EUROPEAN MECHANICS SOCIETY

Colloquium Final Report Form

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Title ... Progress in statistical theory and pseudo-spectral DNS .....

Colloquium No ..542 - Dates and location: ..January 15-18 2013, École Centrale de Lyon, France

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Is there need of another Colloquium on the same or a related subject? NO Which year?

Full registration fee ... None .....

What other funding was obtained? .ONRG (USA), ERCOFTAC (EU), CEA (France), ECL (France)

What were the participants offered? .....

Number of members of Euromech (reduced registration fee) .....

Number of non-members of Euromech (full registration fee) 15

Number of participants from each country:

Austria		Great Britain	1	Slovakia	
Belgium		Greece	1	Slovenia	
Bosnia		Hungary		Spain	
Byelorussia		Ireland		Sweden	
Bulgaria		Italy	1	Switzerland	1
Croatia		Latvia		Ukraine	
Czech Republic		Lithuania		Serbia	
Denmark		Netherlands		Montenegro	
Estonia		Norway		Turkey	
Finland		Poland		Others	7
France	12	Portugal		Canada (2), Israel (1), USA(4)	
Georgia	1	Romania			
Germany		Russia		**Total**	24

List names of Applicants to EUROMECH .....

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Scientific Report

Please type your report on the following pages. Use additional pages if required. Put the date and your signature at the end.

Colloquium No 542 Scientific Report This colloquium is inspired by the legacy of Steve A. Orszag, for both themes, statistical theory and pseudo-spectral DNS. The former ranges from Spectral Linear Theory to triadic nonlinear closures, with wave turbulence theory and generalised EDQNM (Eddy Damped Quasi-Normal Markovian) closure as examples. The latter is restricted to new challenges in fundamental aspects to turbulence, permitted by pseudo-spectral DNS techniques but connected with theory and modelling, with e.g. applications to subgrid scales, for Large Eddy Simulation, and to very large scales, in the infrared limit. Turbulence is also considered interacting with rotation, shear, density-stratification, magnetohydrodynamics.

Even the linear theory, or Spectral Linear Theory, initially used in the so-called 'Rapid Distortion Theory', is an important theme for this meeting. This procedure was recovered around 1986 (e.g. Bayly, Craik) as a useful tool for hydrodynamic stability, e.g. in connection with elliptic flow instability. In a more recent application, many related studies appeared in astrophysics, e.g. for the study of accretion discs using the shearing box approximation. In addition, it can be used for a non-standard non-modal study of transient growth and bypass transition to turbulence, mediated by a generalised vortex-wave interaction in the presence of coupled effects of shear, rotation and stratification (**George Chagelishvili**, Georgia, **Wendell Horton**, USA, coupled with nonlinear dynamics of two-dimensional disturbances). Compressibility effects were addressed by **Sharath Girimaji** (USA) and irreducible anisotropic description by **Robert Rubinstein**, USA. This linear theory is interesting because, in addition to its possible application to transition, it can be extended to fully nonlinear flow cases by pseudo-spectral DNS (**Frank Jacobitz**, USA), and incorporated in more complex flow cases (**Benoit -Joseph Gréa**,France). It also provides the 'bare' linear operators, as Green's functions, with linear dispersion laws when wave modes are present, to be incorporated in Wave Turbulence theory (**Frédéric Moisy** (France)), renormalized expansions (**Semion Sukorianski**, Israel) and generalized EDQNM (confined rotating turbulence, **julian Scott**, France). In some cases, including stably stratified turbulence, rotating turbulence, MHD quasi-static and Alfvénic turbulence, a fully anisotropic (axisymmetric) spectral theory is well advanced, from SLT as the simplest building box to Wave-Turbulence and generalized EDQNM.

Fundamental aspects of turbulence at high Reynolds number can be investigated using the global spectral theory, with a more quantitative dynamical, structural and statistical approach to the cascade mediated by three-point cubic correlations, or triads in Fourier space. This offers an alternative to the approach using third-order two-point structure functions in physical space, routinely following the historical Kolmogorov's way. We have contributed to reconcile the different 'phenomenological' and 'deductive' approaches, as well as the descriptions in Fourier and physical space (**Carlo Casciola**, Italy, **Jean -Marc Chomaz**, France).

There are important modelling issues, with statistical spectral theory and its possible combination with numerical simulation, such as subgrid — or supergrid — scale modelling. Various approaches to the 'infrared' (e.g. very large structures, **Antoine Llor**, France) limit can be seen as a continuation of RNG (Renormalisation Group) techniques applied by Yakhot and Orszag, and are extensively discussed as well. Applications of improved EDQNM (new calculations, **Pierre Sagaut**, France, two-time theories, **David McComb**, UK, **Wouter Bos**, France), were shown and discussed.

A very large survey of DNS with split schemes was offered by **Michel Deville** (Switzerland), advances in the search of singularity in Euler equations (**Marc-Étienne Brachet**, France) and the technique of spectral reduction (**John Bowman**) is promising in DNS, but also for suggesting rational improvements of shell models (**Frank Plunian**, France, **Koji Ohkitani**, UK.)

Monday, February 18, 2013 C. CAMBON

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