Tunnel-Junction Formula with Application to Electron

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This talk is based on the joint works respectively with Takuya Kosaka (Okayama Univ.) and Hagen Neidhardt (Weierstrass Institute for Applied Analysis and Stochastics).

In my talk we will handle the energy operator of an electron living in the two quantum wires, $\Omega_\Lambda := (-\infty, -\Lambda) \cup (\Lambda, \infty)$, with the junction, $[-\Lambda, \Lambda]$. Actually, our physical goal is the control over the electron spin by making the interaction between the phase factor arising at the boundaries and an externally applied phase factor. (You don't want to say, "dream on!" :p) Thus, we are concerned with the relation between the phase factor and the electron spin at the boundaries. We are then interested in the following problems:

i) Are there any possibilities that a phase factor appears in the boundary condition of the electron's wave functions? If so, when and how does it appear?

ii) Is the electron spin affected by the boundary?

iii) Is there a visible relation between the phase factor and the electron spin at the boundary?

To tackle these problems in mathematics, we employ $L^2(\Omega_\Lambda)$ as the electron state space. Thus, the segment $[-\Lambda, \Lambda]$ is regarded as a black box, and then, the electron's configuration space is Ω_Λ. We will observe what happens to the electron at boundaries, $\pm\Lambda$, in order that its energy operator (i.e., Hamiltonian) becomes observable (i.e., self-adjoint). We will pay our particular attention to the electron tunneling through the junction. After considering the problems, I will describe how the phase factor affects the stationary current adopting the Landauer-Büttiker formula.