Two-step melting in Two Dimensions with Long-ranged and Attractive Forces

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The problem of melting in two dimensions has recently found unexpected resolution in which the essentials of the Halperin-Nelson-Young theory were confirmed. The solid and the isotropic liquid state are indeed separated by an intermediate hexatic phase, with solid-hexatic melting of the Berezinsky-Kosterlitz-Thouless type, followed by a conventional first-order hexatic-liquid transition [1]. A key challenge in these simulations are large correlation lengths which could be overcome by a new class of irreversible, rejection-free Markov-chain Monte Carlo algorithms, following the Event-chain paradigm. I will present new numerical evidence that these algorithms indeed open a new dynamical universality class, endowed with faster mixing than reversible Markov chains both for particle-type systems and for the XY model [2]. Moreover, I will present new results for the two-dimensional melting problem in the limit of long-ranged interactions, completing the phase diagram of inverted-power-law potentials, and with attractive interactions of the Lennard-Jones type [3].

[1] E. Bernard and W. Krauth, Phys. Rev. Lett. 107, 155704 (2011);
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[2] S. C. Kapfer & W. Krauth, Phys. Rev. Lett. 119, 240603 (2017);
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[3] F. Schmidt and S. C. Kapfer, in preparation, 2018.