ABSTRACTS

T. Bountis: ***Nonlinear Dynamical Processes and Complexity Science***
A number of conservative and dissipative nonlinear physical processes are reviewed whose dynamics is chaotic. It is emphasized that low dimensional chaos, although complicated, is certainly not complex, in the sense of exhibiting emergence, self-organization, pattern formation and phase transitions. High-dimensional conservative chaos, however, does display features of complexity that need to be understood as they are of great relevance to a number of dynamical engineering processes.

Ko van der Weele: ***Clustering in Granular Matter Dynamics and Traffic Flow***
The notorious occurrence of obstructive clusters in granular transport and traffic flow is well described by a dynamical model, at the basis of which lies the observation that the flux of particles/cars at any given location is a non-monotonic function of their density. In this talk we focus on a newly discovered phenomenon that is a precursor to clustering. This phenomenon, i.e., the formation of a sub-critical pattern, provides a valuable warning signal for the imminent breakdown of the flow.

G. Mylonakis: ***Clustering in Granular Media***
Static and dynamic stress behavior of granular media is examined using continuous and discrete methods. First, an analytical approach using Airy functions is outlined for detecting failure (slip) lines in granular media obeying the Moh-Coulonb failure criterion. Non-linear pde's for a homogeneous medium are derived which are satisfied by differerent stress fields without restrictions as to uniqueness. Analytical and numerical solutions are presented for a number of cases involving earth pressures in rectangular and polar coordinates. In the second part, numerical discrete element methods (DEM's) are outlined for solving stress problems in cases involving complex boundary conditions and large deformations, which are difficult to tackle analytically. Examples involving hoppers, membrane effects in triaxial devices and wave dispersion in resonant column tests are presented.

A. Dimas: ***Nonlinear Water Wave Clustering Leading to Breaking***
A sea state is analyzed into waves of differing frequencies, which travel at different frequencies; therefore, clustering phenomena (nonlinear) are possible which may lead to breaking (the analogy to a shockwave). The methodology is based on numerical simulations.

N. Makris: ***Causality, Analyticity and the Hilbert Transform***
The talk concentrates on linear phenomenological (constitutive) models. The basic transfer functions and time-response functions of linear phenomenological models are revisited. The relation between the analyticity of a transfer function and the causality of the corresponding time-response function is extended for the case of generalized transfer functions. By using the properties of the Hilbert transform and the associated Kramers-Kroning relations it is shown that transfer functions that have a singularity in their imaginary part should be corrected by adding a delta function in their real part. This operation ensures that the resulting time-response function is causal and is consistent with the theory of

generalized functions. Accordingly, the transfer functions of classical visoelastic models presented in standard vibration handbooks are revised.

Y. Stephanedes: ***Traffic Dynamics of Precursors to Near-Incidents***
Pattern formation of traffic variables is investigated in periods that precede near-incidents. The patterns are frequently observed during the formation of shock waves and lane changes, which are principal causal factors of near-incidents. Estimation of near-incident precursors can support understanding of the stochastic properties of near-incidents.

S. Stiros: ***Noise in Dynamic Measurements***
White noise is usually assumed in dynamic measurements by simple instruments (e.g. an accelerometer) and in more complex ones (e.g. robot positioning sensors). Power spectra analysis indicates coloured noise, persistence, even clustering. Additional noise is imposed by effects such as clipping and jitter.

S. Fassois: ***Non-Stationary Random Vibration Modeling and Identification***
Non–stationary random vibration signals appear in many applications ranging from structural vibrations under earthquake excitation, to bridge, and wind turbine vibrations. In this presentation the class of parametric models for non-stationary vibration is presented. The models are distinguished into three main classes: unstructured, stochastic, and deterministic parameter evolution. Corresponding identification methods are briefly presented, along with various novel developments such as "complete" methods with "adaptable" basis functions. Comparisons of the various methods are made via a benchmark study that employs a laboratory bridge–like structure with a moving mass.

Nonlinear Water Wave Clustering Leading to Breaking

Athanassios A. Dimas

Nonlinearity in wave-wave interaction is an important aspect of water wave propagation, and plays an important role in energy transfer between wave components (Hasselmann, 1962), infragravity waves (Longuet-Higgins & Stewart, 1962), and wave breaking (Phillips, 1977). One of the most significant nonlinear wave-wave interactions, for example, is the second order one (quadratic phase coupling), which occurs when two wave frequencies, f_1 and f_2, are present along with their sum or difference frequencies. Such an occurrence is often present during shoaling of irregular waves in the outer coastal zone (upstream of breaking). Energy spectra based on Fourier decomposition can be used to analyze waves in the frequency or wavenumber domain but, since Fourier decomposition is a linear analysis, it contains no information on phase differences coupling. On the other hand, the bispectrum, or its normalized form known as bicoherence, has proven to be a powerful tool to detect quadratic phase coupling associated with wave-wave nonlinear interactions, especially in association with the wavelet transform (Daubechies, 1992), which offers superior results in comparison to Fourier analysis.

