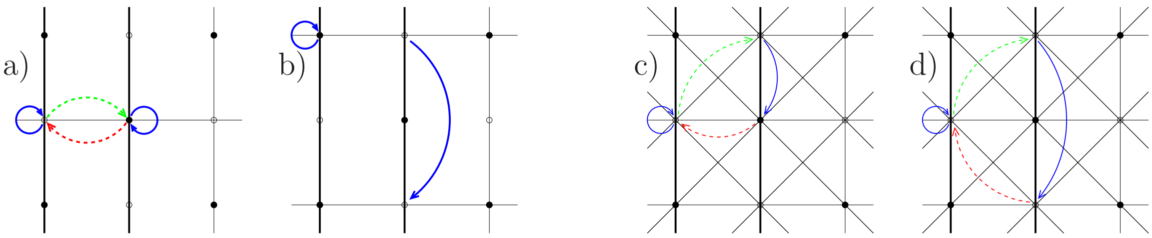

Figure 4.17: a) For stacked lattices with only one current chain (here in horizontal direction), the current-current correlation function reduces to its (antiparallel) on-bond part; the Green functions become local. **b)** For stacked lattices with interplane connections only for every second site, the connecting Green functions (solid arrows) are diagonal in sublattice index $\alpha \in \{A, B\}$. **c)+d)** Generalized stacked lattices with additional hopping along diagonals (see text).

A complementary view is taken in Fig. 4.17. While the completely incoherent case with a single link in current direction leads to diagrams involving only local Green functions as shown in Fig. 4.17a, the case where current bonds touch every second site implies diagrams where all Green functions are local with respect to the sublattice index as shown in Fig. 4.17b. Thus, the lack of coherence with respect to $\boldsymbol{Q}$ as demonstrated in (4.136) translates into a locality of the Green functions with respect to the sublattice index.

In the more general case that current may also flow along diagonals, the two Green functions do no longer only connect equivalent pairs of sites so that nontrivial factors appear in the momentum summation. For example, NNN bonds imply diagrams as shown in Fig. 4.17c which lead to contributions of the form

$$2t_{\|}\, t'_{\|} \sum_{\boldsymbol{k}} \sum_{\boldsymbol{k}'} G_{\boldsymbol{k}}(\omega) G_{\boldsymbol{k}'}(\omega') \Big(\sum_{\alpha} \cos(k_\alpha) \Big) \delta(\boldsymbol{k}_\perp - \boldsymbol{k}'_\perp) \tag{4.138}$$

and diagrams as shown in Fig. 4.17d with contributions[44]

$$4t'^2_{\|} \sum_{\boldsymbol{k}} \sum_{\boldsymbol{k}'} G_{\boldsymbol{k}}(\omega) G_{\boldsymbol{k}'}(\omega') \Big(\sum_{\alpha} \cos(k_\alpha) \Big) \Big(\sum_{\alpha'} \cos(k_{\alpha'}) \Big) \delta(\boldsymbol{k}_\perp - \boldsymbol{k}'_\perp)\,. \tag{4.139}$$

Here, $t_{\|}$ and $t'_{\|}$ denote hopping matrix elements which contribute to the current (and may differ from matrix elements for transport within the planes). Using these and analogous considerations it is easily possible to derive expressions for $\sigma(\omega)$ for arbitrary stacked versions of arbitrary underlying regular lattices. One can even carry out the momentum sums and, thus, arrive at expressions $\tilde{\rho}_{xx}(\epsilon)$ for any such combination. As one example, we remark that pure fcc-like hopping between planes as

[43]Note that this form immediately generalizes to the case of stacked AF planes (both with FM or AF order in current direction).

[44]It is easy to check that the special case $\alpha = \alpha'$ is properly accounted for in this equation. Indeed the terms $2\cos(2k_\alpha)$ (corresponding to the actual diagram shown in Fig. 4.17d) and 2 (corresponding to parallel current vertices) sum up to $4\cos^2(k_\alpha)$.