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A Research Plan for Numerical and Theoretical Studies toward Quantum Turbulence

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Quantum turbulence has been intensively investigated, motivated by a viewpoint that the quantum superfluid state has a great advantage which simplifies the theoretical picture much more than the normal fluid turbulence. As a result, recent experimental and theoretical developments [1] have revealed that the Kolmogorov energy spectrum almost universally holds like the normal fluid turbulence. In this project, we firstly extend the numerical studies about the quantum turbulence [1] to larger scales which enables to examine the systematic scaling properties in the turbulence. Secondly, we numerically and theoretically explore structural aspects with respect to vortices in order to understand its mechanism. Thirdly, we develop visualization techniques on large-scale numerical data. We expect that the results have educational effects, too.

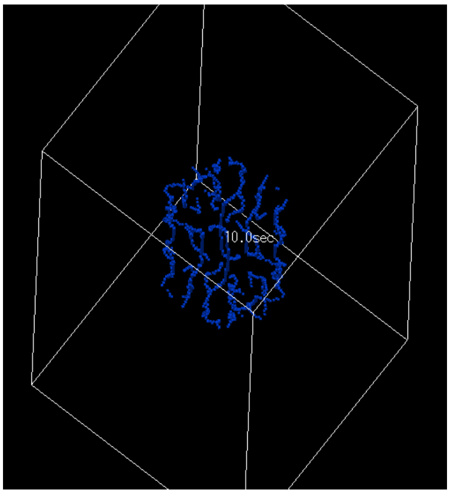

Fig.1

Now, let us show the current status of our preparation for this project. First, we would like to point out that we have already constructed a basic program solving the Gross-Pitaevskii (GP) equation, which corresponds to a target equation in this project. Figure 1 presents a typical snapshot for turbulent state in a trapped superfluid state of an atomic Bose gas. The state is a temporal one which appears in an initial stage, and decays into the steady and stable state due to the damping included in the GP equation. These simulations are performed in realistic scales for atomic Bose gas systems. At the present, we calculate the energy spectrum and the time evolution of the spectrum. Such information will inspire the experimentalists to study quantum turbulence and its dynamical features in atomic Bose gas systems.

[1] M.Kobayashi and M.Tsubota, Phys. Rev. Lett., **94**,065302 (2005)