

# Flow Instabilities & Turbulence in Viscoelastic Fluids

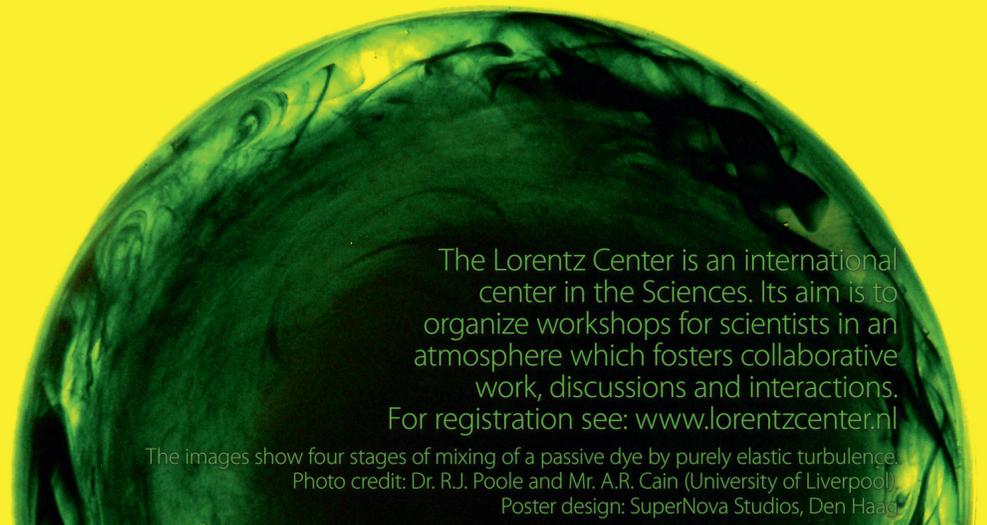
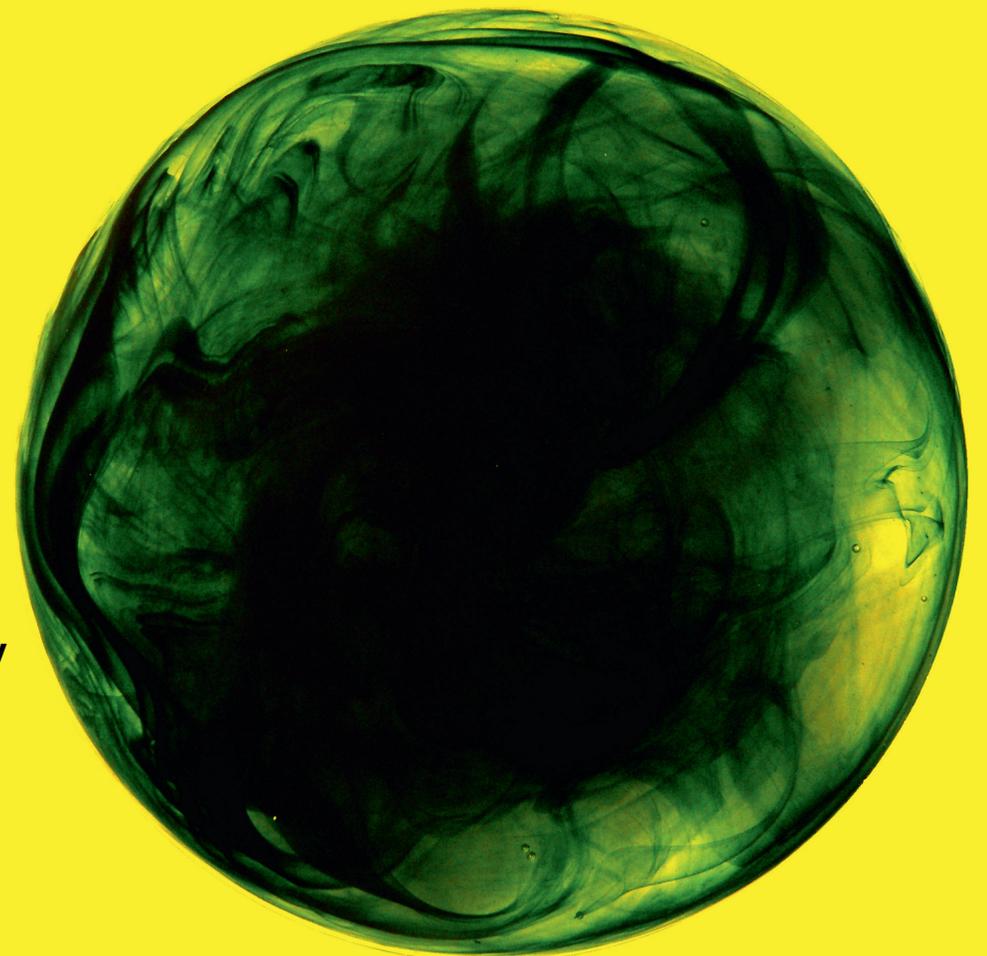
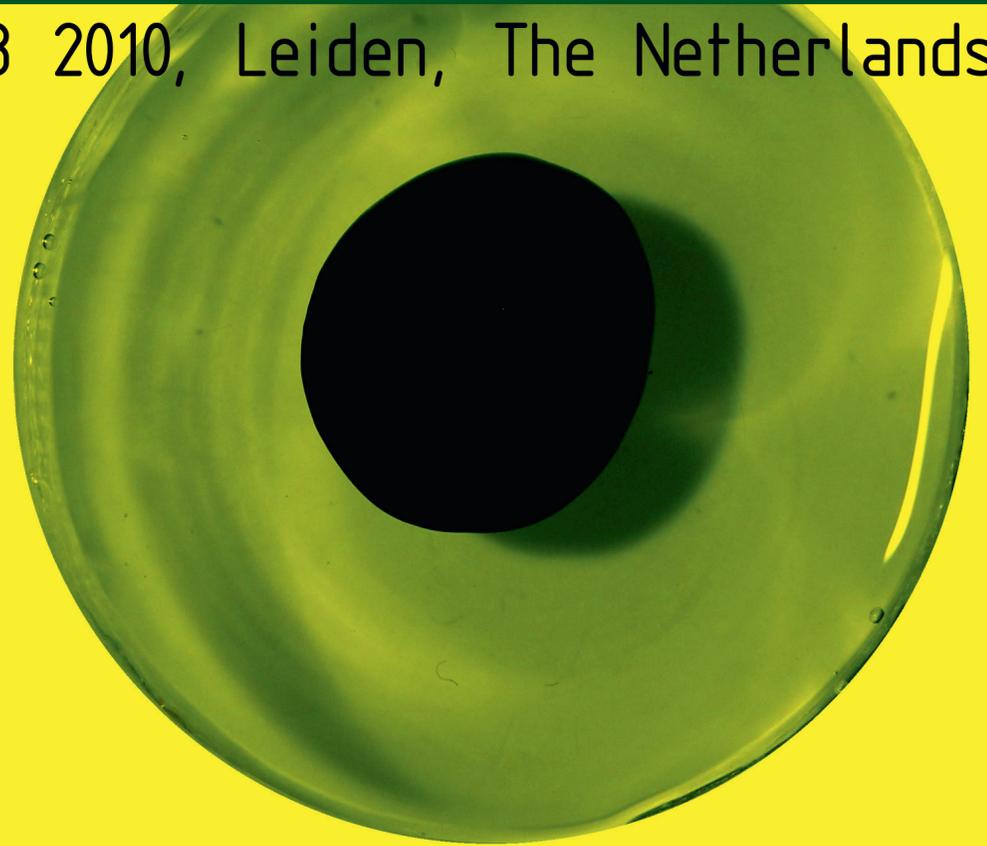
Workshop: July 19 - 23 2010, Leiden, The Netherlands

