FACULTY OF SCIENCE
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DEAN
Professor Qiang ZHOU

Press release **For immediate release**

HKU physicists deploy a new advanced computing system 'Blackbody' for solving the most challenging physics problems

December 16, 2022

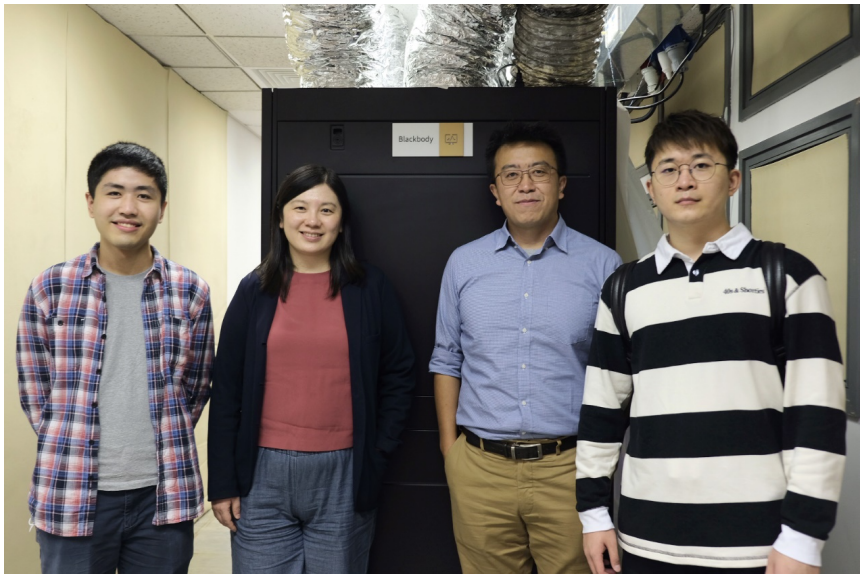

Image 1: Project leaders in research teams from HKU Physics stood next to Blackbody in the mini data center. They led the teams to deploy the new supercomputing system. From the left: Mr Tom Man KWAN; Dr Jane Lixin DAI, Assistant Professor; Dr Zi Yang MENG, Associate Professor and Mr Hongyu LU

In modern times, many groundbreaking discoveries are made in science through numerical computation, which enables scientists to capture the complex, quantum and non-linear physical interactions happening in the universe from galactic to sub-atomic scales. Therefore, scientific computation has become an equally important means as compared with traditional theoretical and experimental research, and high-performance computing (HPC) facilities have also become a necessity for pushing the frontiers of scientific discoveries.

To pursue advances in astronomy, quantum physics, and interdisciplinary science, the research teams led by Dr Jane DAI and Dr Zi Yang MENG from the Department of Physics, The University of Hong Kong (HKU), have worked together to deploy a new supercomputing system, named 'Blackbody' supercomputer (the name stems from their respective research topics of 'Black hole' and 'Quantum many-body physics') at HKU. The system has been set up in fall 2022 and is currently in full operation.

Image 2: Blackbody currently has 1024 physical CPU cores and multiple storage systems. If a person can do one calculation every second, it takes 650 thousand years for the person to calculate all the calculations that Blackbody can compute in just one second.

The launch of this new computing system provides enormous computational capabilities for the researchers to develop novel numerical codes and perform large-scale simulations, which will be used to tackle some of the most complex problems in the quantum physics and astronomy domains.

Dr Jane Dai's research on black hole astrophysics:

Dr Dai's team has developed and employed several state-of-the-art general relativistic and Monte Carlo codes to study the physics around astrophysical black holes. They focus on understanding how materials orbital around black holes, accrete onto black holes and produce energetic outputs in this process. Their simulations help push forward the theoretical understanding of various black hole astrophysical systems such as tidal disruption events, X-ray binaries, active galactic nuclei, which are some of the most luminous sources in the universe. Their results are also relevant for the cosmological evolution of black holes and their evolution together with galaxies since the beginning of the universe. Besides theoretical explorations, the team also collaborates with world-leading astronomers to provide models and interpretations for their observations and help design next-generation telescopes at NASA.

