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: **408**

Title: **Interactive dynamics of convection and solidification**

Dates and location: **18-22 March 2000, Chamonix, France**

Chairperson: **D.S. Riley, University of Nottingham, U.K.**

Co-Chairperson: **P. Ehrhard, Research Centre Karlsruhe, Germany,**
P.H. Steen, Cornell University, Ithaca, NY, U.S.A.

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

Full registration fee: **DM 360.-**

What other funding was obtained? **by** **Research Centre Karlsruhe,**
NASA (USA),
NSF (USA).

What were the participants offered?
Conference reception, coffee breaks (twice per day), conference dinner, free copy of conference proceedings, 5 invited speakers received refunding of costs, US participants received travel support.

Number of members of EUROMECH (reduced registration fee): **18**

Number of non-members of EUROMECH (full registration fee): **15 (+5 invited speakers)**
(Financial report was sent and money transferred to Prof. Hopfinger by April 11th, 2000)
Number of participants from each country:

Austria	2	Germany	5	Romania	
Belgium		Great Britain	6	Russia	
Byelorussia		Greece		Slovakia	
Bosnia		Hungary		Slovenia	
Bulgaria		Ireland		Spain	
Croatia		Italy		Sweden	1
Czech Republic		Latvia		Switzerland	1
Denmark		Lithuania		Ukraine	
Estonia		Netherlands		Yugoslavia	
Finland		Norway		Turkey	
France	7	Poland		Others (USA)	16
Georgia		Portugal		Total	38

Please turn

Scientific Report

Crystal growth, casting, soldering, welding, high-energy surface treatment, nuclear safety systems and geophysical flows are just a few examples where solidification and convection occur together. These processes are interactive on micro- and macroscales: flow affects the distribution of heat and species and hence the freezing process, while solidification changes flow boundaries, as in crusting for example, and may therefore radically alter the convection pattern. Mathematical modellers, experimentalists and applied scientists were invited to this colloquium with the aim of consolidating our understanding of such interactions, of identifying key outstanding issues, and of developing new approaches in this important area of fundamental research. Both invited and contributed papers focused on both fundamental and technologically relevant problems.
The colloquium had 5 invited presentations and 29 contributing presentations, organized in 5 sessions. The contributions roughly divide into three classes, depending on the length scale of interest: (i) phenomena on dendritic (micro-) length scales, (ii) phenomena on mushy (meso-) length scales, (iii) phenomena on rather overall (macro-) length scales.

(i) On the micro-scale, several contributions concentrated on various aspects of directional solidification of binary alloys, such as (localized) morphologies for various flow conditions and for rapid solidification. The morphological instability of pure melts, subject to convection, or the morphological instability of binary alloys with anisotropic kinetics were further foci. The growth of dendrites under diffusion-controlled conditions, as well as subject to forced or free convection, was another broad field, treated both experimentally and by phase-field methods. The final contribution concentrated on accurate experimental methods for the determination of liquid diffusion coefficients.

(ii) On the meso-scale, one focus lay on convection in mushy zones which are relevant in geophysical flows and often feature chimneys. Other contributions treated meso-segregation within the granular phase during equiaxed solidification and derived models for macro-segregation through coarsening of dendrites in the mush. The deformation of steel in the mushy state and the complex solidification behaviour of ternary systems were also topics. Further contributions covered various aspects of solidifying water-salt systems, like simultaneous melting and solidification, thermohaline convection, and natural convection in the mush with forced flow in the liquid zone. A final contribution gave an overview on the phase-change behaviour of liquid crystalline elastomers.

(iii) On the macro-scale, various complex industrial casting processes, such as vertical or horizontal continuous casting of steel, with and without magnetic stirring, strip casting and spin casting were investigated experimentally and/or modelled. Another class of problems considered was solidifying spreading flows, relevant to nuclear safety or to geophysical flows. Models for top-crusting oxidic melts and for metallic melts featuring strongly temperature dependent viscosities were presented as well as experimental investigations on Corium spreading and on axisymmetric spreading of metallic melts, both subject to simultaneous solidification. Further contributions concentrated on other problems, relevant for nuclear safety, such as freezing liquid-metal flows in tubes and the numerical treatment of solidified corium, subject to internal heat liberation and subsequent internal re-melting. Finally, the overall simulation of Czochralski crystal growth, the reactive wetting of alloys on metallic substrates, the solidification of sessile water droplets, the in-situ X-ray visualization of concentration fields in metallic alloys, and the filament deposition technique, as a potential future free-form manufacturing process, were presented.

Proceedings of the Colloquium, containing 28 contributions on about 300 pages, are currently being edited and will be published by *Kluwer Academic Publishers* shortly.

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