

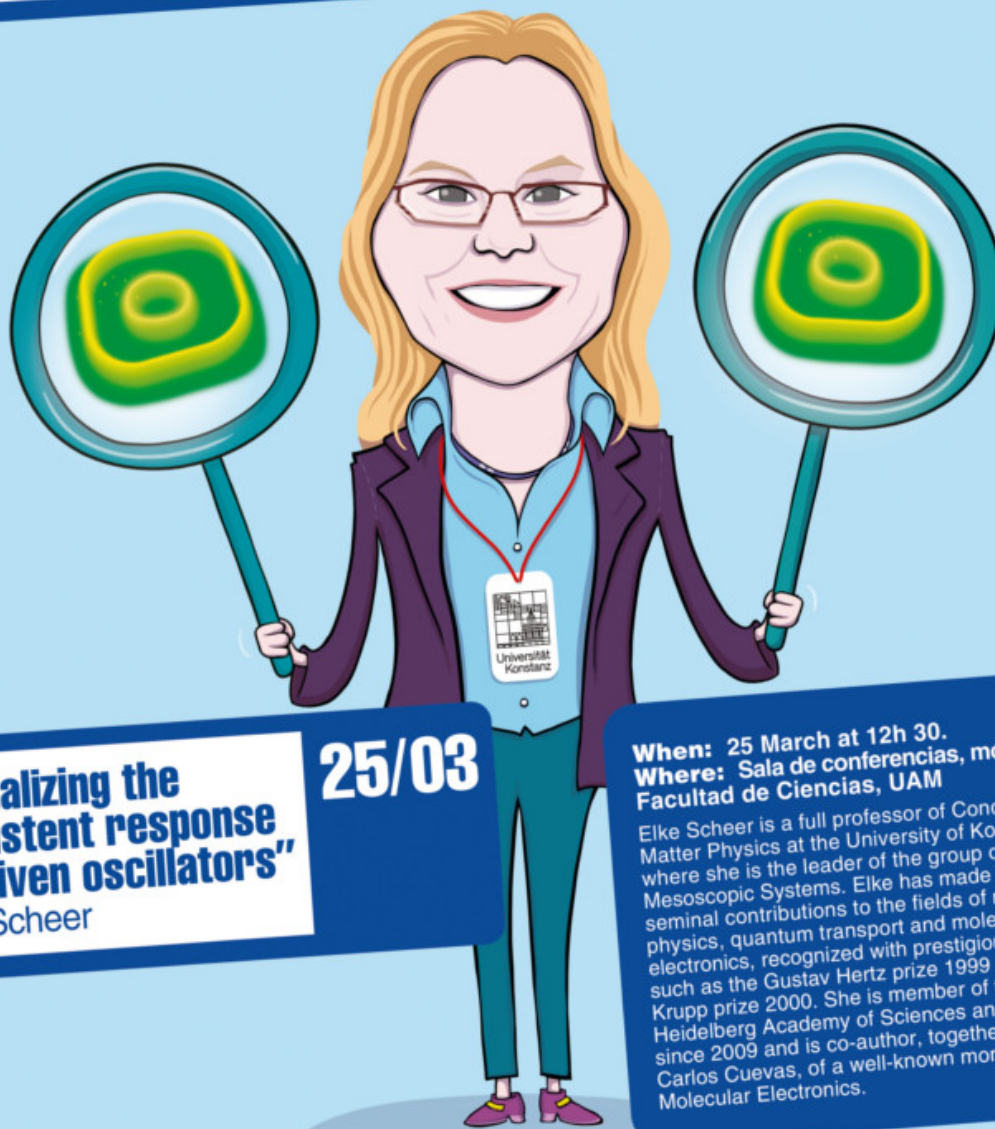
Visualization of Spatial Modulation and Persistent Response States of Strongly-driven Membrane Resonators

INC COLLOQUIUM - OFFICIAL ANNOUNCEMENT

Colloquium Frontiers of Condensed Matter Physics

Dedicated to Prof. Nicolás Cabrera (1913-1989)

2019



**"Visualizing the
persistent response
of driven oscillators"**
Elke Scheer

25/03

When: 25 March at 12h 30.
Where: Sala de conferencias, módulo 00,
Facultad de Ciencias, UAM

Elke Scheer is a full professor of Condensed Matter Physics at the University of Konstanz where she is the leader of the group on Mesoscopic Systems. Elke has made multiple seminal contributions to the fields of mesoscopic physics, quantum transport and molecular electronics, recognized with prestigious prizes such as the Gustav Hertz prize 1999 or the Alfried Krupp prize 2000. She is member of the Heidelberg Academy of Sciences and Humanities since 2009 and is co-author, together with Juan Carlos Cuevas, of a well-known monograph on Molecular Electronics.

