Erratum: Nonequilibrium Transport in Quantum Impurity Models (Bethe-Ansatz for open systems). [Phys. Rev. Lett. 96, 216802 (2006)]

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In a recent Letter [1] two of the authors have proposed a new approach to quantum impurities out of equilibrium. The approach is based on the construction of scattering eigenstates of the Hamiltonian on the infinite line (open system) with the bias appearing as an asymptotic boundary condition. The method was applied to the Interacting Resonance Level Model (IRLM) describing a local level d level coupled to two leads held at different potentials $\mu_i, i = 1, 2$. Also included in the Hamiltonian is an interaction between the leads and the level:

$$H_{IRLM} = -i \sum_{i=1,2} \int dx \psi_i^\dagger(x) \partial \psi_i(x) + \epsilon_d d^\dagger d$$
$$+t(\sum_i \psi_i^\dagger(0) d + h.c.) + U \sum_i \psi_i^\dagger(0)\psi_i(0) d^\dagger d \qquad (1)$$

However a sign error entered in the equations determining the non-equilibrium Bethe- momentum densities $\rho_i, i = 1, 2$. With the sign error the equations in the Letter correspond to the model with U negative. When corrected, the equations take the form:

$$\rho_1(p) = \frac{1}{2\pi}\theta(k_o^1 - p) - \sum_{j=1,2} \int_{-\infty}^{k_o^j} \mathcal{K}(p,k)\rho_j(k)\, dk$$
$$\rho_2(p) = \frac{1}{2\pi}\theta(k_o^2 - p) - \sum_{j=1,2} \int_{-\infty}^{k_o^j} \mathcal{K}(p,k)\rho_j(k)\, dk \qquad (2)$$

with $\mathcal{K}(p,k) \equiv \frac{U}{\pi}(\epsilon_d - k)/[(p+k-2\epsilon_d)^2 + \frac{U^2}{4}(p-k)^2]$.

The Bethe momenta p in lead i are filled from the lower cut-off $(-D)$ up to k_o^i determined from,

$$\int_{-D}^{\mu_i} \frac{1}{2\pi}\, dp = \int_{-D}^{k_o^i} \rho_i(p)\, dp \qquad (3)$$

and the voltage is $V = \mu_1 - \mu_2$.

The I-V curves computed from the corrected equations are shown in Fig. 1,2.

Note that for small positive U the current increases as a function of U at fixed voltage, cf [2], while the current in the Letter decreases since it corresponds to negative U.

A few more comments are in order:

1. The equations 2 are valid for $\epsilon_d > k_o^i, i = 1, 2$. In other cases the scattering matrix has poles and zeroes and new terms need to be added corresponding to these "bound states" solutions, work in progress [3].

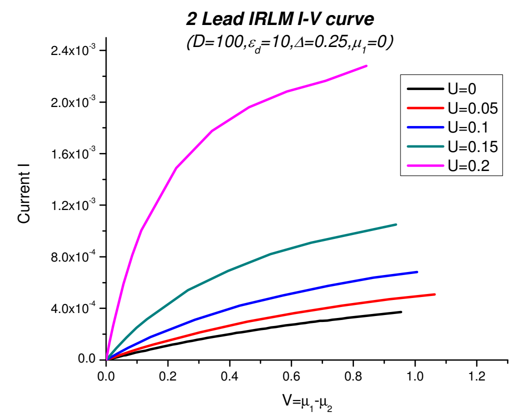

FIG. 1: The current as a function of voltage for various U with $\mu_1 = 0$ and μ_2 being lowered. The bandwidth $D = 100$, the level width $\Delta = 0.25$ and $\epsilon_d = 10$ are all fixed.

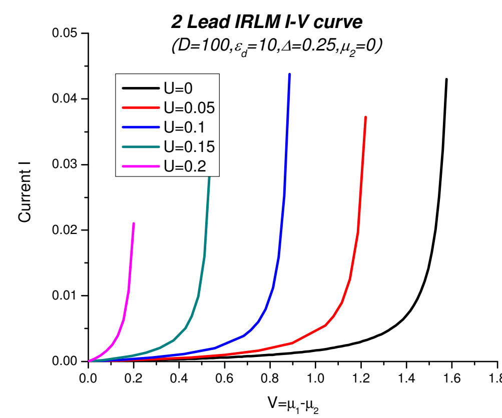

FIG. 2: The current as a function of voltage for various U with $\mu_2 = 0$ and μ_1 being increased. The bandwidth $D = 100$, the level width $\Delta = 0.25$ and $\epsilon_d = 10$ are all fixed.

2. We display here the curves for small values of U for which the current increases with U. For values beyond $U = 2$ the current decreases with increasing U, cf [2].

3. The $I - V$ curves displayed above are not yet in their "universal form". It is still necessary to express them in terms of RG invariant quantities such as the Kondo temperature T_k and the anisotropy parameter while sending the cut-off to infinity. Some proper-

ties displayed by the curves such as the conductivity $G(U) = \frac{dI}{dV}|_{V=0}$, or the details of dependence of the current on U at finite V, need be first expressed universally before they can be compared to U dependence in other cut-off schemes used in other approaches such as perturbation theory, NRG or TD-NRG, work in progress [4].

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[1] P. Mehta, N. Andrei, Phys. Rev. Lett. 96, 216802 (2006)
[2] L. Borda, K. Vladar, A. Zawadowski, cond-mat/0612583
[3] S-P Chao,P. Mehta, N. Andrei, in preparation
[4] E. Lebanon, S-P Chao, P. Mehta, F. Anders, A. Schiller, N. Andrei, in preparation