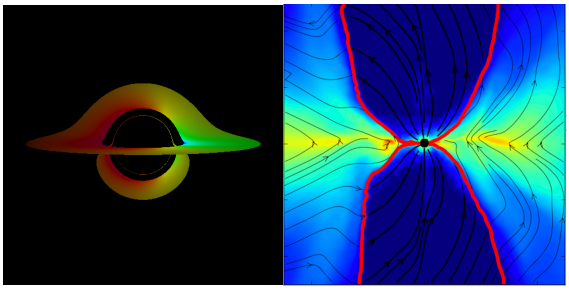

Image 3: Dr Dai's team develops and employs novel general relativistic codes to conduct massive simulations about black hole astrophysics. On the left: Imaging black hole accretion disks using a general relativistic ray-tracing code. On the right: Simulating black hole accretion disks and jets using a general relativistic magnetohydrodynamic code.

Dr Zi Yang Meng's research on quantum many-body physics:

Dr Meng's team develops explainable-AI techniques such as the quantum Monte Carlo algorithm and the tensor-network approaches to identify better effective model and to solve them to reveal fundamental mechanism of quantum many-body systems such as non Fermi-liquid in quantum critical metals, highly entangled quantum matter and topological ordered states and quantum moire 2D materials such magic angle twisted bilayer graphene. Their research works provide the most accurate solutions and new understandings for the frontier quantum materials in which millions of electrons

are strongly interacting with each other in quantum scale, they are crucial for the development of next-generation technologies in hope of addressing the new challenges in the world, such as developing new computing chips breakthrough the limit of Moore's law and building lossless energy transmission systems using high-temperature superconductors.

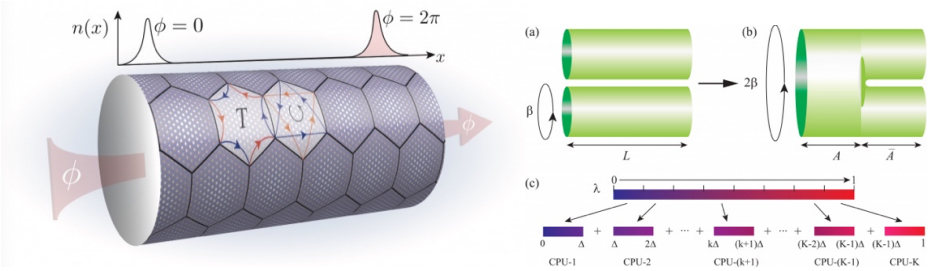

Image 4: On the left: Topological Mott insulator phase discovered by Dr Meng's team from tensor-network simulation [*Nature Communications (2021)*]. On the right: The parallel incremental algorithm developed in Dr Meng's team that could compute the quantum entanglement with unprecedentedly high accuracy [*Physical Review Letters (2022)*].

With the help of the Blackbody supercomputer, the research teams are well equipped now to solve larger and more complex problems in astronomy and quantum physics. 'This cluster is going to a great aid for our research programs in the next couple of years. The progress of the teams has been constrained by computational resources and now we finally have the necessary tool to conduct simulations and convert ideas to results. For setting up this cluster, we have put together a few grants obtained from the HK RGC, NSFC and HKU. We really appreciate their supports as well as the continuous support from the Faculty and Department,' remarked Dr Dai.

Dr Meng also echoed: 'Modern science research need to combine experimental, theoretical, and more importantly, computational approaches, the Blackbody computing machines will allow us to obtain incredibly accurate numerical results with significant predictions, which provides a bridge way to connect traditional theory and experiment studies, such new paradigm of research will lead to more profound and impactful discoveries in quantum physics and astronomy.'

Blackbody is funded through HKU Small Equipment Grant (with Co-Is Dr Man Hoi LEE from Department of Earth Sciences and Dr Jun YANG from Department of Chemistry), NSFC Excellent Young Scientist Fund, RGC Area of Excellence, and start-up funding from the Faculty of Science.

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