EUROMECH   Final Report

EUROPEAN MECHANICS SOCIETY

Please send this report to the Secretary-General of EUROMECH, within one month after the Colloquium.

EUROMECH Colloquium No: 353

Title: **Dynamics of localized disturbances in engineering flows**

Dates and location: **01.-03.04.1996**

Chairman: **Prof. Dr.-Ing. H. Oertel**

Co-Chairman: **Dr.-Ing. J. Delfs**

Is there need of another Colloquium on the same or a related subject? Which year?   *yes , 1999*

Full registration fee: **56**

What other funding was obtained?   **DM 10.698,40**

What were the participants offered? **Booklet of summaries, Coffee Break und Lunch**

Number of members of EUROMECH (reduced registration fee):   **4**
 Speaker free: **27**
Number of non-members of EUROMECH (full registration fee): **25**

Number of participants from each country:

Country		Country		Country	
Austria	____	Germany	27	Romania	____
Belgium	____	Great Britain	4	Russia	4
Byelorussia	____	Greece	____	Slovakia	____
Bosnia	____	Hungary	____	Slovenia	____
Bulgaria	____	Ireland	____	Spain	____
Croatia	____	Italy	____	Sweden	4
Czech Republic	____	Latvia	____	Switzerland	1
Denmark	____	Lithuania	____	Ukraine	3
Estonia	____	Netherlands	1	Yugoslavia	____
Finland	____	Norway	____	Others/USA	2
France	8	Poland	2		
Georgia	____	Portugal	____	Total	56

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Scientific Report *see attachment*

see attachment

Please use additional pages if needed. Put date and signature at the end.

Report EUROMECH Colloquium 353

Scope

The aim of the EUROMECH Colloquium 353 was to bring together scientists working in the field of localized disturbances of flows in order to discuss new developments and the potential for industrial application.

Any realistic disturbance in a flow field is of limited spatial extend. During the last 10–15 years considerable progress has been made in the understanding of the physics of locally excited disturbances in unstable flows. Theoretical and experimental work but also direct numerical simulations have contributed to this progress. First, the colloquium aimed for summarizing the state of the art knowledge in the field of wave packet dynamics including the three dimensional, compressible, and nonparallel linear theory and extentions to nonlinearity as well as experiments and numerical simulation. Further the colloquium was intended to show how the developed theory of localized disturbances can be used in applied engineering problems. The role these disturbances play in the framework of transition to turbulence, active flow control etc. were to be discussed.

Execution

The conference site was the guest house on the campus of the University of Karlsruhe, Germany. As required for EUROMECH Colloquia participation was due to invitation upon evaluation of a submitted abstract by the chairmen. Moreover the activity had to be restricted to about 50 persons. As further required no parallel sessions were organized in order to provide for best possibilities for intense communication among the scientists. The course of events can be looked at in the attached programm schedule which was pretty well met. The social event scheduled on Tuesday Apr.2 consisted in a visit of a musical at the local theater; the tickets were paid by the participants who were interested.

All except of one participant came to the conference. The respective gap in the time schedule was filled by an additional participant whose abstract had been late, but who was invited anyways.

Outcome

This colloquium had attracted papers from a wide range of topics in the field of localized disturbances. Theoretical, numerical and experimental investigations were presented, all of which seem necessary in order to understand the complex phenomena involved. We outline the main points that contribute to the understanding and application of this field of studies:

- New promising analytical as well as numerical approaches for the description of the crucial disturbance initiation process due to localized roughness were presented.

- The problem of evolution of disturbances in flows which are unstable w.r.t. the so called cross–flow instability was intensely discussed. This case is of particular interest for the laminar flow technology of swept wings as used in commercial aircraft. The traditional N-factor prediction method for the laminar-turbulent transition was heavily critcized as being unable to describe the mechanisms responsible for the breakdown of the laminar flow.

  The important experimental observations were summarized as follows: a) the unsteady disturbance modes of the cross-flow instability (CFI) are receptible to freestream turbulence. b) the steady modes are receptible to roughness c) in combination the steady modes are attenuated by unsteady modes (damping effect of freestream turbulence for the stationary mode type of breakdown) d) the occurence of local high frequency disturbances following the CFI is crucial for the breakdown process e) roughness effect dominant for roughnesses within 2-5% distance from the attachment line.

  An absolute instability was found theoretically as well as experimentally in the rotating disk flow which appears to be similar to the swept wing 3d-boundary layer flow. The change from convective to absolute character of the instability occurs as a Reynolds number effect (critical radius for given rotation speed). Question remains to be answered on if the rotating disk findings can be transfered to the swept wing flow.

- The significance of longitudinal ("streaky") structures in conjuction with localized disturbances was underlined by many contributions which referred to this phenomenon. Their importance was addressed w.r.t. to following items: a) longitudinal, long living flow structures can be created by 3d-disturbers leading to considerable heat transfer enhancement b) streaky structures play appearently a crucial role for the generation of turbulent spots by interaction with Tollmien–Schlichting instabilities (TSI). This could serve as a model for the mechanism of the influence of freestream turbulence on TSI. c) occurence of longitudinal structures as result of algebraic growth from localized small and finite amplitude initial disturbance amplitudes. d) pronounced longitudinal structures observed within turbulent spots in Couette flow.

- By experiment it could be shown that the orientation and phase of an initial pulse disturbance play an important role in the non-linear regime of the disturbance evolution.

- The contributions from the sub-field of absolute/convective and global instability theory underlined the following items: a) the enhancement of the concept of absolute instability to global instability provides for an actual design of flow control in low Reynolds number flows. b) the dynamics of wave packets can be correctly simulated with vortex blob methods, giving additionally the possibility of investigating nonlinearity, especially large initial disturbances c) global

instabilities do not always lead to better mixing of jet flows d) the controlled (one-sided) initiation of global instabilities may be used to redirect jets without moving mechanical parts e) in the case of significance of surface tension the breakup of liquid jets into drops can be described (and possibly controlled) by means of absolute instability theory (application: jet printer)

The results show that the application of the aquired knowledge in the field of localized flow disturbances is just about to start. Several examples of such applications in engineering flows have been presented and intensely discussed. The summarizing effect of the Colloquium showed again the potential but also the need for further research into means of application of localized disturbances especially in laminar flow technology and active flow control.

(Dr.-Ing. Jan Delfs, Co-chair EUROMECH Colloquium 353)

encl. : program schedule EUROMECH Colloquium 353
booklet of summaries