Scientific  
Organizers

- Bruno Eckhardt, Marburg
- Ronald Larson, Ann Arbor
- Alexander Morozov, Edinburgh
- Christian Wagner, Saarbrücken

Keynote  
Speakers

- Manuel Alves, Porto
- Yacine Amarouchene, Bordeaux
- Paulo Arratia, Philadelphia
- Daniel Bonn, Amsterdam
- Michael Graham, Madison
- Oliver Harlen, Leeds
- Roger Khayat, London (Ontario)
- Bamin Khomami, Knoxville
- Satish Kumar, Minneapolis
- Anke Lindner, Paris
- Innocent Mutabazi, Le Havre
- Chérif Nouar, Vandoeuvre-Lès-Nancy
- Jordi Ortin, Barcelona
- Matteo Pasquali, Huston
- Fernando de Pinho, Porto
- Robert Poole, Liverpool
- Michael Renardy, Blacksburg
- Eric Shaqfeh, Stanford
- Michael Shelley, New York
- Victor Steinberg, Rehovot
- Suresh Sureshkumar, Syracuse



The Lorentz Center is an international center in the Sciences. Its aim is to organize workshops for scientists in an atmosphere which fosters collaborative work, discussions and interactions. For registration see: [www.lorentzcenter.nl](http://www.lorentzcenter.nl)

The images show four stages of mixing of a passive dye by purely elastic turbulence. Photo credit: Dr. R.J. Poole and Mr. A.R. Cain (University of Liverpool). Poster design: SuperNova Studios, Den Haag



Universiteit Leiden



Netherlands Organisation for Scientific Research  
Physical Sciences



Netherlands Organisation for Scientific Research  
Chemical Sciences



J.M.Burgerscentrum



Ministerie van Onderwijs,  
Cultuur en Wetenschap

Lorentz  
center

## Elastic instabilities and efficient microfluidic rectifiers

P. C. Sousa<sup>(1)</sup>, F. T. Pinho<sup>(2)</sup>, M. S. N. Oliveira<sup>(1)</sup>, M. A. Alves<sup>(1)</sup>

<sup>(1)</sup> Departamento de Engenharia Química, CEFT, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. Email: {psousa, monica.oliveira, mmalves}@fe.up.pt

<sup>(2)</sup> Departamento de Engenharia Mecânica, CEFT, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal. Email: fpinho@fe.up.pt

### Abstract

In this talk we discuss a new type of microfluidic rectifier, with hyperbolic shape, which operates efficiently under creeping flow conditions using viscoelastic fluids. At low flow rates the pressure drop between the inlet and outlet ports of the microchannel is similar for both flow directions, so the diodicity is low. However, above a critical flow rate (or Deborah number), the flow patterns are markedly different in both flow directions, leading to quite different behaviour in terms of pressure drop in the forward and backward flow directions for the same imposed flow rate. Using flow visualization and micro-particle image velocimetry we show that the enhanced pressure drop in the forward direction (along a series of hyperbolic contractions and abrupt expansions) is due to the onset of elastic instabilities that develop in such a highly extensional flow, leading to a complex unsteady flow. We investigate the effects of the shape of the geometry and the depth of the microchannels on the measured diodicity using different types of viscoelastic fluids, and compare the results with those for a Newtonian fluid (distilled water).