

Quantized Vortex Physics in the hcp ^4He , Studied by Torsional Oscillator with Detailed AC Velocity Dependence and Under DC Rotation

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We describe the unique responses of the torsional oscillator(TO) containing hcp ^4He starting below a unique onset temperature, T_o , by studying the AC velocity dependence below T_o [1], and discuss the appearance of the vortex fluid(VF) state[1, 2]. We found a unique T_c , well below T_o , below which hysteretic behavior appears when the AC drive level is changed below T_c [3]. In addition, we found an extra energy dissipation of the TO appears in proportion to the DC rotation speed only below the same T_c [4]. This is the evidence for quantized vortex lines penetration in the supersolid state under DC rotation which we have been searching for at $T \ll T_o$ [2, 5] as in an artificial 3D superfluid[6].

- 1]. A. Penzev, Y. Yasuta, and M. Kubota, Phys Rev Lett 101, 065301 (2008).
- 2]. P. W. Anderson, Nature Phys. Vol. 3, 160 (2007); Phys Rev Lett 100, 215301 (2008).
- 3]. N. Shimizu, Y. Yasuta, and M. Kubota, arXiv:0903.1326.v3.
- 4]. M. Yagi, A. Kitamura, N. Shimizu, Y. Yasuta, M. Kubota, J Low Temp Phys (2011) 162: 492 - 499.
- 5]. M. Kubota, N. Shimizu, Y. Yasuta, A. Kitamura, M. Yagi, J Low Temp Phys (2011) 162: 483 - 491.
- 6]. M. Fukuda, et al., Phys. Rev. B 71, 212502 (2005); M. Kubota, et al., AIP Conf. Proc. 850, (LT24) 283, (2006).