Superfluid density in quasi-one dimensional systems

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Superfluidity (SF) in quasi-one or one-dimensional (1D) systems has recently attracted much interest. An example is experiments on ^{4}He confined in nanopores[1]. Superfluid behavior of cold atoms confined in a 1D trap has also attracted interest.[2] ^{4}He atoms are adsorbed on the inner walls of 1D nanopores, forming nanotubes (films). When the density increases, liquid ^{4}He fills the nanopores and forms nanobars (rods). We first discuss the similarity and difference between SF in nanotubes and in nanobars. Superfluid density in both cases is strongly suppressed by phase slippage at extremely low temperatures, but the observability of this suppression may significantly differ, because of the difference in the number of thermally excited vortex pairs[3]. In films, the number of vortex pairs are so small that it is difficult to observe the suppression at low temperatures. In this connection, we also discuss the difference between purely 1D and quasi-1D cases. Again, superfluid density is strongly suppressed at extremely low temperatures in both cases, but the mechanism of the dissipation of superflow and therefore the observability of the suppression may significantly differ between the two cases.

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[2]For example, G. E. Astrakharchik and L. P. Pitaevski, Phys. Rev. A **70**, 013608 (2004); A. Yu. Cherny, J-S. Caux, and J. Brand, Phys. Rev. A **80**, 043604 (2009).
[3]A. Kotani, K. Yamashita, and D. S. Hirashima, Phys. Rev. B (2011), in press.