

MEXT Grant-in-Aid for Scientific Research
"Luminescence induced optical force" Joint Seminar

Since the invention of laser tweezers by Ashkin in 1986, techniques for mechanically manipulating small particles, ranging from bio-cells to atoms, have advanced significantly. While manipulating nanoparticles remains a challenge, recent studies have begun to explore the use of localized surface plasmon resonance and electronic resonance in nanostructures.

Following our previous Grant-in-Aid for Scientific Research on Innovative Areas project, "Nano-Material Manipulation and Structural Order Control with Optical Forces," we have launched a new project: "Development of Novel Optical Manipulation Systems Based on the Design of Environment and Luminescence," supported by Grant-in-Aid for Scientific Research (S). In our previous project, we theoretically proposed and experimentally demonstrated the selective optical manipulation of nanoparticles, leveraging their quantum mechanical properties, such as size, shape, and internal structure.

In this current project, we are developing a new method of optical manipulation using the force generated by luminescence—one of the most fundamental phenomena in the optical response of materials. This method is based on designing the dielectric and radiation environments. We have successfully demonstrated the potential of selecting nanoparticles based on their specific luminescence lines, using recoil forces from stimulated emission in photo-excited particles. This process goes beyond conventional optical manipulation techniques and opens up the possibility of optomechanics, where mechanical vibrations are induced by luminescence. We are also exploring new optical manipulation methods based on superfluorescence.

This seminar will include progress reports from our project members and feature talks from guest researchers active in related fields.

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Date: 20th October 2024 (Sunday) 14:00 ~ 21st October 2024 (Tuesday) 11:20
Venue: Okinawa Institute of Science and Technology, Seminar Room C210

Sunday 20th October, 2024

14:00 - 14:10 Opening Remarks H. Ishihara (Osaka University)

14:10 - 15:40: Session 1 (Progress Reports) **Chair: H. Ishihara**

- 14:10 - 14:40 (30min.) M. Ashida (Osaka University)
"Selective optical manipulation of detonation nanodiamonds"
- 14:40 - 15:10 (30min.) S. Akita (Osaka Metropolitan University)
"Observation of luminescence induced opto-mechanics effect"
- 15:10 - 15:40 (30min.) N. Yokoshi (Osaka Metropolitan University)
"Chiral Optics and superfluorescence induced optical force"

15:40 - 16:00: Coffee break

16:00 - 17:00: Session 2 (Invited lectures) **Chair: M. Ashida**

- 16:00 - 16:30 (30min.) K. Sasaki (Hokkaido University) **Invited**
"Topological properties of nano-localized plasmonic fields"
- 16:30 - 17:00 (30min.) C. Pin (OIST) **Invited**
"Plasmonic nanogap antennas designed for the excitation of optical nanovortices"

Monday 21st October, 2024

9:30 - 10:30: Session 3 (Invited lectures) **Chair: S. Akita**

- 9:30 - 10:00 (30min.): R. Ohta (Hokkaido University) **Invited**
"Strain-induced opto-mechanical system with rare-earth ions"
- 10:00 - 10:30 (30min.): V. G. Truong (OIST) **Invited**
"Metamaterial Plasmonic Tweezers for Stable Nanoscale Trapping and Beyond"

10:30 - 11:15 Session 4 (Research presentations) **Chair: N. Yokoshi**

- 10:30 - 11:15 (45min.) Y. Tomoshige (Osaka University)
"Analysis by nonlocal response theory of enhanced photoluminescence in molecule coupled with plasmonic nanocavity"
- S. Inoue (Osaka University)
"Novel hot carrier generation due to radiative coupling between collective and individual excitations in metallic thin films",
- Y. Umekawa (Osaka University)
"Theoretical proposal for observing recoil force by stimulated emission"

11:15 - 11:20: Closing Remark