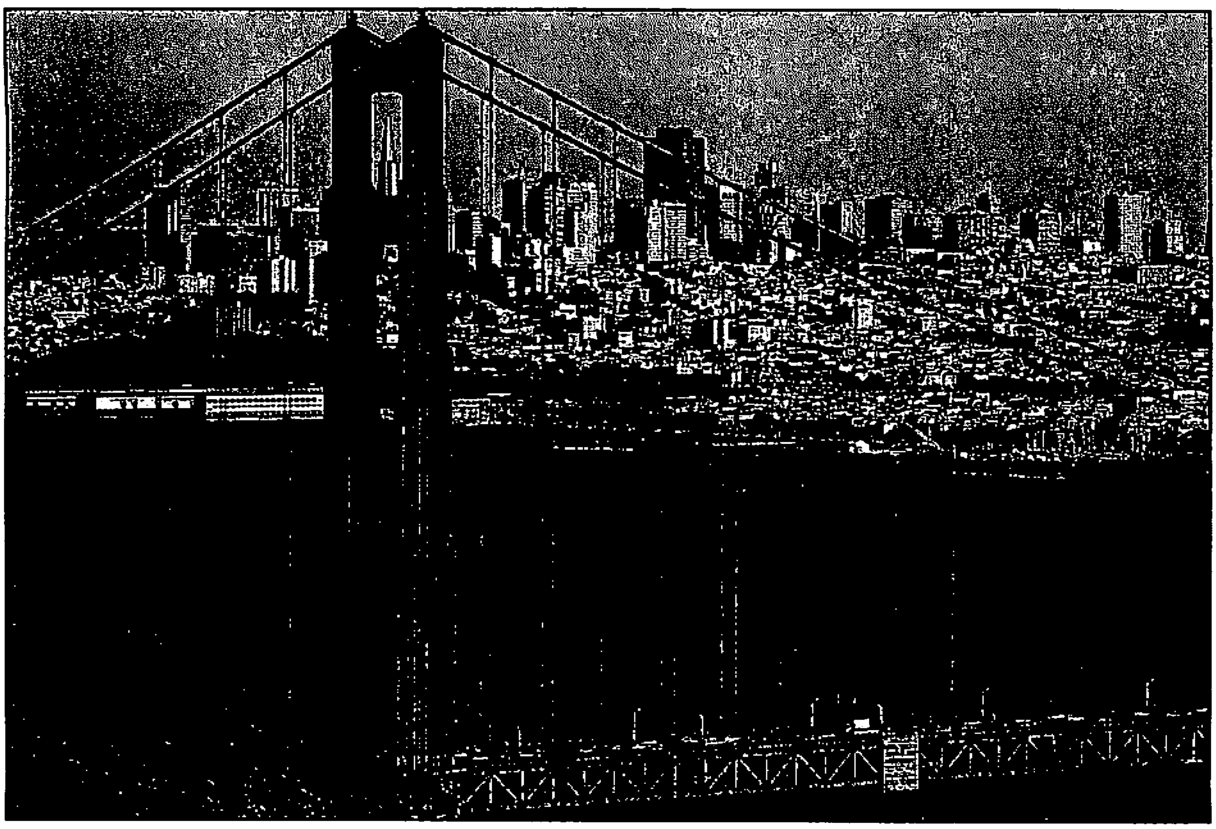
BULLETIN

OF THE AMERICAN PHYSICAL SOCIETY

67th Annual Meeting of the APS Division of Fluid Dynamics

November 23-25, 2014

San Francisco, California



Volume 59, Number 20

APS physics™

is to extend the available information on *ALS* by means of a detailed exploration of the parameter space in which it occurs. Frequency analysis from time series simultaneously recorded at several points of the domain has been applied to identify the different transitions taking place. The *VLF* occurs in a wide range of control parameters and its interaction with the axially localized states is crucial is most transitions, either between different *ALS* or to the chaotic regime.

*Spanish Ministry of Education and Science Grants (with FEDER funds) FIS2013-40880 and BES-2010-041542.

15:07
D11 5 Precession of a rapidly rotating cylinder flow: traverse through resonance* JUAN LOPEZ, *Arizona State Univ* FRANCISCO MARQUES, *Universitat Politècnica de Catalunya* The flow in a rapidly rotating cylinder that is titled and also rotating around another axis can undergo sudden transitions to turbulence. Experimental observations of this have been associated with triadic resonances. The experimental and theoretical results are well-established in the literature, but there remains a lack of understanding of the physical mechanisms at play in the sudden transition from laminar to turbulent flow with very small variations in the governing parameters. Here, we present direct numerical simulations of a traverse in parameter space through an isolated resonance, and describe in detail the bifurcations involved in the sudden transition.

*U.S. National Science Foundation Grant CBET-1336410 and Spanish Ministry of Education and Science Grant (with FEDER funds) FIS2013-40880.

