TURBULENCE IN A ROTOR/STATOR CAVITY IN THE VICINITY OF THE CRITICAL POINT OF SF_6

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The extreme regimes of spatial turbo-pumps are sources of complex hydrodynamic phenomena that may be critical to their operation: appearance of instabilities, excitation of vibrational modes, new sources of dissipation and heat transfer. Understanding and accurately predicting the hydrodynamics in these systems play a crucial role in the stability and the performance of these machines. To achieve the very high Reynolds numbers ($Re \sim 10^7$ to 10^8) of these flows and also to exhibit possible resonances of cavity modes induced by the fluid compressibility, we conducted an experimental study of rotor / stator flows in sulfur hexafluoride (SF_6) in the vicinity of its critical point. Indeed, in these circumstances thermodynamical properties are very particular and both the viscosity of the fluid and its sound speed decrease consequently when compared to their normal pressure and temperature conditions values. Our results, obtained in a container containing SF_6 at a pressure up to 60 bars and a temperature around 45 °C, show the appearance of resonances of the cavity rotor / stator with frequencies consistent with our theoretical model which is based on the Helmholtz resonator model, as can be seen on figure 1. Our project at the intersection of two disciplines -hydrodynamics and thermodynamics- allows also the study of the coupling between the turbulent fluctuations of the flow and the thermodynamic fluctuations of the fluid itself. We therefore describe our first results concerning the properties (spectra, probability density fluctuations) of this new type of compressible turbulence and / or interaction with the thermodynamic fluctuations of the fluid on which it lives.

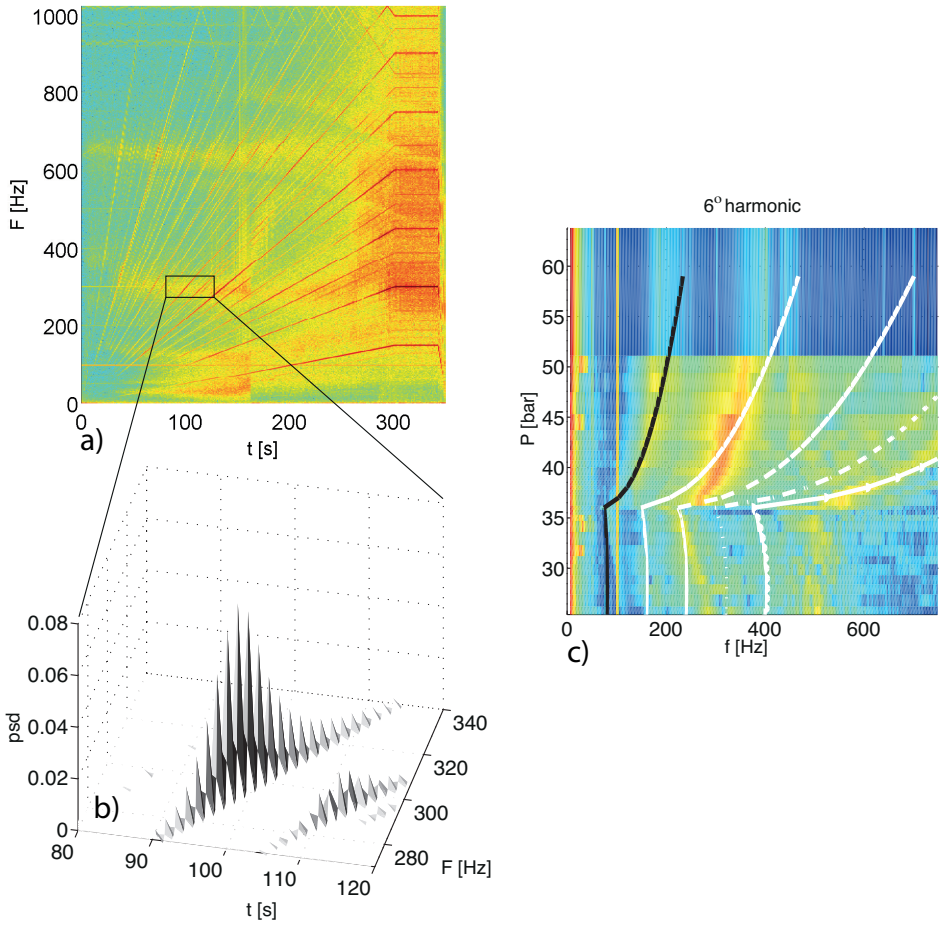

Figure 1. a) Spectrogram of the acceleration of the stator. b) Resonant mode of the cavity excited by the turbulent flow. c) Evolution of the resonant mode as a function of pressure and the predicted resonant frequency (black line) and its harmonics (white lines).