The development of nonlinear normal modes using invariant manifolds – a history

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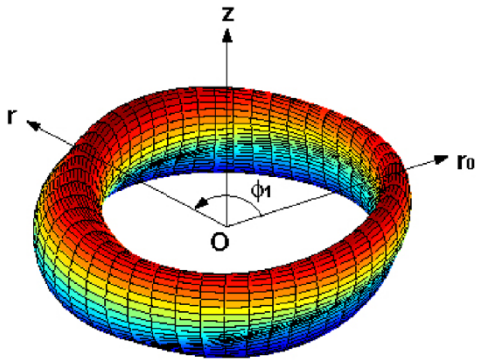
Periodic oscillations of multi-degree-of-freedom conservative systems were known to the earliest investigators of dynamics. It is now widely recognized that such motions are quite special. The Lyapunov subcenter theorem describes local invariant manifolds that contain families of such motions under certain non-resonance conditions. In seminal work in the 1960's, Rosenberg developed methods for describing and constructing these motions for conservative systems and labeled them as nonlinear normal modes (NNMs). Work on conservative systems was continued by Rand, Vakakis, Pak, and others through the 70's and 80's, including results on stability and bifurcations. In the early 90's the NNM concept was generalized by the presenter and Pierre to include non-conservative systems by employing invariant manifold theory. This approach spawned subsequent efforts on computational methods for generating reduced-order models using NNMs and experimental methods for capturing them, and also raised a fundamental question about the uniqueness of the underlying invariant manifolds, which has only recently been resolved. This talk will provide a survey of these developments, with a focus on my involvement with the subject.



Bio-sketch of S. Shaw

Steve Shaw received his Ph.D. in Theoretical and Applied Mechanics from Cornell University in 1983. He currently is Professor of Mechanical Engineering at Florida Institute of Technology and University Distinguished Professor Emeritus of Mechanical Engineering and Adjunct Professor of Physics at Michigan State University. He has also held visiting appointments at Caltech, the University of Michigan, the University of California-Santa Barbara, and McGill University. His honors include the ASME Henry Hess Award, the SAE Arch T. Colwell Merit Award, the ASME N. O. Myklestad Award, the ASME T. K. Caughey Dynamics Medal, and election to the rank of Fellow of the ASME. His research has focused on nonlinear dynamics and vibrations with applications to piecewise smooth systems, nonlinear normal modes, vibration absorbers, and micro/nano-electro-mechanical systems.