15:20
D11 6 Instabilities of the sidewall boundary layer in a rapidly rotating, split cylinder* PALOMA GUTIERREZ-CASTILLO, JUAN LOPEZ, *Arizona State Univ* The flow in a rapidly rotating cylinder is studied numerically. The cylinder is split in two with the top rotating slightly faster than the half. The interior basic state is in solid-body rotation with the mean rotation rate. Differential rotation drives boundary layers on the sidewall, and the top and bottom endwalls drive fluid into the sidewall layer. The basic state loses stability to three-dimensional perturbations when both the mean rotation and differential rotation increase. Then, the sidewall boundary layer and the corner flow in the slower half undergo a number of instabilities. These include slow low-azimuthal-wavenumber modes whose frequencies excite inertial waves in the interior as well as fast high-azimuthal-wavenumber modes whose impact is contained in the sidewall boundary layer region. Some of these high azimuthal-wavenumber modes have a complicated behavior with pairs of Gortler vortices present in the bottom corner of the cylinder. The behavior becomes even more complicated with mixed modes with interacting low and high azimuthal wavenumbers, and nonlinear competition due to Eckhaus instabilities and mode interactions.

*Supported by NSF Grant CBET-1336410.

15:33
D11 7 On the nonlinear stability of the circular Couette flow to viscous axisymmetric perturbations PUN WONG YAU, SHIXIAO WANG, *University of Auckland* ZVI RUSAK, *Rensselaer Polytechnic Institute* An axisymmetric viscous nonlinear stability analysis of the circular Couette flow to any finite amplitude perturbation is developed. The analysis is based on investigating the reduced Arnol'd energy-Casimir function A_{rd}, which consists of the sum of the total kinetic energy of the flow E and the Casimir circulation dependent function C_S, i.e. $A_{rd} = E + C_S$. In this case, ΔA_{rd} is used as a Lyapunov function, which represents the difference between the reduced Arnol'd function at a later time t and the corresponding base flow value. The requirement for the temporal decay of ΔA_{rd} leads to two novel conditions for the nonlinear stability of this steady flow against axisymmetric viscous perturbations of any finite amplitude. We also establish for the very first time a definite nonlinear stability region in terms of the operational parameters for the circular Couette flow. Once the flow is nonlinearly stable and stays axisymmetric, it always decays asymptotically to a unique steady state defined by the rotating cylinders. The results from this research shed a new fundamental physical insight into a classical flow problem that was studied for many decades.

15:46
D11 8 At what spatio-temporal scales can inertial waves be found in rotating turbulence? PIERRE-PHILIPPE CORTET, ANTOINE CAMPAGNE, *Laboratoire FAST, CNRS, Université Paris-Sud, France* BASILE GALLET, *Laboratoire SPHYNX, Service de Physique de l'État Condensé, DSM, CEA Saclay, CNRS, 91191 Gif-sur-Yvette, France* FRÉDÉRIC MOISY, *Laboratoire FAST, CNRS, Université Paris-Sud, France* We present a spatio-temporal analysis of a statistically stationary rotating turbulence experiments aiming to extract a statistical signature of inertial waves and to determine at what scales and frequencies these waves can be detected. This analysis is performed from two-point correlations of temporal Fourier transform of the velocity fields time series obtained from stereoscopic PIV measurements in the rotating frame. From this data, it is possible to quantify the degree of anisotropy of turbulence due to global rotation both as a function of angular frequency ω and spatial scale normal to the rotation axis $r_\perp$. This frequency and scale dependent anisotropy is found compatible with the dispersion relation of inertial waves, provided that a weak nonlinearity condition is satisfied in terms of a properly defined Rossby number dependant on the spatio-temporal scale $(\omega, r_\perp)$.

15:59
D11 9 On the development of lift and drag in a rotating and translating cylinder* ANTONIO MARTIN-ALCANTARA, *Universidad de Malaga (Spain)* ENRIQUE SANMIGUEL-ROJAS, *Universidad de Cordoba (Spain)* RAMON FERNANDEZ-FERIA, *Universidad de Malaga (Spain)* The two-dimensional flow around a rotating cylinder is investigated numerically using a vorticity forces formulation with the aim of analyzing the flow structures, and their evolutions, that contribute to the lift and drag forces on the cylinder. The Reynolds number, based on the cylinder diameter and steady free-stream speed, considered is $Re = 200$, while the non-dimensional rotation rate (ratio of the surface speed and free-stream speed) selected were $\alpha = 1$ and 3. For $\alpha = 1$ the wake behind the cylinder for the fully developed flow is oscillatory due to vortex shedding, and so are the lift and drag forces. For $\alpha = 3$ the fully developed flow is steady with constant (high) lift and (low) drag. Each of these cases is considered in two different transient problems, one with angular acceleration of the cylinder and constant speed, and the other one with translating acceleration of the cylinder and constant rotation. Special attention is paid to explaining the mechanisms of vortex shedding suppression for high rotation (when $\alpha = 3$) and its relation to the mechanisms by which the lift is enhanced and the drag is almost suppressed when the fully developed flow is reached.

*Supported by the Ministerio de Economia y Competitividad of Spain Grant No. DPI2013-40479-P.

16:12
D11 10 Robustness of point vortex equilibria in the vicinity of a Kasper Wing RHODRI NELSON, TAKASHI SAKAJO,