

# ROBOTICS, DYNAMICS, CONTROL SEMINAR

*Japan IFToMM Council*

**TIME:** 10:15-11:15am

**DATE:** Monday, December 5<sup>th</sup>, 2011

**PLACE:** Conference Room 31A, 3F, Engineering 2  
Hongo Campus, University of Tokyo

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## Grazing Induced Bifurcations in Impact Oscillator

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In this lecture I will discuss linear oscillators undergoing impact with secondary elastic supports, which are studied experimentally and semi-analytically for near-grazing conditions [1]. We discovered a narrow band of chaos close to the grazing condition and this phenomenon was observed experimentally for a range of system parameters. Through numerical stability analysis, we argue that this abrupt onset to chaos is caused by a dangerous bifurcation in which two unstable period-3 orbits, created at "invisible" grazing, take part [2]. The experimentally observed bifurcations are explained with help from simulations based on mapping solutions between locally smooth subspaces. Smooth as well as non-smooth bifurcations are observed, and the resulting atypical bifurcations are explained, often as an interplay between them. In order to understand the observed bifurcation scenarios, a global analysis is required, due to the influence of stable and unstable orbits which are born in distant bifurcations but become important at near-grazing conditions [3]. The good degree of correspondence experiment and theory fully justifies the modelling approach.

### References

1. Ing, J., Pavlovskaja, E.E., Wiercigroch, M. and Banerjee, S. 2008 *Philosophical Transactions of the Royal Society – Part A* **366**, 679-704. Experimental study of impact oscillator with one sided elastic constraint.
2. Banerjee, S., Ing, J., Pavlovskaja, E., Wiercigroch, M. and Reddy, R. 2009 *Physical Review E* **79**, 037201. Invisible grazing and dangerous bifurcations in impacting systems.
3. Ing, J., Pavlovskaja, E., Wiercigroch, M. and Banerjee, S. 2010 *International Journal of Bifurcation and Chaos* **20**(11), 3801-3817. Complex dynamics of bilinear oscillator close to grazing.

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### Biography

Professor Marian Wiercigroch educated in Poland, UK and US holds a prestigious Sixth Century Chair at the University of Aberdeen. He is a founding director of internationally renowned the Centre for Applied Dynamics Research and a Director of Internationalisation for the College of Physical Sciences. His area of research is theoretical and experimental nonlinear dynamics, which he applies to various engineering problems such as oil & gas drilling, rotor systems, underwater acoustics, fatigue and vibration isolation and renewable energy harvesting. Professor Wiercigroch has published extensively (over 250 journal and conference papers) and sits on some eight editorial boards of peer review journals. He is an editor of *Acta Mechanica Sinica* and an associate editor of *International Journal of Mechanical Sciences*. He is a frequent keynote and plenary speaker on major conferences. He has received many awards and distinctions including a Senior Fulbright Scholarship in 1994. In 2009 for his contribution to engineering and mathematics he was elected a Fellow of the Royal Society of Edinburgh, the national academy.