Strongly-interacting bosons at dimensional crossover: single-particle correlation and anomalous cooling

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Dimensionality plays an essential role in determining the nature and properties of quantum gases. Fruitful physics may appear at the crossover between dimensions. In the current generation of cold atom experiments, the dimensionality of the system can be controlled by optical lattices. In this talk, I will firstly present our recent study of strongly-interacting bosons at 2D-1D dimensional crossover [1]. We find, using Cesium atoms in optical lattices, that the single-particle correlation function of the system evolves from a Berezinskii-Kosterlitz-Thouless (BKT) form to a Tomonaga-Luttinger liquid (TLL) type. The behavior of the correlation with distance, reflects the fact that the particles see their dimensionality as being one or two depending on whether they are probed on short or long distances, respectively. These results are consistent with our theoretical prediction [2] obtained via ab-initio quantum Monte Carlo (QMC) calculations. In addition, the comparison of the experimentally measured correlation function with the QMC calculation, allows us to perform thermometry on the low dimensional bosons with 1 nK sensitivity [3]. Strikingly, during the dimensional reduction process, we find that the temperature for the 1D case can be much lower than the initial temperature in 3D. Our findings show that this decrease results from the interplay of dimensional reduction and strong interactions.

References

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