UDC 533.9.004.14; 621.039.6

L.V. Abdurakhimov, M.Yu. Brazhnikov, G.V. Kolmakov,
A.A. Levchenko*, I.A. Remizov

ISSP RAS, Chernogolovka, Moscow region, Russia, 142432
*E-mail: levch@issp.ac.ru

Turbulence on the surface of cryogenic liquids in restricted geometry of experimental cell

We report on results of experimental investigations of nonlinear phenomena on the surface of liquid hydrogen and helium. The experiments were carried out at temperature T=1.7 K for superfluid helium and at T=15 K for liquid hydrogen. Helium and hydrogen gases were condensed into the copper cup of inner diameter 30 mm (helium) and 60 mm (hydrogen) and depth 4 mm.

Key words: helium, hydrogen, low temperature kelvin.

Л.В. Абдурахимов, М.Ю. Бражников, Г.В. Колмаков, А.А. Левченко, И.А. Ремизов

Турбулентность на поверхности криогенных жидкостей в ограниченной геометрии экспериментальной ячейки

Мы сообщаем о результатах экспериментальных исследований нелинейных явлений на поверхности жидкого водорода и гелия. Эксперименты проводились при температуре Т=1,7 К при сверхтекучем гелии и при Т=15 К для жидкого водорода. Газы гелия и водорода конденсируются в медную чашку внутренним диаметром 30 мм (гелия) и 60 мм (водорода) и глубиной 4 мм.

Ключевые слова: гелий, водород, низкие температуры, кельвин.

Л.В. Абдурахимов, М.Ю. Бражников, Г.В. Колмаков, А.А. Левченко, И.А. Ремизов

Геометриясы шектелген тәжірибелік ұяшықтағы криогенді сұйықтардың бетіндегі турбуленттілік

Біз сұйық сутегінің және гелийдің бетіндегі бейсызық құбылыстардың тәжірибелік зерттеулерінің нәтижелерін баяндаймыз. Тәжірибелер асқын аққыш гелийде Т=1,7 К температурада және сұйық сутегі үшін Т=15 К температурада жүргізілді. Гелийдің және сутегінің газдары ішкі диаметрі 30 мм (гелийге) және 60 мм (сутегіге) және тереңдігі 4 мм мыс ыдысқа конденсирленеді.

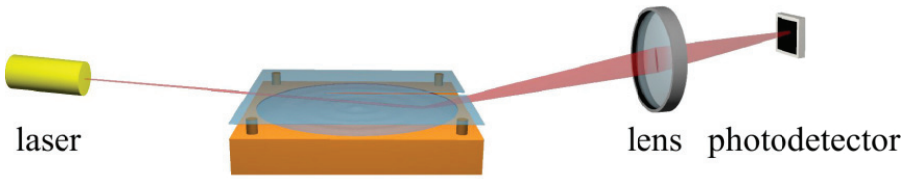
Түйін сөздер: гелий, сутегі, төмен температуралар, кельвин.

We report on results of experimental investigations of nonlinear phenomena on the surface of liquid hydrogen and helium. The experiments were carried out at temperature T=1.7 K for superfluid helium and at T=15 K for liquid hydrogen. Helium and hydrogen gases were condensed into the copper cup of inner diameter 30 mm (helium) and 60 mm (hydrogen) and depth 4 mm. The cup and a copper plate which has been fixed 4 mm above the cup form a flat capacitor. A Source of charges glued to the bottom of the cup ionizes liquid. The surface of liquid is charged with positive ions when DC voltage of about 1 kV is applied between the plates of capacitor. A low-frequency AC voltage applied in addition to the DC voltage excites waves on the charged surface of liquid. Waves are detected by means of a laser beam reflected from the surface of liquid and then focused into a photodetector. Variation of angle between the laser beam and the oscillating surface leads to the modulation of the power of reflected light $P(t)$. As we have shown earlier [1] the power spectrum P^2_ω, obtained by Fast Fourier Transformof the $P(t)$, is proportional to the spectrum of the pair correlation function of the surface elevation.

The first result is experimental observation of two bottleneck effects near the high frequency boundary of the inertial range on the spectrum of the turbulence in the system of capillary waves

on the surface of liquid hydrogen and superfluid helium driven by a harmonic force. Both effects are manifested as a local maximum on the spectrum of pair correlation function of the surface elevation. On the surface of liquid hydrogen the local maxima can be seen only during reconfiguration of the turbulent cascade caused by a generation of waves below the driving frequency. The other one observed in the steady state spectra of capillary turbulence on the surface of superfluid helium [2] is explained by detuning between harmonics in turbulent cascade and resonant modes of the experimental basin.

The second result is experimental registration of low-frequency harmonics on the surface of liquid hydrogen in a square cell and on the surface of superfluid helium in a cylindrical cell excited by monochromatic force. It was shown [3] that conditions for generation of waves in the low-frequency range can be found experimentally by variation of the frequency of driving force and a discreteness of the spectrum of surface waves changing the boundaries of experimental cells. As on the surface of superfluid helium, and on the surface of liquid hydrogen low-frequency harmonics are generated mainly due to three-wave interactions. Energy from range of excitation is transferred simultaneously towards high frequencies in direct cascade and towards low frequency harmonics.



References

1 Brazhnikov M, Levchenko A, Mezhov-Deglin L, Instr. Exp. Tech.45(6), 758 (2002)
2 Л.В. Абдурахимов, М.Ю. Бражников, А.А. Левченко, И.А. Ремизов, С.В. Филатов, УФН 182, 879 (2012)
3 Л.В. Абдурахимов, М.Ю. Бражников, А.А. Левченко, А.М. Лихтер, И.А. Ремизов, направлено в ФНТ.