

**Computational Astrophysics Laboratory**  
**Chief Scientist: Toshikazu Ebisuzaki (Ph.D.)**



**(0) Research field**

CPR Subcommittee: Physics,

**Keywords:**

high performance computing, space debris, Blackhole, adaptive optics, origin of life

**(1) Long-term goal of laboratory and research background**

In our laboratory, we explore the method of control of thermal blooming effect of a laser beam propagating through turbulent atmosphere in Innovative Science and Technology Initiative for Security, ATLA, Japan. In addition, we promote EUSO (Extreme universe Space Observatory) project to detect ultra-high energy cosmic rays ( $\sim 10^{20}$ eV) and identify the source objects. Furthermore, we study the cosmic-ray acceleration by wakefield acceleration on an accreting blackhole.

**(2) Current research activities (FY2021) and plan (until Mar. 2025)**

① In the framework of Innovative Science and Technology Initiative for Security, "Predictive adaptive optics for high intensity beam to moving objects at distant place", we measure absorption coefficient of atmosphere directly with a thermal blooming chamber. We conducted a laser beam propagation test in Tanegashima island. The lenses for the wide field of view telescope were polished to improve the performance. The optics was confirmed that it focused 405nm laser light at the distance of 1900mm as designed and that viewing angle covered 20 degrees. The focused light will be converted to digital signal by analog-to-digital conversion board shown in Figure 2. Fifty boards have been produced and tested so far and it was found that they worked fine. We are now assembling elementary modules for photon detection (Figure 3).

② In the JEM-EUSO collaboration, we launched the mini-EUSO telescope with a diameter of 25 cm to the International space station. It was attached to the UV transparent window and have been observing the dark side of the Earth in near UV region, for the first time. It has already provided us many valuable observations of atmospheric discharge phenomena and meteors, and the results will be published soon.

③ We constructed wakefield acceleration theory in the jets of an accreting blackhole and apply to the microquasars ( $\sim 10M_{\odot}$ ), intermediate BH objects ( $100\sim 1000M_{\odot}$ ) nucleus of Seyfert galaxies ( $\sim 10M_{\odot}$ ), radio galaxies and blasars ( $10^7\sim 10^9 M_{\odot}$ ), as well as neutrino driven accretion flow (NDAF) disk around a newly formed blackhole by the merging of two neutron stars and core collapse of a massive star. The results are well consistent with the observation of neutrinos and gamma-rays as well as cosmic-rays. Those results will be published soon.

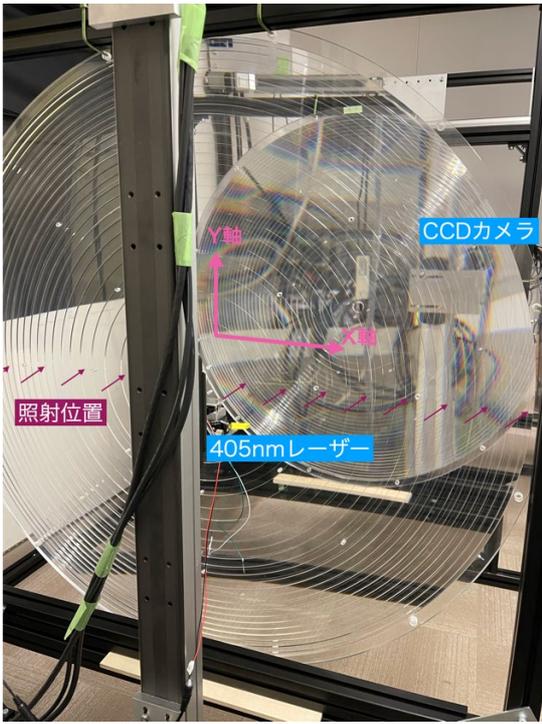


Figure 1 : Setup of optics measurement system



Figure 2 : Dedicated analog to digital conversion board for 128 channels (left) and the test bench (right)

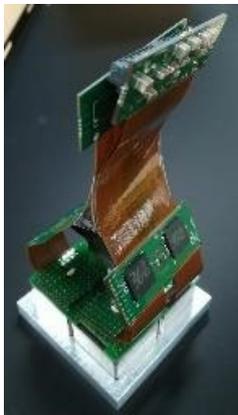


Figure 3: Elementary module for photon detection under assembling

### (3) Members

as of March, 2021

#### (Chief Scientist)

Toshikazu Ebisuzaki

Iriko Kaneko

#### (Research Staff)

Yoshiyuki Takizawa

Tomoki Matsuyama

Marco Casolino

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Junichiro Makino

Tomohiro Tsukihana

#### (Assistant and Part-timer)

Tomoko Ohata

Shigeru Sato

Akane Shiho

Midori Takizawa

### (4) Representative research achievements

1. “Nanotube Active Water Pump Driven by Alternating Hydrophobicity”, Noriyoshi Arai, Takahiro Koishi, Toshikazu Ebisuzaki, **ACS Nano**, 15,2,2481-2489, (2021).
2. “カンキツ突然変異誘発とDNA多型解析”, 松山直樹、戎崎俊一、小田切 正人、齋藤 洋太郎、齋藤 徳人、和田 智之、北村 尚、下川 卓志、八幡 昌紀、**DNA多型**,29-1,40-42(2021).
3. “Astrophysical wake acceleration driven by relativistic Alfvénic pulse emitted from bursting accretion disk”, Toshikazu Ebisuzaki, Toshiki Tajima, **Astroparticle Physics**, 128, 102567(2021)
4. “Mini-EUSO Mission to Study Earth UV Emissions on board the ISS” S. Bacholle *et al*, **Astrophysical Journal Supplement Series**,253,2 (2021).
5. “PZLAST: an ultra-fast amino acid sequence similarity search server against public metagenomes”, Hiroshi Mori, Hitoshi Ishikawa, Koichi Higashi, Yoshiaki Kato, Toshikazu Ebisuzaki, Ken Kurokawa, **Bioinformatics**, 37,21, 3944-3946(2021)

### Laboratory Homepage

[https://www.riken.jp/en/research/labs/chief/comput\\_astro/index.html](https://www.riken.jp/en/research/labs/chief/comput_astro/index.html)

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