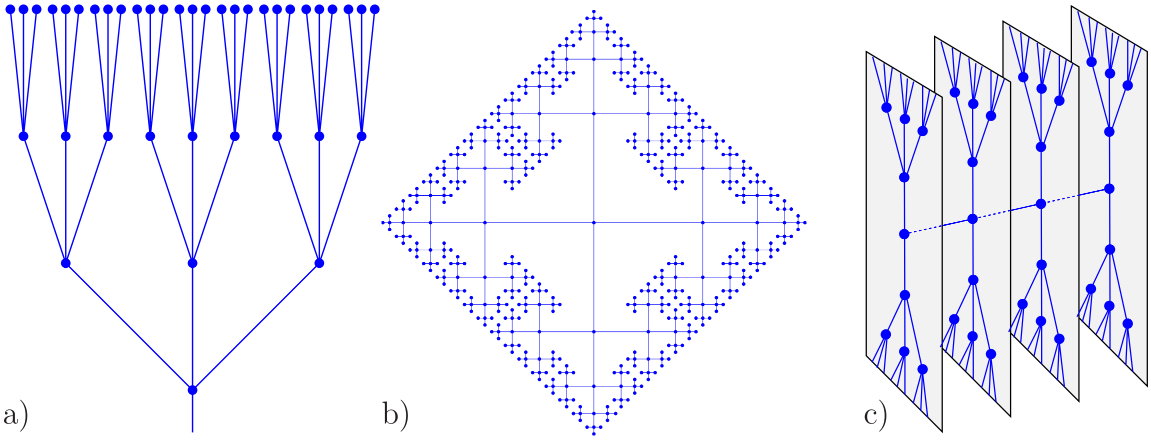

Figure 4.6: Bethe lattice: equivalent schematic representations of portions of a Bethe lattice for $Z = 4$.

of bonds or between sites are a priori undefined for the Bethe lattice.[22] It is not possible to embed the Bethe lattice in any dimension so that it is locally isotropic with respect to NN bond lengths and angles. Thus, no $\boldsymbol{k}$ space can be associated with the Bethe lattice. These facts are illustrated by the three equivalent schematic representations of finite portions of the Bethe lattice for $Z = 4$ in Fig. 4.6. In the conventional tree-like drawing Fig. 4.6 a, the sites are arranged in levels. Each site is connected by one bond to the lower level while $K = Z - 1$ bonds extend to the upper level. In the planar drawing Fig. 4.6 b, we have chosen to arrange the bonds with constant angle but geometrically decreasing bond length counted from some central site so that the total spatial extent of the full graph is finite (with both outer and inner surfaces). Drawing Fig. 4.6 c, finally, illustrates a layout of the lattice on stacked planes where one central site on each plane is connected to the neighboring planes. Since the different layouts leave the topology invariant, they correspond to the same (unperturbed) lattice Hamiltonian and, therefore, share all local properties for arbitrary coordination number Z.

Consideration of directional transport such as the optical conductivity $\sigma(\omega)$ obviously requires at least one direction to be defined; a finite conductivity can only arise if some bonds are nonorthogonal with respect to this direction. In this section, we will first explore the possibilities strictly for the Bethe lattice, i.e., for fixed topology, and then also in the DMFT context, i.e., for fixed local properties in the limit $Z \to \infty$. Figure 4.6 a suggests applying the fields in the vertical direction. For equidistant levels and in the long-wavelength limit this definition would at first sight resemble the situation in current direction in regular lattices. The uniform current per bond expected from linear response theory within this picture (cf. subsection 4.4.1) would, however, change the charge on each bond due to the lack of inversion symmetry and the broken translational invariance. Then, the system would act more like a capacitor

[22]Therefore, hopping matrix elements cannot be computed from Wannier functions, but have to be regarded as independent parameters of an abstract model.