



Communication

Darkmatter, Supersolidity and Possible Implications

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In 2008 the authors proposed that supersolid matter might be considered as possible candidate for collisionless cold Dark matter. Leggett predicted an exotic quantum matter, which consists of particles forming an incompressible solid structure simultaneously having superfluidity of zero viscosity, in 1970. Recently, Xiang et al (found the existence of supersolid matter in the laboratory. In 2025, a group of Italian physicist made an exciting scientific breakthrough, where researchers have successfully turned light into a "supersolid" for the first time ever. This is the result of a long-standing pursuit of fundamental research. Usually, solids don't move on their own, but supersolids change direction and density depending on particle interactions while maintaining an organized lattice structure. Supersolids require extremely low temperatures to form — usually very close to absolute zero (minus 459.67 degrees Fahrenheit, or minus 273.15 degrees Celsius). New interests emerged regarding the building structure of quantum vacuum. Here, the vacuum consists of supersolid matter with no viscosity where quantum fluctuations predominate. Quantum fluctuation is considered as pervading all over the universe and conservative in nature. There lies the difference between quantum fluctuations with other type of fluctuations, for example, thermal fluctuation. Thermal fluctuation is dissipative in nature in contrast to quantum fluctuation. One can envisage the following implications.

1. This supersolid may act like Madelung Fluid. Madelung fluid plays very important role in understanding the quantum processes as shown in stochastic interpretation of quantum theory. However, this supersolid matter may have some memory since it maintains both lattice structure as well as fluidity. In that case non-linear Schrodinger equation can be associated with this type of fluid.

2. The universe is supposed to be full of dark matter that influences the evolution of the universe but not observed directly. Here, the supersolid matter is considered as one type of Dark matter (cold Dark matter) since it can be formed at very low temperature.

3. This non-linearity associated with supersolid may be responsible for the structure formation of the universe.

4. The Cosmic Microwave Background Radiation (CMBR) which has temperature of the order 2.73 degree Kelvin can be traced back to its origin to this type of quantum vacuum.

Very recently, Cavedon considered supersolid structure in the bottom level where the displacement in supersolid medium plays an important role for gravitational phenomena. Since supersolid matter has no viscosity it is not conceivable to think of displacement and hence his subsequent results. It is possible that supersolid structure of the quantum vacuum may act like fabric of space time. The challenging issue is that without any cohesiveness it is very difficult to think of space time fabric. One of the possible solutions is that due to predominance of quantum fluctuations in supersolid matter the nonlocality may help us to think of building space-time fabric. Many such possibilities may be associated with the discovery of such a new state of matter like supersolidity. This opens up new vistas understanding the space-time structure at small scale and the future process of unification of quantum theory and gravitation.

References

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