論 文 の 内 容 の 要 旨

論文題目　Crossover from Exciton Polariton Condensation to Photon Lasing
(励起子ポラリトン凝縮からレーザー発振へのクロスオーバー)

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A semiconductor laser is a ubiquitous device used throughout industry particularly for optical communication and data storage. As the name suggests, a laser (Light Amplification by Stimulated Emission of Radiation) emits and amplifies light by stimulated emission with population inversion. In recent years, a new device, the polariton laser has been suggested and demonstrated. A polariton laser emits coherent light similar to a semiconductor laser but the mechanism of light emission is different. A polariton laser uses exciton-polariton condensation and emits coherent light by leakage of photonic component of exciton-polaritons without population inversion. Exciton-polaritons, composite particles made of excitons and cavity photons, form a condensate via stimulated cooling at sufficiently low temperatures. Its main attractive feature is that the polariton laser threshold is lower than that of a semiconductor laser and the coherence properties of emitted light is inherited from the exciton-polariton condensate.

One of the open questions about the physical aspect of a polariton laser is a high density state of exciton-polariton condensate. In low density regime, an exciton-polariton behaves as a composite boson. On the other hand, in the high density regime, exciton-polaritons overlap with each other and the fermionic character of electrons and holes becomes apparent. The bosonic exciton-polariton

and fermionic electron-hole-photon pictures are overlap continuously by changing the carrier density. The crossover physics is an important subject not only for applications but also for understanding fundamental physics.

In this thesis, we create a high density state of exciton-polaritons of this system, beyond that which is necessary to form a condensate and characterize the crossover from exciton-polariton condensation to photon lasing by a time- and spatial-resolved measurement. A high density state of exciton-polariton condensate is photoexcited by a pulsed laser. The highest density reaches about seven hundred times as high as that of the exciton-polariton condensation threshold. By measuring the first-order coherence, above the second threshold, we observed the plateaued spatial coherence indicating the single mode photon lasing.

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