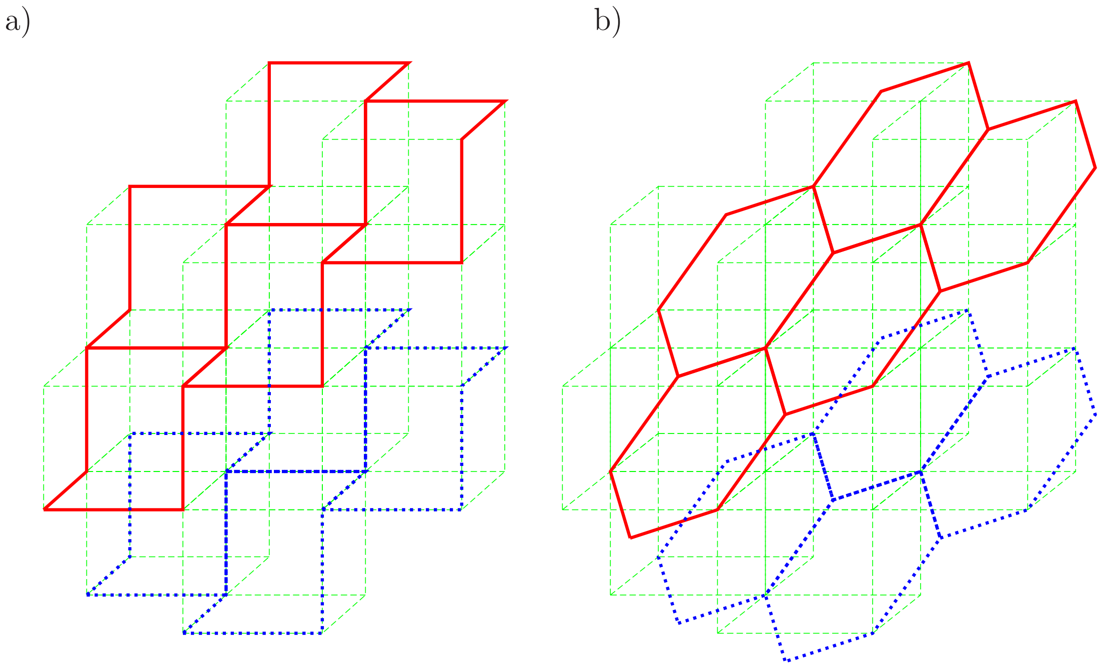

Figure B.1: Honeycomb lattice ($d = 2$) embedded in $d + 1 = 3$ dimensions. **a)** Hopping bonds, i.e., distribution of nonzero matrix elements according to (B.12). **b)** Projection of d-dimensional sublattices onto planes.

Since the spectrum of a Hamiltonian is unchanged under any basis transformation we can perform the $\boldsymbol{k}$ sum in (2.1) directly in the $d+1$-dimensional representation. The numerical result, Fig. B.2, shows that the hd DOS vanishes at $\epsilon = 0$ for $d \geq 2$. More precisely, for $|\epsilon| \to 0$, $\rho(\epsilon) \propto |\epsilon \ln(\epsilon)|$ for the diamond lattice ($d = 3$) and $\rho(\epsilon) \propto |\epsilon|$ otherwise. Thus, the hyperdiamond lattice is a semimetal at half filling in the noninteracting limit.

In order to extract transport properties one has to eliminate the extra dimension by projecting back onto the physical d-dimensional space, a hyperplane in $d + 1$ dimensions. In a first step we classify the sites belonging to each planar sheet by considering the quantity $s(\boldsymbol{r}) := \sum_{\alpha=1}^{d} r_\alpha$. We define the origin with $s(\boldsymbol{r} = \boldsymbol{0}) = 0$ to belong to the A sublattice. From (B.12) we can read off that the neighboring B sites connected by hopping bonds have $s = +1$. More generally, hopping from A to B sublattice increases s by one, while hopping from B to A always decreases s by one. Thus, all sites $\boldsymbol{r}_i^n$ belonging to the planar sheet n are identified by $\lfloor s(\boldsymbol{r}_i^n)/2 \rfloor = n$, where $n \in \mathbb{Z}$ and $\lfloor x \rfloor$ is the largest integer $n \leq x$. Thus, the extent of each sheet in the $d + 1$-dimensional space-diagonal direction

$$\mathbf{1} = \frac{1}{\sqrt{d+1}}(1, 1, \ldots, 1) \tag{B.15}$$

is finite with Euclidean thickness $1/\sqrt{d+1}$ so that any transport must vanish in this direction. Projecting out direction $\mathbf{1}$ and using $\tilde{\boldsymbol{\tau}}_l \cdot \mathbf{1} = 1/\sqrt{d+1}$ we obtain for the