$H_{reservoir}$ is the reservoir Hamiltonian which is a function of the voltage difference $\frac{\mu_R(x)-\mu_L(x)}{-e} = V$ and the right and left electronic densities $n_{R,\sigma}(x) \equiv \rho_{R,\sigma}(x) + < F|n_{R,\sigma}(x)|F >$, $n_{L,\sigma}(x) \equiv \rho_{L,\sigma}(x) + < F|n_{L,\sigma}(x)|F >$. The Bosonic representation of the densities is: $\rho_{R,\sigma}(x) = \frac{1}{2\sqrt{\pi}}(\partial_x \vartheta_\sigma(x) - \partial_x \varphi_\sigma(x))$ and $\rho_{L,\sigma}(x) = \frac{1}{2\sqrt{\pi}}(\partial_x \vartheta_\sigma(x) + \partial_x \varphi_\sigma(x))$ [32, 33]. Due to the fact that the commutator for the electronic densities is space dependent, the average density is space dependent $< F|n_{R,\sigma}(x) + n_{L,\sigma}(x)|F >= n_e[1 - \frac{\mathbf{h(x,d)}}{2}]$ where $n_e = \frac{1-\delta}{a}$ is the electronic density in the leads. The space dependent electrostatic potential caused by the space dependent charge density is given by $\delta v(x) = \frac{\mu_R(x)+\mu_L(x)}{(-e)}$ [34]. This potential will introduce current fluctuations.

4. Dirac's method for the exclusion of double occupancy-an application to the finite wire-leads system-A Bosonization formulation for the constraints

We will extend the Quantum Mechanical results obtained in the previous section to the wire Hamiltonian H_{wire} and we will introduce a new formulation for the constraints using the method of Bosonization. For the wire Hamiltonian H_{wire}, we will enforce the exclusion of double occupancy. The operator for exclusion of double occupancy [8] leads to the constraint condition for the ground state $|F>$ which replaces the non-interacting Fermi sea $|F^{(0)}>$. The exclusion of double occupancy is enforced by the two electrons operator $\Psi_\uparrow(x)\Psi_\downarrow(x)|F>= 0$ for $|x| \leq \frac{d}{2}$. Except for half filling, $\Psi_\uparrow(x)\Psi_\downarrow(x)$ is the only *primary* constraint [1]. In order to find all the *secondary* constraints [1], we have to commute the constraint operator $\Psi_\uparrow(x)\Psi_\downarrow(x)$ with the Hamiltonian. If this commutator is not equal to the constraint field, new constraints are generated. Using the Bosonic representation $\Psi_\sigma(x)$ given in equation (5), we compute the representation of the pair operator $\Psi_\uparrow(x)\Psi_\downarrow(x)$. The pair operator is represented in terms of the Bosonic fields, $\vartheta_e(x)$, $\varphi_e(x)$,$\vartheta_s(x)$ and $\varphi_s(x)$:

$$\Psi_\uparrow(x)\Psi_\downarrow(x)|F>= 2e^{-i\sqrt{4\pi}\varphi_e(x)}Q_1(x)|F>= 0; \quad |x| \leq \frac{d}{2} \tag{15}$$

where $Q_1(x)$ is the Bosonic constraint :

$$Q_1(x) = cos[2K_F x + \sqrt{\pi}\vartheta_e(x)] + cos[\sqrt{2\pi}\vartheta_s(x)]; \qquad Q_1(x)|F>= 0 \tag{16}$$

In order to understand the effect of the constraints, we will present a simplified description. For this purpose we will ignore the $2K_F$ oscillations, and we will approximate $Q_1(x)$ by $Q_1(x) \approx cos[\sqrt{2\pi}\vartheta_s(x)]$. From the equation $cos[\sqrt{2\pi}\vartheta_s(x)|F> \approx 0$, we learn that the