Thermalized two-dimensional photonic gas in a 'white-wall' photon box

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Bose-Einstein condensation, the accumulation of bosonic particles in the energetic ground state, leading to a macroscopic ground state population below a critical temperature, has been demonstrated in several physical systems. Although being perhaps the best known example of a bosonic gas, Planck's blackbody radiation (photons in thermal equilibrium with the walls of a three-dimensional cavity) is an exceptional case in showing no Bose-Einstein condensation at low temperatures. Instead of collectively occupying the lowest energy mode, the photons disappear in the cavity walls when the temperature is decreased - corresponding to a vanishing chemical potential of the photons.

Here we report on the observation of a two-dimensional thermalized photon gas from a dye molecule filled optical microresonator with freely adjustable chemical potential. Thermalisation is achieved in a photon number-conserving way by multiple photon scattering off the dye molecules, and the resonator geometry provides both a (effective) photon mass and a confining potential - key prerequisites for a Bose-Einstein condensation of photons. As a striking example of the unusual system properties, we show that the thermalization process leads to a concentration of photons at the center of the confining potential. This spatial light concentration is a natural consequence of minimizing the potential energy of the trapped photon gas, an effect with prospects for increasing the efficiency of diffuse solar light collection. The current status of the experiment will be reported.