

# BIFD 2015

Sixth International Symposium on

**Bifurcations and Instabilities  
in Fluid Dynamics**

ESPCI PARIS • 15-17 July 2015



BOOK OF ABSTRACTS

## Welcome to BIFD 2015!

BIFD 2015 is the sixth edition of an international conference founded a decade ago to treat the topics of Bifurcations and Instabilities in Fluid Dynamics.

The scope of BIFD includes the classical hydrodynamic instabilities in shear, rotating and convective flows (Taylor-Couette, Rayleigh-Bénard, Kelvin-Helmholtz, Benard-Marangoni, Rayleigh-Taylor, Faraday) and related topics such as flow in thin films, transition to turbulence, magnetohydrodynamics, geophysical and astrophysical fluids, flow control, biolocomotion and propulsion. Industrial, environmental and biomedical applications are welcome; experimental, theoretical and computational studies are all encouraged.

The organizing committee of BIFD 2015 is:

Laurette Tuckerman, CNRS and ESPCI (co-chair)  
José Eduardo Wesfreid, CNRS and ESPCI (co-chair)  
Jean-Christophe Robinet, ENSAM  
Maurice Rossi, CNRS and UPMC

The previous BIFD conferences were held in:

BIFD 2004 Madeira, Portugal  
BIFD 2006 Technical University of Denmark (DTU), Lyngby, Denmark  
BIFD 2009 University of Nottingham, United Kingdom  
BIFD 2011 Universitat Politècnica de Catalunya, Barcelona, Spain  
BIFD 2013 Technion – Israel Institute of Technology, Haifa, Israel  
Past organizers have been P. Bar-Yoseph, A. Oron, A. Gelfgat, M. Brøns, A. Cliffe, A. Meseguer, F. Marques, and I. Mercader.

The meeting has grown from 20 or so participants to the over 400 participants we welcome today in Paris, in six parallel sessions, held over three days.

We thank ESPCI (Ecole Supérieure de Physique et de Chimie Industrielle), UPMC (Université Pierre et Marie Curie), PSL (Paris Sciences et Lettres) Chaire Total de l'ESPCI, the Région Ile de France, PMMH (Physique et Mécanique des Milieux Hétérogènes), Fonds Charpak, and AFM (Association Française de Mécanique) for their support and the Ecole des Mines and the Institut Océanographique for hosting our conference.

We wish all of you a very productive and enjoyable conference!

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The BIFD international advisory committee is:

Pinhas Bar-Yoseph, Technion  
Morten Brøns, DTU  
Alexander Gelfgat, Tel-Aviv  
Alexander Oron, Technion  
Alvaro Meseguer, UPC

The Bifurcations and Instabilities in Fluid Dynamics Association is a non-profit organization devoted to promotion of research in instabilities and bifurcations in fluid mechanics, whose main objective is the realization of this bi-annual international scientific conference.



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## FLEXIBLE FIBERS IN SHEAR FLOW

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**Abstract** Modes of the dynamics of flexible fibers in shear flow in a plane perpendicular to vorticity are analyzed numerically.

Dynamics of flexible fibers in shear flow are analyzed numerically for a wide range of the ratios  $A$  of the fiber bending force to the hydrodynamic force. The Reynolds number is much smaller than unity, and the Péclet number much greater than one. A fiber is modeled as a chain of solid beads as in Ref. [1]. The centers of the consecutive beads are linked by springs. The equilibrium length of each spring is such that the consecutive beads almost touch each other. The spring constant is large, and the fiber's length practically does not change with time. At the equilibrium, the fiber is straight. At a deformed configuration, there appear a bending force exerted on each bead, proportional to the bending parameter  $A$ . The details of the model and the numerical method can be found in Ref. [2]. Velocities of the beads at given positions are evaluated with the use of the HYDROMULTIPOLE numerical code, based on solving the Stokes equations by the multiple expansion [3]. The time-dependent positions of the beads are determined by the adaptive fourth order Runge-Kutta method.

Initially, the fiber is aligned with the flow, and the springs are at the equilibrium. Owing to symmetry, the centers of all the beads move in the plane perpendicular to the vorticity direction. The fiber end-to-end vector tumbles, in a similar way as a rigid elongated body [4]. While the fiber turns, its shape evolves accordingly, and the center-of-mass oscillates across the flow. A surprisingly rich spectrum of different modes is observed when the value of  $A$  is systematically changed, with regular and chaotic trajectories. (For the details, see Ref. [5].)

For some ranges of small and large values of  $A$ , the center-of-mass trajectories are periodic with a single tumbling time  $\tau$ , and there is no migration across the flow. For a certain range of small values of  $A$ , evolutions during every second tumbling time are the same, but consecutive tumbling times differ from each other, what leads to regular migrating trajectories of the fiber center-of-mass. For moderate values of  $A$ , a chaotic behavior is observed - a large sensitivity of the dynamics to a small change of  $A$ , with (typically) many irregular, erratic trajectories or (exceptionally) some regular migrating trajectories. At a moderate value of  $A$ , a transition is observed between a 'straightening out' mode of more stiff fibers to the coiled mode of more flexible fibers. In the straightening out mode, the fiber significantly changes its shape while tumbling - from almost straight and aligned with the flow to S-shaped. In the coiled mode, the fiber is always compact, it never aligns with the flow.

## References

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