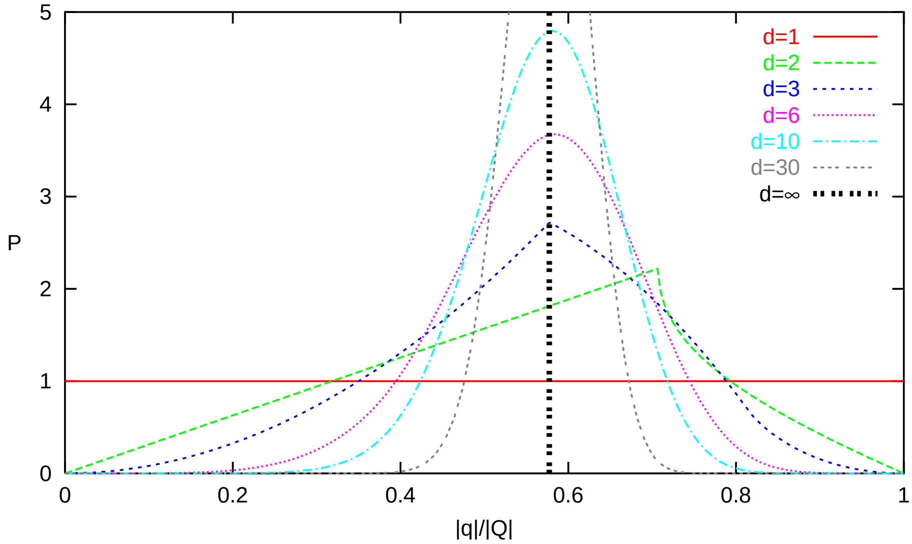

Figure A.2: Probability distribution $P(|\boldsymbol{q}|/|\boldsymbol{Q}|)$ of the Euclidean vector length of momenta $|\boldsymbol{q}|$ within the Brillouin zone for hypercubic lattices, normalized by $|\boldsymbol{Q}| = \pi\sqrt{d}$. In the limit $d \to \infty$, almost all $\boldsymbol{q}$ vectors (i.e., a unit fraction) are of length $\pi\sqrt{d/3}$.

On the other hand, small momenta and small momentum transfers have little phase space in high dimensions which leads to the irrelevance of momentum conservation in integrations over the full Brillouin zone. The Fermi surface cuts the Brillouin zone boundary infinitely often which is not surprising: each of the $2d$ hypersurfaces defined by $k_\alpha = \pm\pi$ is cut once for the hc lattice. The somewhat unphysical consequence is strongly enhanced umklapp scattering. As illustrated in Fig. A.2, the distribution of $|\boldsymbol{q}|$ is peaked around $\pi\sqrt{d/3}$ with vanishing width for $d \to \infty$. Thus, a unit fraction of all vectors has exactly the same lengths in this limit. In this sense, the generic $\boldsymbol{q}$ vectors are characterized by an intersection of the surface of a hypersphere of radius $\pi\sqrt{d/3}$ with a hypercube of side length 2π.

A.3 Dynamical Cluster Approximation, CDMFT, and Random Dispersion Approximation

We will here shortly characterize two approaches, the dynamical cluster approximation (DCA) and the CDMFT ("C" for "cellular"), which generalize the DMFT by introducing some aspects of finite dimensionality without being systematic in $1/Z$. We will also discuss the random dispersion approximation which is not an extension but an alternative approach to the DMFT in the limit of $Z \to \infty$.

The DCA is a generalization of the DMFT which introduces momentum dependence for the self-energy (Hettler, Tahvildar-Zadeh, Jarrell, Pruschke, and Krishnamurthy, 1998; 2000). This isaccomplished by dividing the Brillouin zone into regular patches characterized by some average momentum. The self-energy is then