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Critical Point Coupling and Proximity Effects in He-4 at the Superfluid Transition[1]

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We report measurements of specific heat and superfluid density for ^{4}He confined in an array of $(2\mu\text{m})^3$ boxes at 2μm separation and linked through a 33 nm film [1]. We find a strong enhancement of the specific heat and the superfluid density relative to control measurements where the boxes are placed farther apart [2]; and, measurements of the film itself in the absence of the boxes. We demonstrate that this coupling is due to the finite-size correlation length associated with the helium in the boxes. The surprising result, however, is that this coupling extends over distances 30-50 times the correlation length. This cannot be understood on the basis of the meaning of the correlation length as the distance over which order propagates in a critical system. These observations have implications in the understanding of experiments with helium confined in heterogeneous media, and, more generally, to other coupled critical systems where competing order is present.

[1] J. K. Perron, and F. M. Gasparini, Phys. Rev. Lett. **109**, 035302 (2012)
[2] J. K. Perron, M. O. Kimball, K. P. Mooney, and F. M. Gasparini, Nature Phys. **6**, 499 (2010)

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