

#### **Dynamics of a Gear System with Impacts**

#### Petri T Piiroinen<sup>1</sup>, Joanna Mason<sup>2</sup>

<sup>1</sup>National University of Ireland, Galway - Ireland <sup>2</sup>University of Limerick - Ireland <sup>1</sup>Petri.Piiroinen@nuigalway.ie









#### A model of gear model with backlash

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Mason et al., JSV '07, IJBC '08, SIADS '09, CHAOS '11, '12, MATCOM '13













# Domains of attraction for a gear model with backlash





# Domains of attraction for a gear model with backlash





# Domains of attraction for a gear model with backlash





# Domains of attraction for a gear model with backlash







## **Bifurcations**





## **Domains of attraction**





Manifolds







**Bifurcations** 



























#### Smooth and nonsmooth Basin-Boundary Metamorphoses









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#### epsilon=0.055

epsilon=0.072

#### epsilon=0.077















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epsilon=0.078

epsilon=0.080

epsilon=0.081





0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9







0.3 0.8 0.1 0.2 0.4 0.5 0.6 0.7 0.9





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#### epsilon=0.08115

epsilon=0.0811589

#### epsilon=0.0811590















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#### epsilon=0.0903

epsilon=0.0904













#### Global analysis of an impacting system

- Gaps in the locus of boundary crises due to grazing bifurcations
- Basin-boundary metamorphoses due to grazing
- Codimension-two bifurcations points
- Boundary crisis or grazing bifurcations?
- How generic are these results?



# Thank you!