

凝聚态物理-北京大学论坛

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Evaporative cooling induced exciton-polariton condensate in a ZnO microcavity

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陈张海, 1998.2-1998.6, 1999.3-1999.7 澳大利亚国立大学访问学者; 1999.8-2003.11 日本东北大学多元物质科学研究所博士后; 2003年起任复旦大学物理系教授、博士生导师; 2006-2010 任复旦大学应用表面物理国家重点实验室副主任; 2010起任复旦大学物理系副主任。获中国物理学会2010-2011年度黄昆物理奖; 2012年获国家杰出青年基金。主要研究领域为凝聚态光谱物理, 目前主要开展的研究方向为(1) 半导体纳米微腔中光-物质相互作用物理及其可能的器件应用; (2) 固体环境中类氢里德堡原子的量子混沌运动。

Abstract: Exciton-polaritons exhibit a number of intriguing properties reflecting their half-light, half-matter nature. Unlike the BEC phase transition of cold atom gas, the polariton system can be hardly found in a full thermal equilibrium due to the limited lifetime of polaritons. For achieving the condensation threshold in a bosonic gas, an efficient cooling mechanism is essential. In an exciton polariton gas, because of the solid state environment, light effective mass and the exciton component, the cooling and/or energy relaxation of polaritons and thus the realization of polariton BEC is mediated by the phonon relaxation which may be stimulated by the final state occupation. We remind that, in order to cool down a gas system, its mean kinetic energy should be reduced by evaporating the high energy particles. This process is referred to as evaporative cooling. It can build up the phase-density within a short time interval, which is why it has been widely used to achieve the BEC in cold atom systems. When polariton gas is trapped in a three-dimensionally confined potential well with a limited barrier height, the evaporative cooling can be strongly enhanced by the polariton-polariton scattering due to the tight confinement from the trap. Basing on a quasi-zero-dimensional microcavity of ZnO, we demonstrate the efficiency of this cooling mechanism in a polariton gas system with well defined discrete energy spectrum which relaxes closely to the thermal distribution, and show that it allows reducing the effective temperature of the polariton gas down to about 20 K in the room temperature experiments.

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