Supersolidity in Two-dimensional supersolids in the presence of an obstacle

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A supersolid is the state that exhibits Bose-Einstein condensation(BEC) and Bragg peak simultaneously. It has been studied for more than 40 years theoretically and experimentally. After the experiments of Kim and Chan[1] the topic attracts many researchers and many studies have done. Experiments of Cold atoms are also attractive. The realization of supersolids is expected in the BEC of ^{52}Cr[2] and ^{164}Dy[3] because of their strong magnetic dipole-dipole interaction.

As in theory, Pomeau and Rica[4] showed two-dimensional supersolids do not have supersoridity in the presence of an obstacle in the framework of the Gross-Pitaevskii(GP) theory. However we expect that as in the one-dimensional case[5], there is superuidity in two-dimensional supersolids.

We solved a modified version of the GP equation[4] with a finite range two-body repulsive interaction. Fig.1 shows the density profile of the macroscopic wave function for velocity $v = 0$.This solution is a supersolid phase. The ground states are hexagonal in all solid regime where we calculated. The main results are as follows.

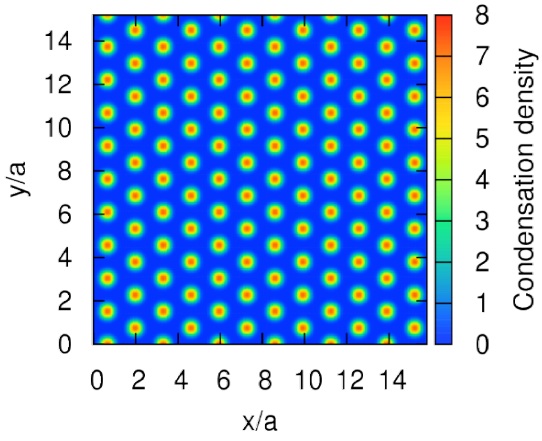

Figure 1: Density profile for velocity $v = 0$, potential height $U_0 = 0$ and $\Lambda = 60$. a is the interaction length.

First, in the absence of an external potential, we showed the phase diagram of Λ and v, where Λ is a dimensionless parameter which represents the strength of interaction. We obtained the SF(Superuid)-SS(Supersolid) first order phase transition line. In the one-dimensional case[5], the phase transition line is second order.

Second, in the presence of the external potential that separates the supersolid into two regimes, we showed the Josephson-relation which is the relation between a difference of two macroscopic phase and a current. Similarly to the famous Josephson-relation in Superconductors[6], the relation exhibits superuidity. Similarly to the one-dimensional case[5], in the large U_0 limit the Josephson-relation comes closer to sine. We can also calculate non-classical rotational of inertia fraction in this model.

In this presentation, we will show the detail data and discuss the properties of two-dimensional supersolids and supersolidity.

References

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