

Please send this report to the Secretary of the European Mechanics Council, Professor Bengt Lundberg, School of Engineering, Uppsala University, Box 534, S-751 21 Uppsala, Sweden, within one month after the Colloquium.

General

Euromech Colloquium No: 312

Title: Turbulence and vortices in hypersonic flows

Co-Chairmen: -

Place and country: DLR Göttingen, Bunsenstr. 10, D-37079 Göttingen, Germany

Dates: 05.10.93 - 07.10.93

Finance

The conference fee 120,00DM included meals, conference dinner, book of abstracts, tea/coffee, guided city tour

Funding: conference fee, contributions from local industry, contributions from DLR

Accommodation (type and cost): hotel accommodation (50.-- DM - 150.-- DM per night)

Meals: 3 lunches, one conference dinner

Participation

Total number of participants: 31

Distribution of participants by country:

Code	Country	Number	Code	Country	Number
A	Austria	<u> </u>	IRL	Ireland	<u> </u>
B	Belgium	<u> 1 </u>	LT	Larvia	<u> </u>
BG	Bulgaria	<u> </u>	LV	Lithuania	<u> </u>
CH	Switzerland	<u> 1 </u>	N	Norway	<u> </u>
CS	Czechoslovakia	<u> </u>	NL	Netherlands	<u> 1 </u>
D	Germany	<u> 16 </u>	P	Portugal	<u> </u>
DK	Denmark	<u> </u>	PL	Poland	<u> </u>
E	Spain	<u> </u>	R	Rumania	<u> </u>
EE	Estonia	<u> </u>	S	Sweden	<u> 2 </u>
F	France	<u> 3 </u>	SF	Finland	<u> </u>
GB	Great Britain	<u> 3 </u>	YU	Yugoslavia	<u> </u>
GR	Greece	<u> </u>	CIS	CIS	<u> </u>
H	Hungary	<u> </u>	-	Others Russia	<u> 2 </u>
I	Italy	<u> 2 </u>			

Is there need of another colloquium on the same subject? Which year? 1997

Please turn

About 35 colleagues enrolled for the colloquium, 21 papers were accepted. According to the submitted papers the colloquium was organized into the following sessions:

- Boundary Layer Instability and Transition, (3 sessions, 9 papers)
- Vortices and Turbulence, (3 sessions, 8 papers)
- Shock and Vortex Interactions, (1 session, 4 papers)

No special papers were submitted on sound generation by hypersonic flows and on measurement techniques, although very interesting details of time resolving and optical (e.g. infrared) measurements were reported.

The main interest appeared to be concentrated on problems of boundary layer instability and transition. Very interesting papers on theoretical studies both by stability theory and by direct numerical simulation, and on measurements of the flow over flat plates and cones were presented.

Instability of hypersonic flows over pointed cones was investigated by a theory considering nonlocal effects, i.e. spatial variations of the nonparallel basic and disturbance flow components. Flows over blunted cones were calculated by local, linear instability theory. Experiments on blunted cones were conducted at Mach numbers up to $M = 9$. A wide range of nose radii was employed, the results showing that increasing nose Reynolds number delays transition up to a critical Reynolds number. Above this critical nose Reynolds number transition reversal occurs with early transition being observed in the vicinity of the nose. This is related to the effects of the bow shock entropy layer and to interaction of stream disturbances with the stagnation region of the body.

Direct numerical simulation (DNS), in particular temporal DNS, has been applied to transition studies in hypersonic boundary layers on flat plates and experimental studies have also been conducted using hot wire measurements and infrared thermography. Still, there seems to be a strong demand for more and improved experimental data on the instability development and transition of boundary layers on cones and flat plates.

In the sessions on Vortices and Turbulence, a main issue was the development of Görtler vortices at concave surfaces. Three papers were concerned with this phenomenon, two of them theoretical and one describing an experimental investigation. The practical reason for this increased interest seems to lay in the importance of Görtler vortices for the wall heat transfer of hypersonic boundary layers on space craft.

The general aspects of turbulent flows over hypersonic vehicles and the numerical calculation of such flows were another important topic of this part of the meeting. One paper dealt with simulation of vortices in rarefied flows using the Direct Simulation Monte Carlo method. Turbulence models for hypersonic boundary layers were discussed in another paper. The need for more experimental data to validate such models was very convincingly demonstrated.

Shock/boundary layer, vortex/boundary layer, vortex/shock and shock/shock interactions were discussed in the last session. Particularly interesting in terms of experimental techniques (use of infrared thermography and of real time holographic interferometry) were the papers on vortex/boundary layer interaction in 3-d boundary layers and on shock/shock interactions.

Göttingen, 25.02.1994