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Title: Visualization of Spatial Modulation and Persistent Response States of Strongly-driven Membrane Resonators.

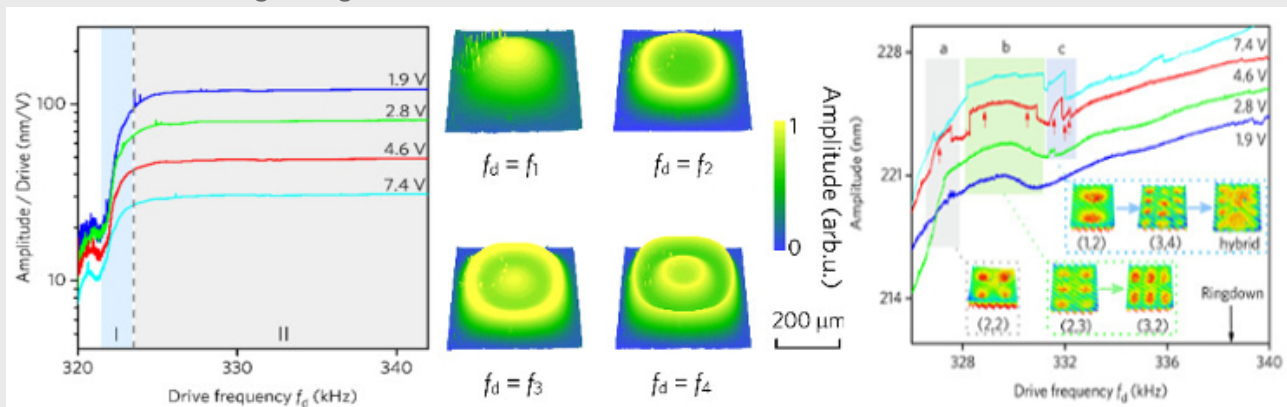
When: Monday, March 25, (2019), 12:30.

Place: Sala de Conferencias, Módulo 00, Facultad de Ciencias, Universidad Autónoma de Madrid.

Speaker: Elke Scheer, Department of Physics, University of Konstanz, 78457 Konstanz, Germany.

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icro- and nano-scale mechanical resonators operated in the nonlinear regime exhibit unusual dynamic behavior, e.g. the phenomenon of persistent response, which denotes the development of a vibrating state with nearly constant and high amplitude over a wide frequency range, see Fig. 1 left. So far, the requirements and the underlying mechanism to obtain the persistent response state have been unclear, mainly because of the difficulties to characterize this complex vibrational state experimentally. Here we present a method based on optical interferometry to directly image the vibrational state of membrane resonators. We show that upon increasing the driving strength the membrane first adopts a deflection pattern determined by localized, ring-shaped overtones of the driven mode (Fig. 1 middle) and that we denote as spatial modulation. At even larger driving strength, the persistent response arises as a signature of mode coupling between different flexural modes and their localized overtones, see Fig. 1 right.



Persistent response and spatial modulation: Left, four nonlinear resonance curves generated by different excitation voltages showing the mean amplitude response averaged over the whole membrane area. Two distinct frequency ranges are separated by a dashed line and are marked as I and II. Middle: Four examples of spatial deflection patterns observed at different driving frequencies f_d in range I associated with the spatial overtones of the ground mode mode. Right: Zoom into range II. The amplitude forms a plateau, but reveals small steps and kinks in the saturated area, some of them being marked by colored areas. In these areas the evolution of different mode patterns is captured. The red arrows indicate the position where the deflection patterns were captured.

We propose a phase diagram for the manifold vibrational states that the membrane can adopt and a model based on the coupling of nonlinear oscillators that qualitatively

describes the experimental observations.