prevention of species extinction in ecology; and (3) elimination of undesirable bursts in a chemical reaction system. An extensive paper based on these results was published in Physical Review E.

Mukesh's second project was to examine the characterization of dynamical invariant sets responsible for transient chaos by unstable periodic orbits embedded in the sets. The problem was challenging because it involved the intriguing definition of the natural measure associated with nonattracting chaotic saddles and required a thorough understanding of the dynamical properties of unstable periodic orbits. He obtained publishable results in short time that the formulation of the natural measure by unstable periodic orbits, studied mostly for chaotic attractors, is applicable to chaotic saddles as well. He also derived a scaling law, with convincing numerical support, for the probability of detecting unstable periodic orbits from experimental measurements of transient chaos. This research was published in two papers: one in Physical Review E and another in International Journal of Bifurcation and Chaos.

While at Kansas in 1999, Mukesh also contributed to the problem of computing the generating partition for two-dimensional symbolic dynamics, which was important as there had been no systematic method for identifying the symbolic dynamics in high dimensions. Our approach made use of the infinite set of unstable periodic orbits embedded in the chaotic set and is proven to be efficient. The paper was published in Physical Review E.

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In August 1999, Mukesh moved with me to Arizona State University (ASU). There he worked on analyzing transient chaotic time series with me and Eric Kostelich. The motivation was that although there were many papers on chaotic data analysis, at the time there was almost no result on how to analyze transient chaotic data, despite the pervasiveness of transient chaos in natural systems. Mukesh concentrated on extracting unstable periodic orbits from transient chaotic data and successfully demonstrated the of a well known algorithm, originally designed for chaotic attractor, to transient chaotic data. He also investigated the computation of the correlation dimension and Lyapunov exponents from transient chaotic data. He published two papers in Physical Review E on this project.

One additional problem that Mukesh worked on concerned the nature of chaotic transients in spatially extended ecological systems, which are mathematically described by discrete time maps on continuous spatial variables. This project was under the joint supervision of me and Prof. Bob Holt from the Ecology Department at University of Kansas. Mukesh looked into the dynamical origin of and the scaling laws associated with various transient chaotic behaviors reported in the literature. His carefully controlled numerical experiments yielded evidence supporting our theoretical speculation that the reported so-called "supertransients" actually have a low-dimensional origin. A paper was published in Physics Letters A.

Mukesh was clearly very productive when he did Ph.D. research with me. He had a warm personality that makes working with him a true pleasure. He jointed Prof. Kurt Wiesenfeld's group at Georgia Tech in May 2000 to become a post-doctoral fellow, and later moved to Florida Atlantic University. While I do not know much about his work at these places, I can see from his CV that he has been productive. I recommend him strongly.

Sincerely,

Ying-Cheng Lai
Professor of Mathematics
Professor of Electrical Engineering
Fellow of the American Physical Society