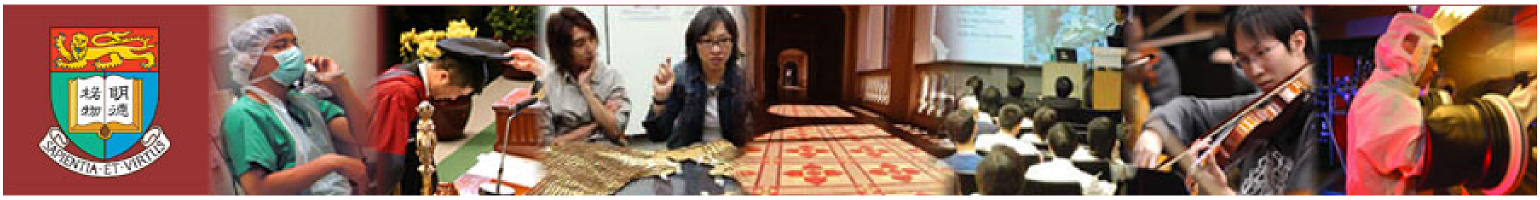

16:12 JD.005 Flow field around a sphere colliding against a wall. , R ZENIT, School of Chemical Engineering, Cornell University, M L HUNT, Mechanical Engineering Department, California Institute of Technology — This study investigates the flow field and the fluid agitation generated by particle collisions. The motion of a particle towards a wall, or towards another particle, will result in a collision if the Reynolds number of the flow is large. As the particle approaches the wall, the fluid in the gap between the particle and the wall will be displaced. When the particle touches the wall and rebounds, the direction of the flow will reverse. This process produces a considerable agitation in the fluid phase. To study this process an immersed pendulum experiment was built to produce controlled collisions of particles. A fine string is attached to a particle, which is positioned at rest from some initial angle. Once released, the particle accelerates towards a wall, or to another suspended particle, resulting in a collision. The fluid is seeded with neutrally buoyant micro-spheres, which illuminated by a laser sheet serve as flow tracers. The motion of the particles and tracers is recorded using a high speed digital camera. The images are digitally processed to calculate displacements and velocities for different times before and after the collision. Flow fields are obtained for different impact velocities, particle diameters and solid-fluid density ratios, as well as for particle-wall and particle-particle collisions. Preliminary results show that for the flow conditions tested, the rebound of the particle is dependent on the shape of the wake behind the particle at the moment of collision, and not only on the flow in the gap between the particle and the wall. The amount of collision-generated agitation appears to increase with impact velocity and density ratio.

16:25 JD.006 Saline and particle-laden intrusions in a confined linear stratification , FRANS DE ROOIJ, University of Cambridge — In many environmental and industrial situations well-mixed fluid flows into a density-stratified ambient fluid. A horizontally propagating intrusion may form, driven by the density differences due to gradients in composition, temperature or particle concentration. We present laboratory experiments investigating both saline and particle-laden lock-release intrusions into a saline, continuously stratified ambient. These experiments show that saline intrusions generate a spectrum of internal wave modes which reduce the propagation velocity of the intrusion. The lowest columnar wave modes propagate upstream of the intrusion and change the stratification before arrival of the intrusion. The relative importance of the various modes depends on the relative density of the intrusion. The experimental observations compare favourably with calculations based on the theory for internal columnar wave modes, including the reflections from the end of the tank. The experiments on particle-laden intrusions exhibit an initial evolution very similar to the saline intrusions. However, at later times, the settling of particles induces a striking transition: the intrusion is arrested and separates into a light current carrying mainly interstitial fluid, and a dense particle-laden current. Strong interactions are observed with the internal waves, yielding a more complex upstream motion in shorter tanks.

16:38 JD.007 Particle-Generated Turbulence in Dispersed Homogeneous Flows , J.-H. CHEN, University of Michigan, G.M. FAETH, University of Michigan, J.-S. WU, National Chiao-Tung University, Taiwan — Homogeneous turbulence generated by uniform fluxes of monodisperse spherical particles moving through a uniform flowing gas was studied, motivated by the importance of this turbulence production mechanism for dense sprays, bubbly flows, rainstorms and the like. Measurements of phase velocities, moments, probability density functions, temporal power spectra, spatial integral scales and particle fluxes were obtained using phase-discriminating laser velocimetry and particle sampling in a counterflowing particle/air wind tunnel. Instantaneous velocity records showed that particle wake disturbances were the same as the properties of laminar-like turbulent wakes that have been observed for particle wakes at intermediate Reynolds numbers in turbulent environments. Relative turbulence intensities are proportional to the square-root of particle kinetic energy dissipation rates, in accord with simple stochastic theory. Other properties, however, exhibit complex behavior due to contributions from both particle wakes and interwake turbulence.

MONDAY AFTERNOON, 11/23/98 –

Session JE. : Vortex Dynamics V

Monday afternoon, 15:20, Grand Ballroom B, Adam's Mark Hotel

15:20 JE.001 Nonlinear Waves, Computer Algebra and Vortex Dynamics[1] , K.W. CHOW, D.W.C. LAI, University of Hong Kong — New solutions of two dimensional, inviscid, steady vortex dynamics are derived by techniques from the theory of solitons and nonlinear waves. The case where the vorticity and the stream function are related by the hyperbolic sinh function serves as an illustrative example. The 'positon' of certain nonlinear evolution equations is obtained by a special coalescence of wavenumbers in the multi-soliton solution. The 'positon' of the sinh-Poisson equation is nonsingular, and the streamlines consist of a sequence of tripoles in the long wave limit. Computer algebra software is employed to verify the validity of the solutions independently. Relevance of these novel solutions and comparison with similar works in the literature are discussed.

[1] Supported by the Hong Kong Research Grants Council

15:33 JE.002 Towards a Numerical Proof of the Hydrodynamic Blowup Problem , R.B. PELZ, Rutgers University, J.M. GREENE, General Atomics — The evolution of an initially smooth, incompressible, inviscid flow has not been proven to remain smooth for all time. The existence of a spontaneous singularity may be shown numerically if the solution is self-similar and steady within this self-similar frame. We present numerical solutions of the spherical collapse of a symmetric vortex structure in which radius and time can be combined. Only a local self-similarity is reasonable, i.e., the inner solution is singular with a crossover region which allows the matching of the inner with an outer regular flow.

15:46 JE.003 An Integral Transform for Inviscid Shear Flow[1] , P.J. MORRISON, Department of Physics and Institute for Fusion Studies, University of Texas at Austin[2], NEIL J. BALMFORTH, Scripps Institutionof Oceanography, University of California at San Diego — The linear dynamics of inviscid shear flow in a channel is solved by means of a novel integral transform. The integral transform, a generalization of the Hilbert transform, maps Rayleigh's equation into an equation that is trivial to solve. Inversion of the transform thus gives the solution. The transform is shown to possess an inverse for large classes of functions. Numerical implementation of the transform provides an effective means of resolving the fine scale structure that develops in the vorticity. The transform is also used to describe the response of the shear flow system to external forcing.

[1] This work was supported by the U.S. Dept. of Energy Contract No. DE-FG03-96ER-54346.
[2] Supported in part by the Fonds pour la Formation de Chercheurs et l'Aide á la Recherche du Canada.