The wavelet-based bispectrum or bicoherence is capable of detecting phase coupling with temporal resolution. The theory of wavelet bicoherence was introduced by Van Milligen et al. (1995) who used it to detect phase coupling of plasma turbulence. Subsequently, Chung and Powers (1998) and Larsen et al. (2001) studied the statistical properties of the wavelet bicoherence and pointed out that wavelet bicoherence estimates have a larger number of effective degrees of freedom than Fourier bicoherence estimates. In recent years, the technique has been applied to wave analysis as well as other ocean engineering applications (e.g., Hasselmann et al., 1963; Elgar and Guza, 1985; Elgar et al., 1990, 1993; Liu, 2000a,b; 2004; Massel, 2001; Mori et al., 2002; Huang, 2004; Rozynski and Reeve, 2005; Elsayed, 2006a,b).

This proposal is an experimental study of nonlinear wave clustering during propagation leading to breaking of irregular water waves over a beach of constant slope 1:10. The objective is to identify the effect of incoming wave spectra on wave breaking that is due to clustering effects during shoaling. The experiments will be performed in the wave basin (12x7m) of the Hydraulic Engineering Laboratory, Department of Civil Engineering, University of Patras, that has a maximum water depth of 1m and is equipped with a paddle wave maker. Free-surface elevation time series will be obtained by 8 wave gauges in the shoaling region leading up to breaking. Irregular waves of the JONSWAP spectrum will be examined. The resulting time series will be analyzed using the bicoherence method to identify the behavior of the frequency components of the waves leading up to breaking as well as their effect on breaking characteristics.

References

[1] Chung, J., Powers, J., 1998. The statistics of wavelet-based bicoherence. Proceedings of the IEEE-SP International Symposium on Time-Frequency and Time-Scale Analysis. Pittsburgh, Pennsylvania, USA, pp. 141–144.

[2] Daubechies, I., 1992. Ten Lectures on Wavelets. Society for Industrial & Applied Mathematics, Philadelphia, PA.

[3] Elgar, S., Guza, R.T., 1985. Observations of bispectra of shoaling surface gravity waves. Journal of Fluid Mechanics 161, 425–448.

[4] Elgar, S., Guza, R.T., 1988. Statistics of bicoherence. IEEE Transactions on Acoustics, Speech, and Signal Processing 36, 1667–1668.

[5] Elgar, S., Freilich, M., Guza, R.T., 1990. Model-data comparisons of moments of nonbreaking shoaling surface gravity waves. Journal of Geophysical Research 95 (C9), 16055–16063.

[6] Elgar, S., Guza, R.T., Freilich, M., 1993. Observations of nonlinear interactions in directionally spread shoaling surface gravity waves. Journal of Geophysical Research 98 (C11), 20299–20305.

[7] Elsayed, M.A.K., 2006a. A novel technique in analyzing non-linear wave–wave interaction. Ocean Engineering 33, 168–180.

[8] Elsayed, M.A.K., 2006b. Wavelet bicoherence analysis of wind–wave interaction. Ocean Engineering 33, 458–470.

[9] Hasselmann, K., 1962. On the non-linear energy transfer in a gravity-wave spectrum, Part I. General theory. Journal of Fluid Mechanics 12, 481–500.

[10] Hasselmann, K.,Munk,W., MacDonald, G.,1963. Bispectra of oceanwaves. In: Rosenblatt, M. (Ed.), Time Series Analysis. Wiley, New York, pp. 125–139.

[11] Huang, M.C., 2004. Wave parameters and functions inwavelet analysis. Ocean Engineering 31, 111–125.

[12] Larsen, Y., Hanssen, A., Pecseli, H.L., 2001. Analysis of non-stationary mode coupling by means of wavelet-bicoherence. IEEE International Conference on Acoustics, Speech, and Signal Processing. Salt Lake City, Utah, USA, pp. 3581–3584.

[13] Liu, P.C., 2000a. Is the wind wave frequency spectrum outdated? Ocean Engineering 27, 577–588.

[14] Liu, P.C., 2000b. Wave grouping characteristics in nearshore Great Lakes. Ocean Engineering 27, 1221–1230.

[15] Liu, P.C., 2004. A discretewavelet analysis of freakwaves in the ocean. Journal of Applied Mathematics 5, 379–394.

[16] Longuet-Higgins, M.S., Stewart, R.W., 1962. Radiation stress and mass transport in gravity waves, with application to surf-beats. Journal of Fluid Mechanics 13, 481–504.

[17] Massel, S.R., 2001.Wavelet analysis for processing of ocean surfacewave records. Ocean Engineering 28, 957–987.

[18] Mori, N., Liu, P.C., Yasuda, T., 2002. Analysis of freak wave measurements in the Sea of Japan. Ocean Engineering 29, 1399–1414.

[19] Phillips, O.M., 1977. The Dynamics of the Upper Ocean. Cambridge University Press, New York.

[20] Rozynski, G., Reeve, D., 2005. Multi-resolution analysis of nearshore hydrodynamics using discrete wavelet transforms. Coastal Engineering 52, 771–792.

[21] Torrence, C., Compo, G.P., 1998. A practical guide to wavelet analysis. Bulletin of American Meteorology Society 79 (1), 61–78.

[22] Van Milligen, B.P., Sánchez, E., Estrada, T., Hidalgo, C., Brañas, B., Carreras, B., García, L., 1995. Wavelet bicoherence: a new turbulence analysis tool. Physics of Plasmas 2 (8), 3017–3032.