# Joint Studies Programs

As one of the important functions of an inter-university research institute, IMS facilitates joint studies programs for which funds are available to cover the costs of research expenses as well as the travel and accommodation expenses of individuals. Proposals from domestic scientists are reviewed and selected by an interuniversity committee.

## (1) Special Projects

### A. Development of Polarized Quantum Beam Sources and their Applications to Molecular Science

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By using particle accelerator technologies, polarized quantum beams of various kinds can be produced. At the UVSOR facility, circular polarized coherent synchrotron radiation ranging from visible to deep UV can be produced by using resonator free electron laser (Figure 1).[1] We have demonstrated that such polarized radiation is a powerful tool for molecular science.[2,3] In this joint study program, we are going to develop techniques to produce polarized quantum beams of various kinds and explore their applications.

We are developing a technique called coherent harmonic generation to produce coherent synchrotron radiation with circular polarization in the VUV range. By using an external laser source, we can produce micro-bunching on electron bunches circulating in the storage ring. Such electron bunches can radiate coherently at the laser harmonics and we can control its polarity by using a variable polarization undualtor.[4]

We are developing a polarized gamma-ray source based on a technique called laser Compton scattering. Laser photons are injected to the electron beam and are scattered off, and they are converted to gamma-rays *via* inverse Compton scattering process.[5] The gamma-rays keep the polarity of the incident laser photons. Thus, we can control the polarity of the gamma-rays by controlling that of the laser photons. In addition, the gamma-rays are quasi-monochromatic, energy tunable and ultra-short in pulse length.

We are developing polarized electron source based on an electron gun technology, which has been developed in Nagoya University (Figure 2). By using GaAs photocathode, spin polarization higher than 90% has been demonstrated.[6] By using a laser source synchronized with the RF acceleration of the storage ring, the polarized electron pulses are synchronized in time with other quantum beams described above.

We are going to apply these unique quantum beams to biomolecular science and materials science. An interesting point is that all these quantum beam sources are synchronized. We will explore combined use of these beams.

**Figure 1.** UVSOR Free Electron Laser.

**Figure 2.** Photocathode Electron Gun to produce spin polarized electron beam.

### References

1) M. Hosaka, S. Koda, M. Katoh, J. Yamazaki, K. Hayashi, Y. Takashima, T. Gejo and H. Hama, *Nucl. Instrum. Methods Phys. Res., Sect. A* **483**, 146–151 (2002).
2) J. Takahashi, H. Shinojima, M. Seyama, Y. Ueno, T. Kaneko, K. Kobayashi, H. Mita, M. Adachi, M. Hosaka and M. Katoh, *Int. J. Mol. Sci.* **10**, 3044–3064 (2009).
3) T. Nakagawa, T. Yokoyama, M. Hosaka and M. Katoh, *Rev. Sci. Instrum.* **78**, 023907 (2007).
4) M. Labat, M. Hosaka, M. Shimada, M. Katoh and M. E. Couprie, *Phys. Rev. Lett.* **101**, 164803 (2008).
5) Y. Taira, M. Adachi, H. Zen, T. Tanikawa, M. Hosaka, Y. Takashima, N. Yamamoto, K. Soda and M. Katoh, *Nucl. Instrum. Methods Phys. Res., Sect. A* **637**, 5116–5119 (2011).
6) N. Yamamoto, X. G. Jin, A. Mano, T. Ujihara, Y. Takeda, S. Okumi, T. Nakanishi, T. Yasue, T. Koshikawa, T. Ohshima, T. Saka and H. Horinaka, *J. Phys.: Conf. Series* **298**, 012017 (2011).

## (2) Research Symposia

(From Oct. 2010 to Sep. 2011)

| Dates | Theme | Chair |
|---|---|---|
| Jan. 7– 8, 2011 | Recent Progress and Prospects of Cluster Science and Functional Nano-Structure Science | **NISHI, Nobuyuki** |
| Oct. 5– 6, 2010 | Surafce and Interface Chemistry for Green Innovation | **MATSUMOTO, Yoshiyasu**<br>**YOKOYAMA, Toshihiko** |
| Jan. 14, 2011 | Generation and Applications of Intense THz Radiation | **KIMURA, Shin-ichi** |
| Jan. 8– 9, 2011 | Currents Status and Future Prospects of Coordination Chemistry | **TANAKA, Koji** |
| Mar. 1, 2011 | Progress and Strategy in Physical Chemistry and Biophysical Chemistry | **KITAGAWA, Teizo**<br>**KOSUGI, Nobuhiro** |
| Jun. 28–29, 2011 | The 5$^{th}$ Symposium of Japan Society for Molecular Science | **NAKAI, Hiromi**<br>**SAITO, Shinji** |
| Jul. 9, 2011 | Preparatory Meeting for Molecular Science Summer School | **AKASE, Dai**<br>**FURUTANI, Yuji** |

## (3) Numbers of Joint Studies Programs

| Categories | | Oct. 2010–Mar. 2011 | Apr. 2011–Sep. 2011 | Total |
|---|---|---|---|---|
| Special Projects | | 0 | 1 | 1 |
| Research Symposia | | 5 | 1 | 6 |
| Research Symposia for Young Researchers | | 1 | 0 | 1 |
| Cooperative Research | | 63 | 53 | 116 |
| Use of Facility | Instrument Center | 32 | 42 | 74 |
| | Equipment Development Center | 5 | 8 | 13 |
| Use of UVSOR Facility | | 77 | 61 | 138 |
| Use of Facility Program of the Computer Center | | | | 171* |

* from April 2010 to March 2011