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Structure Factor of Superfluid He II about Dispersion Minimum

J.X. ZHENG-JOHANSSON, IOFPR, SWE, P-I. JOHANSSON, Uppsala University, SWE — The SHM-RSB/Δ_b-dynamic scheme of He II has within the framework of the well established condensed matter theory facilitated the predictions of superfluidity, critical velocity, circulation quantization, and other key properties of He II in overall good agreement with experiments[1]. In relevance to neutron scattering this scheme leads to that at the dispersion minimum (q_b, Δ_s), the structure factor of He II contains an elastic and inelastic component: $S(q) = S^{\rm el}(q) + S^{\rm inel}(q)$. Here $S^{\rm el}(q) = \frac{N}{2\pi\hbar} e^{-2W}[1 + \int g(R) e^{i\mathbf{q}_b\cdot\mathbf{R}} dR] f_0 \delta(\omega - 0)$ probes the instantaneous configuration of the disordered superfluid atoms and is a broad function. $S^{\rm inel}(q) = \frac{1}{2\pi\hbar N}\delta(q - q_b) f_b \delta(\omega - \frac{\Delta_s}{\hbar})$ is due to scattering by the excitations of superfluid bond Δ_b, at an energy cost Δ_s. (Definitions for other variables are given e.g. in [1]2004b.) Δ_b has its origin in many-quantum-atom correlation and thus has a well defined value through this many- atoms averaging operation. Accordingly $S^{\rm inel}(q)$ is a sharp function; it is related to the dynamic structure factor here as: $S_b^{\rm inel}(q)|_{q=q_b} = S_b(q,\omega)|_{\omega=\frac{\Delta_s}{\hbar}}$.

[1] J.X. Zheng- Johansson and P-I. Johansson, in "New Developments in Superconductivity Research", R.W. Stevens Editor, Nova Science, 2003, ISBN 1-59033-862-6; "The Microscopic Theory of Superfluid He II", Nova Science, 2004a, ISBN 1-59033-974-6; arXi:cond- mat/0410442, 2004b; arXi:cond-mat/0410485, 2004c.

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