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Excitonic Superfluidity in Quantum Hall Bilayers: The Wisdom of Experience

ALLAN H. MACDONNELL, University of Texas at Austin

Bose-Einstein condensation (BEC) occurs in Helium liquids where it is responsible for superfluidity and in many metals where pairs of electrons (Cooper pairs) act as bosons and condense giving rise to superconductivity. More recently Bose-Einstein condensation was observed in vapors of weakly interacting alkali metal atoms providing a new window on the quantum behavior of many-interacting particles. I will discuss yet another example of Bose-Einstein condensation which has been discussed in the solid state physics literature for more than 40 years, but has been realized experimentally only recently. The bosons in this case are pairs formed from an electron in one semiconductor quantum well layer and a hole (a missing electron) in a second semiconductor quantum well layer, which combine in a bound state known as an exciton. Many of the properties of excitonic BECs follow from the fact that their number is not quite perfectly conserved, as Einstein had assumed. I will discuss recent experimental results on the properties of semiconductor bilayer exciton BECs and efforts to develop a theory that is able to account for what is seen.