平成 30 年 1 月 29 日

応用物理学会北海道支部
会員各位

応用物理学会北海道支部

講演会のお知らせ

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演題：Single-atom superradiance
講師：Kyungwon An 氏
（Professor, Department of Physics and Astronomy, Seoul National University）
日時：平成 30 年 2 月 7 日（水） 11:00～12:00
場所：電子科学研究所セミナー室２
後援：応用物理学会北海道支部 （共催団体：電子科学研究所）

講演の要旨
Superradiance originally refers to the collective emission of densely packed quantum emitters. It is fundamentally different from ordinary spontaneous emission in that its emission power scales as the square of the number of emitters whereas it does linearly in the ordinary spontaneous emission. Recently several research groups have demonstrated new approaches to superradiance. A laser pulse is introduced to an ensemble of millions of atoms to imprint phase correlation and thus to induce an immediate superradiant output. However, the output occurred in the same direction as the input, making it difficult to separate them. In another approach, a few emitters are prepared in a cavity and their quantum states are individually manipulated to exhibit controlled collective emission. However, due to technical difficulties, the number of emitters participating in superradiance has been limited to two so far. In this presentation, I will report our recent observation of coherent super
radiance made by single atoms in a cavity [1] in such a way that the output is completely separated from the input and tens of atoms participate in superradiance as they control atomic states individually. In our experiment, single two-level atoms are prepared in the same quantum superposition state and then made to traverse a cavity one by one. A single atom in the cavity then emits a photon collectively with the past atoms that have already gone through

the cavity. Such collective interaction among time-separated atoms has never been observed before. We observe the emission power increases as the square of the number N of the atoms traversing the cavity during the cavity-field decay time. The N-squared dependence occurs even when the number of photons in the cavity exceeds unity without exhibiting any lasing threshold. The present study provides a platform for phase-controlled atom-field interaction. Squeezed vacuum and Schrödinger cat states can be generated and superabsorption, the opposite of superradiance, can be realized. Greatly enhanced emission of single atoms can be used to build efficient atom-photon quantum interfaces. Moreover, the thresholdless lasing property can be utilized in making more efficient lasers.

References
[1] J. Kim, D. Yang, S. Oh and K. An, Coherent Single-Atom Superradiance, Science, 21 Dec 2017:eaar2179 (DOI: 10.1126/science.aar2179)

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