than as a usual conductor. For a uniform current flow, one would have to balance incoming and outgoing current on each site; in the long-wavelength limit this would amount to geometrically reducing the level spacing upward by a factor of $1/(Z-1)$ and, consequently, imply a semi-finite lattice. In fact, the latter situation is very similar to that depicted in Fig. 4.6 b for which any current definition would also seem artificial. In contrast, the layout depicted in Fig. 4.6 c is translationally invariant in the stacking direction so that fields and currents can be unambiguously defined in this direction. The main drawbacks of this interpretation are that the lattice sites within a plane are then no longer equivalent and that the current flow is limited to a single chain of bonds and, thus, does not scale to the thermodynamic limit. As we will show below, there is also no Drude peak in the noninteracting limit for this model.

Clearly, the pathologies of the Bethe lattice are even worse for transport phenomena than for local properties.[23] Still, the availability of DMFT data has led many researchers to trying to extract meaningful results for transport properties, in particular $\sigma(\omega)$, as well. Rozenberg et al. (1995) just ignored the difficulties, used the formalism valid for the hypercubic lattice, and wrongly stated that the hc f-sum rule (4.44) was still observed (cf. subsection 4.4.3). Freericks found a derivation within the “tree level picture” Fig. 4.6 a (Freericks and Jarrell, 1995*a*; Freericks, 2000). Stumpf (1999) discussed $\sigma(\omega)$ for the single-link stacked picture Fig. 4.6 c. In contrast to above approaches, Uhrig and Vlaming (1993) explored the freedom within the DMFT of changing terms of $\mathcal{O}(1/d)$ in the Hamiltonian and computed $\sigma(\omega)$ for stacked Bethe lattices.

For the remainder of this section, we attempt a systematic and exhaustive discussion of ways of defining and computing $\sigma(\omega)$ consistently on the basis of DMFT calculations using a semi-elliptic DOS. For each choice, we characterize the general behavior of $\sigma(\omega)$ and the specific form of the f-sum rule. Specifically, the derivations strictly for the Bethe lattice by Freericks and by Stumpf are discussed in subsection 4.4.1 and subsection 4.4.2, respectively. Going beyond the cited work, we point out an inconsistency in the former approach and explain the lack of coherent transport in the latter. Conductivity for stacked lattices is reviewed in a broad context in subsection 4.4.3. In subsection 4.4.4, we show that full off-diagonal disorder generally leads to a very similar expression for $\sigma(\omega)$ as the single-link stacked approach by Stumpf. Finally, we show that our generalized-dispersion approach for the first time yields definition and expressions for an isotropic conductivity corresponding to the semi-elliptic Bethe DOS in subsection 4.4.5.

4.4.1 Treelike Layout of the Bethe Lattice

In this subsection, we will discuss a formalism developed by Freericks which is based on the treelike layout of the Bethe lattice shown in Fig. 4.6 a. Initially, Freericks and coworkers had followed Rozenberg's approach of computing $\sigma(\omega)$ for the Bethe lattice by application of the expression (4.73) derived for the hc lattice (Chung and

[23] For a discussion of the importance of surface effects, see Sec. 2.2.