第２回 物理学教室談話会

Testing gravity at the quantum-classical boundary

講師　**Yanbei Chen（カリフォルニア工科大学・教授）**

日時　**６月２５日（木）16:40–18:00**

場所　**W1-B 211 教室**

要旨

Macroscopic mechanical systems are being pushed ever closer to the quantum regime. Gravitational-wave detectors such as LIGO now operate near quantum measurement limits, while optomechanical and levitated systems are approaching regimes where massive objects can be prepared, monitored, and controlled quantum mechanically. These advances open a new possibility: testing not only gravity with quantum sensors, but the quantum nature of gravity itself. A leading idea is to demonstrate entanglement between two massive objects mediated solely by their Newtonian gravitational interaction. Such an observation would provide strong evidence that gravity cannot be described as a purely classical communication channel. At the same time, semiclassical and classical-channel models of gravity provide important intermediate targets. They predict self-gravity, decoherence, and feedback effects that may be accessible before full gravitationally mediated entanglement is observed.

I will discuss two broad approaches to this quantum-classical boundary. In Schrödinger-Newton-type models, gravity is sourced by the quantum state, leading to nonlinear modifications of Schrödinger evolution and possible self-gravity effects in macroscopic objects. These effects can be enhanced in solids because most of the mass is concentrated near lattice sites. In universal-monitoring or collapse-inspired models, matter is continuously monitored by additional degrees of freedom in nature. This gives rise to gravity-induced decoherence and connects naturally to the Diósi-Penrose proposal, in which gravity may limit macroscopic quantum superpositions. I will also describe how experiments beyond tabletop optomechanics may contribute to this program. Space-based gravitational-wave detectors, precision inertial sensors, matter-wave interferometers, and tests of anomalous heating or diffusion can all probe different aspects of collapse and semiclassical-gravity models. Together, these experiments offer a route toward mapping the boundary between quantum mechanics, classical gravity, and possible new physics.

問い合わせ先：山本一博（内線：4047, yamamoto@phys.kyushu-u.ac.jp）