The Center for Control, Dynamical Systems, and Computation
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Presents

Arnol'd Tongues Arising from a Grazing-Sliding Bifurcation

Hinke Osinga
Department of Engineering Mathematics
University of Bristol

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Abstract:
We investigate a system with a sliding surface that has an unstable periodic orbit of focus type. This scenario is typical for a forced friction oscillator, which we use as the leading example. Sliding corresponds to sticking in this model. The instability of the periodic orbit is induced by the friction coefficient, which decreases with increased relative speed between the contacting surfaces. We derive a normal form return map near the onset of this instability and show that attracting invariant polygons arise in the system. We are able to construct a fractal-like bifurcation diagram that shows how the number of sides of the polygon varies as a function of the parameters. The polygons can be viewed as the analogon of an invariant torus for piecewise-smooth systems. Indeed, the dynamics on the polygons is phase-locked in large regions of the parameter space that form so-called Arnol'd tongues. However, not all is equivalent to smooth systems! The Arnol'd tongues look more like sausages and there is more to the polygons than the eye can see.

About the Speaker:
Hinke Osinga is Reader (equivalent to Associate Professor) in the Department of Engineering Mathematics at the University of Bristol, UK. She studied at the University of Groningen, the Netherlands, and obtained a Ph.D. in Mathematics and Natural Sciences in 1996. Subsequently, she held positions at the University of Minnesota, Minneapolis, California Institute of Technology, Pasadena, and the University of Exeter, UK. She is currently holding a five-year Advanced Research Fellowship funded by the Engineering and Physical Sciences Research Council. Her research is focused on global bifurcation theory in dynamical systems with special interest in systems with multiple time scales, piecewise-smooth systems and noninvertible system. She specializes in the development of algorithms for computing invariant manifolds and visualizing such bifurcations. Her work has an impact not only in dynamical systems, where remarkably little is known about what happens precisely to manifolds that have dimensions larger than one when they are involved in global bifurcations, but also in applications, particularly in biology and neurophysiology, where pictures often say more than a thousand words.