

Action at the Distance

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Can correlation effects in a fluid confined in big but finite compartments linked by small openings, such as shallow channels, occur over distances much larger than the bulk correlation length? Recently, Gasparini and co-workers [1] have demonstrated such rather striking "action-at-a-distance" effects in a two-dimensional array of microscopic boxes filled with superfluid 4He and linked by either channels or a uniform film. The measurements of several responses show that under certain conditions these boxes can be strongly coupled. What seems to be crucial in this work is the size of boxes and connectors and the vicinity of the critical point. Perron and Gasparini [2] suggested that observed action-at-a-distance effects might be a more general feature of systems with phase transitions than is usually supposed. We present a system exhibiting extraordinarily long-range cooperative effects, on a length scale far exceeding the bulk correlation length. We give a theoretical explanation of these phenomena based on the mesoscopic picture of phase coexistence in finite systems, which is confirmed by Monte Carlo simulation studies. Our work demonstrates that such action-at-a-distance can occur in classical systems involving simple or complex fluids, such as colloid-polymer mixtures, or ferromagnets which can be confirmed experimentally.

References

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