PHYSCON 2007

CONTROL OF TURBULENCE SPECTRA BY ACOUSTIC FORCING

POLINA LANDA
Physics Department, Lomonosov Moscow State University, Leninskie Gory, Moscow 117234, Russia
planda@mail.ru

VADIM USHAKOV
Central Institute of Aerohydrodynamics, Radio str. 17, Moscow 107005, Russia
uvadim@mail.ru

It can be shown that in the linear approximation equations of mechanics of continuum moving medium have solutions describing hydrodynamic and acoustical waves. These waves are distinguished by dispersion law and propagation velocity. Because of nonlinearity, in real media hydrodynamic and acoustic waves are interacting. The control of turbulence by acoustic forcing can be considered as a result of this interaction. It is known that low-frequency acoustic forcing intensifies turbulent pulsations, whereas high-frequency acoustic forcing suppresses turbulence [1; 2].

Within the initial part of the unexcited jet, spectral densities of the pulsations of fluid velocity and pressure are of a resonant character. Our experiments show that turbulent pulsations intensifies if the frequency of acoustic forcing f_a is equal to the frequency f_m corresponding to the maximum of the spectral density of unexcited jet at some distance from the nozzle. In this case the spectral density have peaks at frequencies multiple of the f_a. If the forcing frequency f_a is twice as large as f_m, then strong amplification of the velocity pulsations appears at frequencies near $f_a/2$. The turbulence suppression arises when f_a is four times greater than f_m.

The phenomenon that is similar to the Stochastic Resonance is also found in a turbulent jet with acoustic forcing. In this case the role of external noise plays the initial turbulence at the nozzle exit section and the acoustic forcing plays the role of periodic signal. It is experimentally shown that increasing of the initial turbulence leads to the non-monotone behavior of the hydrodynamical wave amplitude on a frequency of f_a at some fixed distance from the nozzle exit section [3].

References

A.E. Ginevsky, Ye.V. Vlasov and R.K. Karavosov, Acoustic Control of Turbulence Jets, (Springer, Heidelberg, 2004).

P.S. Landa, P.V.E. McClintock, Development of turbulence in subsonic submerged jets, Physics Reports 397 (2004) 162.

P.S. Landa, V.G. Ushakov, Manifestation of “Stochastic Resonance” in submerged acoustically forced jets, JETP Letters vol. 86, issue 5, 2007.