Research Interests

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My research lies in the areas of partial differential equations and mathematical physics, more specifically, in scattering theory, semi-classical analysis, magnetic Hamiltonians, and the Aharonov-Bohm effect. Scattering theory studies interacting physical system on scales of time and/or distance much larger than the interaction region itself. Semi-classical analysis studies the dependence of differential and pseudodifferential operators, their solutions and other related objects on a small parameter. Originally motivated by Bohr correspondence principle, which asserts that classical mechanics is the limit of quantum mechanics, as Planck's constant $\hbar \to 0$, which corresponds to a change of scales, the tools and techniques of semi-classical analysis have found numerous applications to many areas of science in which a small parameter plays a crucial role, for example, the inverse of the square root of the nuclear mass in the Born-Oppenheimer approximation, the adiabatic parameter in adiabatic theory, the magnetic field strength in solid-state physics, the inverse of the square root of the energy in high-energy spectral problems, the inverse of the norm of the position in scattering theory, and others.

Magnetic Hamiltonians describe physical systems in the presence of magnetic fields. The Aharonov-Bohm effect concerns such physical systems in which the magnetic field is non-zero only at a point. The Aharonov-Bohm effect is considered one of the most significant quantum mechanical phenomenon. It refers to the situation in which an electrically charged particle interacts with the magnetic field even in regions of space where the field vanishes. Unexplainable from the point of view of classical mechanics, the Aharonov-Bohm effect suggests that magnetic potentials have a physical meaning themselves and that potential energy and not forces and force fields should be taken as the starting point of formulating physical theory, contrary to what has been done since Newton's equations of motion.