Summary of Previous Research

I have studied eigenvalue problems for linearized operators arising in stability analyses of traveling wave solutions to Schrödinger operators and reaction-diffusion systems, using topological methods and computational approaches. In recent years, I have focused in particular on applying infinite-dimensional geometry and topology to stability problems in reaction-diffusion systems, and conducting mathematical analyses of models used in mathematical biology and mathematical medicine.

- I proposed an approach that combines topological and computational methods for eigenvalue problems of Schrödinger operators with periodic potentials under relatively compact perturbations. (Publication list: refereed paper 4)

- Regarding the formation of galaxies and planetary systems, I investigated the dynamics of compressible fluids with self-gravitation using center manifold theory. I showed that gravitational collapse (the so-called Jeans instability) can occur, and that spherically symmetric patterns and layered patterns emerge as thermodynamic parameters vary. (Publication list: refereed paper 2)

- For the modified Benney equation, a model describing traffic congestion flow, I proved that spatially periodic traveling waves exist as families parameterized by the period, and that these solutions become unstable via a Hopf bifurcation in the limit as the period tends to infinity. (Publication list: refereed paper 3)

- It is known that phosphates on cell membranes exhibit polarization toward regions of high membrane curvature. As a mathematical investigation of this phenomenon, I showed that the maximum point of a spot solution to a reaction-diffusion system on a surface moves toward a local maximum (or minimum) of the Gaussian curvature of the surface.

- For the stability of traveling waves in reaction-diffusion systems on spatially multi-dimensional cylindrical domains, I extended stability index theory so that the number of eigenvalues inside a disk can be detected via the first Chern number of a complex vector bundle over the Fredholm–Grassmann manifold. (Achievements list: preprint 1)

- For nonlocal reaction-diffusion equations used to describe propagation phenomena in mathematical biology and population dynamics, I constructed an approximation theory for reaction-diffusion systems including advection terms and spatial shifts. (Achievements list: refereed paper 1 and preprints 2)

- For a reaction-diffusion model describing differentiation waves appearing in seminiferous tubules, I showed that patterns are formed by heteroclinic orbits connecting spatially periodic solutions, known as defect solutions. (Achievements list: preprint 3)