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Preface to this Festschrift for Patrick Huerre

In June of 2012, a group of friends and colleagues gathered at the École polytechnique for a surprise celebration of Patrick Huerre's 65th birthday. Throughout the day, at the barbeque grill and in the conference hall, as stories of personal memories and of ongoing research were shared, the idea for a colloquium took shape. It seemed timely to unite the instability community for a discussion of current tools and trends. This colloquium, named "Trends in Open Shear Flow Instability", took place one year later, during the first three days of July 2013, at the École polytechnique. It was a joint Euromech-Eucass Colloquium, co-sponsored by the European initiative E-CAero, by École polytechnique and LaSIPS. The colloquium was hosted by the Laboratoire d'Hydrodynamique de l'École polytechnique, which Patrick founded in 1990.

Fifty-eight researchers from eight European countries, from the US and from Chile participated in the colloquium. The complete conference program, comprising 38 talks and 12 posters, is documented on the following pages. The present volume of the *European Journal of Mechanics B/Fluids* compiles contributions from colloquium participants. Many of these are different from the authors' oral presentations, and all of them underwent regular peer review. This special issue intends to showcase the principal trends that emerged at the colloquium.

Among the most recurrent topics were the following:

(i) the relation between local and global instability characteristics;
(ii) nonlinear analysis;
(iii) modeling of the effects of turbulence on flow instability.

The computation of multi-dimensional temporal eigenmodes, commonly called *global modes*, started to be popular a little more than a decade ago [1]. Linear global mode analysis today has come to be a commonplace tool, and three-dimensional configurations are increasingly attainable [2,3]. With the widespread application comes the danger that global mode analysis may be used naïvely in inappropriate settings; specifically, the importance of *non-modal* dynamics for the unstable behaviour of flows was emphasized once more at the colloquium. Non-modal analysis may be formalized in a temporal or in a spatial framework. In both cases, optimal flow perturbations are typically determined in the form of leading singular modes of either the propagator (temporal) or the resolvent operator (spatial). The former characterizes the *transient growth* of initial perturbations, a concept that has been widely used both in globally stable and unstable situations for many years. The latter characterizes the flow response to sustained harmonic forcing, and as such it is applicable only in globally stable situations, although the extended concept of the *pseudospectrum* may be useful also for the analysis of globally unstable flows. This spatial variant of non-modal analysis, introduced in the early 1990s [4], has received increased attention fairly recently.

Clearly, these global analysis tools have not simply replaced the classical local methods, or made them obsolete. In some circumstances, the simplicity and cost-efficiency of local analysis remains a decisive argument. Moreover, linear local properties allow predictions about the *nonlinear global* dynamics in a way that cannot be reproduced with linear global methods [5]. Perhaps most importantly, the local approach is particularly well-suited for the interpretation of many physical phenomena, because it provides a clear inherent notion of spatial causality. The popular concept of a "wavemaker", as a localized flow region that supports a global instability, is by construction a local conception. In a global framework, a localized analysis of instability mechanisms is usually attempted by investigating the *sensitivity* of an eigenmode to localized changes of the global operator. The conceptual link between local "wavemakers" and global sensitivities is explored in two independent contributions [5,6]. Another study [7] uses the WKBJ formalism that allows to construct a linear global mode from local analysis results [8]. The global instability is thereby ascribed to the presence of an absolutely unstable region of the flow. In Patrick's words, the common trend is to "compute global, discuss local": quantitative predictions are sought from global analysis, but their qualitative discussion usually requires a re-localization of the flow phenomena.

Numerous approaches to nonlinear instability dynamics were exposed at the colloquium. Among these are classical methods like the weakly nonlinear expansion, identification of exact coherent structures, as well as the computationally intensive search for nonlinear optimal perturbations. On the particular nonlinear topic of turbulent transition in wall-bounded flows, the present volume features a very special contribution by Paul Manneville [9].

As far as the analysis remains linear, but is applied to turbulent flow situations, the consistent modeling of the effect of small-scale turbulence on the dynamics of large-scale instability structures is still a subject of debate. Peter Monkewitz remarked that the ultimate goal should be to identify a base state with an a priori unknown turbulent viscosity distribution, which would yield saturated instabilities that reproduce a measured turbulent mean flow. Current RANS-guided approaches aim just a bit below this high mark. The effects of nonlinearity and turbulence are specifically under investigation with regard to their role in the generation of jet noise. The modeling of linear instability

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wavepackets in turbulent mean flows [10] yields remarkable noise predictions in some regimes. In particular, such wavepacket models provide a clear interpretation of observed superdirective sound from subsonic jets [11].

Local and global instability, wavemakers, linear wavepackets in turbulent mean flows, and superdirective jet noise: without Patrick's groundbreaking contributions, we would talk differently about these things, or perhaps not at all. Our thinking would be different, and for quite a few of us it can be said: we would be different. This special issue is dedicated to Patrick, as it attests to his profound and lasting impact on the study of flow instability. What is much more, the enthusiastic participation of so many colleagues in the colloquium and in this volume shows plainly the esteem that Patrick enjoys in the community, which is not to be explained by impact metrics alone.

So here's to you, Patrick, to stable health and happiness. Absolutely.

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