Fragmentation and Elementary Excitations in Ultracold Systems

Contributed Talk

Shivam Singh and Ayan Khan

Department of Physics, SEAS, Bennett University, Greater Noida, India

Bose-Einstein condensate (BEC) with strong dipole-dipole interactions (DDI), arising from the large magnetic moment of the atoms, has emerged as a prominent field of research to study exotic quantum phases like quantum droplet and super-solid. These novel phases arises from the competition between mean-field (MF), beyond MF (BMF) and DDI. One must also note that, nearly two decades ago, the theoretical prediction of a similar state of matter (droplet) emerged, by taking into account the Efimov, a phenomenon that facilitates the formation of bound states involving three interacting bodies. In our current study of dipolar systems, we have considered the combined effects of cubic (arising from MF interaction), quartic (due to BMF interaction in quasi one-dimension), and quintic (as a result of three-body interaction) non-linearities. Our findings suggest that switching off the dipole-dipole interaction leads to the emergence density fragmentation. Additionally, we observe a nonzero beyond-mean-field (BMF) interaction is crucial for structure formation. Finally, both the coupling strength and the number of particles play a significant role in determining the system's behavior. Further, we elaborate on the small amplitude excitations and non-trivial out of equilibrium phenomena, including dynamical phase transitions.We have analyzed elementary excitations in a double- well potential with cubic and quintic non-linearity and tried to capture the system's dynamics.