

2006 59th Annual Meeting of the APS Division of Fluid Dynamics

Tampa Bay, Florida

<http://www.aps.org/meet/DFD06>

9:44AM LH.00005 Reverse Dynamo-Flow Generation, SWADESH MAHAJAN — The “reverse dynamo” mechanism, the amplification/generation of the fast plasma flows by microscale (turbulent) magnetic fields via magneto-fluid coupling is recognized and explored. It is shown that macroscopic magnetic fields and flows are generated simultaneously and proportionately from microscale fields and flows. The stronger the microscale driver is, the stronger the macroscopic products will be. A detailed calculation based on the double Beltrami driver fields is carried out to illustrate the general features of the system.

10:10AM LH.00006 Entropy conservation in dynamic plasma simulations, JOACHIM BIRN, Los Alamos National Laboratory, MICHAEL HESSE, NASA/Goddard Space Flight Center, KARL SCHINDLER, Ruhr-University Bochum, Germany — The one-fluid magnetohydrodynamic (MHD) equations are the most common tool in investigating plasma behavior on temporal and spatial scales that are large compared to typical particle scales, such as gyroperiods and gyroradii. One of the frequent assumptions is that of adiabatic, i.e., entropy conserving, transport. In general, non-isotropic, plasmas this assumption may be violated, in addition to the possible break-down of the frozen-in flux approximation of ideal MHD. Here, entropy conservation is investigated for the dynamic field evolution associated with fast magnetic reconnection, based on a comparison between resistive MHD and particle-in-cell (PIC) simulations. Specifically, the entropy and mass integrated along magnetic flux tubes are compared between the simulations. It is shown that there is very good agreement between the conservation of these quantities in the two simulation approaches, despite the effects of dissipation, provided that the resistivity in the MHD simulation is strongly localized. This follows from the fact that dissipation is highly localized in the PIC simulation also, and that slippage and heat flux across magnetic flux tubes have negligible effect. This result lends support for using the entropy-conserving MHD approach not only before and after reconnection but even as a constraint connecting the two phases.

Tuesday, November 21, 2006 8:00AM - 10:23AM – **Session LI Experimental Techniques II Tampa Marriott Waterside Hotel and Marina Meeting Room 5**

8:00AM LI.00001 Simultaneous velocity and temperature measurements in turbulent flows using laser-cantilever anemometry and a thermocouple sensor, MICHAEL HÖLLING, FLORIAN HEIDEMANN, MARINO BEENHAKKER, STEPHAN BARTH, ACHIM KITTEL, JOACHIM PEINKE, University of Oldenburg, Institute of Physics — We present a setup that combines our newly developed laser-cantilever anemometer (LCA) and temperature sensor. These sensors allow for high temporal and spatial resolution measurements. The LCA measures flow velocity by optically detecting the deflection of a tiny cantilever. A coaxial thermocouple of gold and platinum with a diameter of around 1 micrometer gives information about the temperature. The goal of the work is to measure fluid temperature and velocity in ‘one spacial point’ by positioning the sensor tips as close to one another as possible. Due to the different measurement principles of both sensors we do not expect any significant interference. In the analysis we focus on correlations between temperature fluctuations and velocity fluctuations, which is of current interest in local isotropic turbulence research.

8:13AM LI.00002 MR Velocimetry Protocols for Small Water-Filled Channels, L. GUY RAGUIN, Department of Mechanical Engineering, Michigan State University, DIMITRIOS C. KARAMPINOS, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, LUISA CIOBANU, Biomedical Imaging Center, Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, JOHN G. GEORGIADIS, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Unlike optical velocimetry methods, nuclear magnetic resonance (NMR) relaxes the requirement of having optical access to flow, and additionally allows multiple field-specific contrast mechanisms (fluid displacement, diffusion, chemical species, etc). For small channel networks, the trade-offs between spatial and temporal resolutions leads to the following conundrum: it is better to obtain spatially resolved velocity fields but only for slowly evolving flows, or temporally resolved average velocities in each of the small channels? To explore this issue, we compare a fast and localized NMR velocimetry technique based on multiple modulation multiple echoes (MMMEV), with classical NMR imaging velocimetry protocols (flow-compensated phase-contrast spin-echo, pulse-gradient spin-echo, and spin-tagging spin-echo) in a microchannel network.

8:26AM LI.00003 RELIEF Velocimetry for Large-Scale Wind Tunnel Facilities, S. GOGINENI, Innovative Scientific Solutions, Inc., W. LEMPERT, The Ohio State Univ., J. GORD, R. SCHMIT, AFRL — The U.S. Air Force Research Laboratory (AFRL) has determined that a need exists for a seedless diagnostic instrumentation capable of obtaining quantitative flow data in large scale aerodynamic facilities, with particular emphasis on the high subsonic to moderate supersonic flow regimes. For this purpose, a RELIEF (Raman Excitation + Laser Induced Electronic Fluorescence) technique using ultra-fast laser technology is being developed. During the Phase I program, it was demonstrated that: (i) Raman shifting cells, which offer great system simplicity and increased robustness, can be used to generate the required Stokes tagging beam when using psec pulses, (ii) psec tagging result in efficient vibrational excitation (tagging) and that it enables the use of greatly (factor of ten) reduced single pulse energy, and (iii) the ArF excimer interrogation laser can be replaced with an Nd:YAG-based system. During the Phase II program, focus is being made on optimization of the optical technologies demonstrated in Phase I and delivery and integration of a complete ultra-fast flow tagging system to the AFRL Trisonic Flow Facility. These details along with the implementation of the integrated system to make velocity field measurements of the flow produced external to and within a transonic cavity model will be presented. Authors acknowledge the help of Y. Zuzeeq, M. Uddi, K. Frederickson, N. Jiang, S. Roy, and T. R. Meyer for their contributions during the experiments.

8:39AM LI.00004 MEMS Based Flow Sensors and Their Application on Flow Imaging, YINGCHEN YANG, NANNAN CHEN, JONATHAN ENGEL, CRAIG TUCKER, SAUNVIT PANDYA, CHANG LIU, University of Illinois at Urbana-Champaign, MICRO AND NANOTECHNOLOGY LABORATORY TEAM — We report characterization and application of recently developed, MEMS based, out-of-plane hot-wire anemometer (HWA) sensor and bio-inspired artificial hair cell (AHC) sensor. Sensitivities of 0.2mm/s for HWA and 0.1mm/s for AHC have been achieved in water flows, comparing with 1mm/s of a conventional HWA. In contrast to its high sensitivity, the AHC sensor can survive 55° bending of its hair, making it very robust. After calibration, both HWA and AHC sensors were employed for dipole field and wake measurements. The dipole field was generated by a vibrating sphere in a large water tank; the measurement results match very well with the analytical model. The wake was created by a circular cylinder in a water channel; the RMS velocity distributions replicate the main features of a typical wake accurately. The two types of sensors were also applied in array format to mimic a fish lateral line for imaging hydrodynamic events. Multi-modal sensors capable of simultaneous measurement of flow velocity, shear stress, pressure and temperature are under development.

8:52AM LI.00005 ABSTRACT WITHDRAWN —