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Entropic Order

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Ordered phases of matter, such as solids, ferromagnets, superfluids, or quantum topological order, typically only exist at low temperatures. Upending the conventional wisdom, we present explicit local models in which all such phases persist to arbitrarily high temperature. The physical mechanism is that order in one degree of freedom can enable many more to freely fluctuate, leading to "entropic order", whereby typical high energy states are ordered! Interacting bosons can lead to entropic order at any temperature, avoiding existing no-go theorems on long-range order or entanglement at high temperature. We also show how we can obtain superconductors at very high temperature using these ideas.
We explain the connection to the no-hair theorem for large Black Holes. We emphasize a few critical open questions about these unconventional models.

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