EUROMECH

Final Report

Date: 16 June 92

Please send this report to the Secretary of the European Mechanics Council, Professor Bengt Lundberg, Dept of Mechanical Engineering, Luleå University of Technology, S-951 87 Luleå, Sweden, within one month after the Colloquium.

General

Euromech Colloquium No: 288

Title: Turbulent Flows Undergoing Distortion and Rotation

Co-Chairmen: C. CAMBON

Place and country: LYON, FRANCE

Dates: April 6-8 1992

Finance

The conference fee 1000 FF included

Funding: Grants from ERCOFTAC (2000 ECU) + 40 000 FF (French organizations CNRS, DRET)

Accomodation (type and cost): Hotels + 10 students rooms at E.C.L. (55 FF)

Meals: Cafeteria at E.C.L. (Ecole Centrale de Lyon)

Participation

Total number of participants: 55

Distribution of participants by country:

Code	Country	Number	Code	Country	Number
A	Austria		I	Italy	2
B	Belgium	1	IRL	Ireland	
BG	Bulgaria		N	Norway	1
CH	Switzerland	2	NL	Netherlands	1
CS	Czechoslovakia	1	P	Portugal	
D	Germany	1	PL	Poland	
DK	Denmark		R	Rumania	
E	Spain		S	Sweden	4
EE	Estonia		SF	Finland	
F	France	31	YU	Yugoslavia	
GB	Great Britain	5	CIS	CIS	
GR	Greece		-	Others	6
H	Hungary				

Is there need of another colloquium on the same subject? Which year? Yes. 1994 ?

Please turn

Initially, the main goal of this Colloquium was the investigation of coupled effects of compression-distortion (compression in the sense of a large variation in mean volume) and rotation on turbulence ; a particular emphasis being given on applications to reciprocating engines with swirl or tumble effects. With respect to these initial objectives, an important change of emphasis occured. This change was partly due to the suppression of the word "compression" in the title. The actual meeting focussed on background rotation effects, from a more general and fundamental stand-point. In this sense, there was a link with the 245 EUROMECH (Cambridge, April 1989). The author as chairman believes that the resulting retargeting, even though not completely controlled, made the Colloquium more penetrating. A close mutual interaction did occur between scientists interested in "Rapid Distortion Theory" (RDT) or linear stability analysis, nonlinear stability analysis, Direct (or Large Eddy) Numerical Simulation (DNS), as well as in one and two-point statistical approaches. Qualitative comparisons with recent experimental results were also made. Approaches in geophysical turbulence were compared to those used in engineering, in order to clearly display similarities and differences in conclusions despite their different terminology and "jargon".

Main Scientific Developments

The Colloquium was organised around 7 principal 50 mn talks, each one introducing a specific topic. Only these topics and the principal lecturers are quoted in the following :

* Rapid Distortion Theory and kinematic simulations (J.C.R. HUNT)
* Rotation, tumble and stretching in engine-related flows (J.H. WHITELAW)
* Rotating free-shear flows (D.J. TRITTON)
* Linear and non-linear stability of elliptical flows (F. WALEFFE)
* Rotating isotropic turbulence. Computation and modelling (N.N. MANSOUR)
* Dynamics of quasi-two dimensional flows under rotation (E.J. HOPFINGER)
* Turbulence models with new variables (structure tensor) (W.C. REYNOLDS)

Please use additional pages if needed and sign at the end.

One of the more striking conclusions, that emerged from the different approaches, is that production of turbulence can be more efficient in zones including *both* large scale vorticity and strain, than in pure straining zones. In convergence zones, increasing dissipation and non-linearities can counterbalance and even dominate "production" effects by linear vortex-stretching. 3D (three-dimensional) secondary instabilities including rotation (such as the elliptical flows instabilities) can generate more "turbulent energy" than classical 2D instabilities (such as Kelvin-Helmholtz). In the same way, the growth of the 3D perturbation is often linked to a complete breakdown of the large scale structure (whose stability is considered). This is also the case for quasi 2D eddies under a counter-rotating system, having a vorticity of the same order of magnitude as the rotation rate itself. Provided that both the background velocity field and that of the perturbation are chosen in a realistic way (according to the "kinematic simulation" and RDT), the main features of the flow pattern can be captured by a linear analysis (HUNT et al.), being much less cumbersome than DNS. Nevertheless the catastrophic character of the breakdown of certain vortex structures of the background field can be only predicted by theoretical nonlinear analyses (WALEFFE) or visualized using DNS (or LES) and experiments.

In addition to these qualitative results on the stability and turbulence, threshold values were proposed for dimensionless numbers, close to specific Rossby numbers. SOme disagreement was identified when comparing recent proposals in a geophysical context with classic criteria (BRADSHAW - RICHARDSON).

Finally, different talks illustrated how the statistical approach reflected the emergence of oriented structures. New proposals for improving one and two-point closure models for rotational mean flows were introduced (MANSOUR, REYNOLDS).

A more detailed report will be proposed by the author for publication in the J. Fluid Mech.

A two-day ERCOFTAC workshop organized by PEPIT (Lyon-Grenoble Pilot Centre) followed the EUROMECH Colloquium. Discussions concerned one point statistics with which the detailed anisotropic structure of turbulent flows can be captured. Moreover, several compressibility effects, hardly addressed during the EUROMECH, were reviewed, and on the occasion, a special interest group on "Turbulence in compressible flows" has been launched.

Participants and financial arrangements

In addition to the seven "main" talks, about 20 regular 30 mn talks were given. More than half of the lecturers were from outside France. Regarding the total number of participants (about 55) the ratio of French participants to non-French participants is larger, due to an easier last-minute registration. The distribution from different countries is as follows:

France	31
United Kingdom	5
Sweden	4
USA	3
Switzerland	2
Italy	2
Germany, Norway, Belgium, Netherlands, Tchecoslovakia	1 (for each)
Others (non-European)	3

Cancellations of two talks by Russian scientists (Sabelnikov and Federov), due to problems in using fast mail (FAX) as well as long delays for visas and ticketing, is very much regretted. Our organisation paid the travel and stay expenses of the seven invited lecturers, except for F. WALEFFE (Université de Liège and CTR-USA) whose travel expenses were generously covered by his present affiliation (CTR). Costs were also reduced because two others foreign lecturers were present in France (D.J. TRITTON and N.N. MANSOUR) before the meeting. Grants for students or participants from eastern Europe were offered by the ERCOFTAC Organisation (about 10). In order to cover all the remaining expenses, a 1 000 FF fee was requested from each regular participant. Moreover two financial contributions of 20 000 FF each were given by French organisations (CNRS - SPI Department and DRET). This is gratefully acknowledged.