Cluster-based growth algorithm for decagonal quasicrystals

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Experimental evidence shows that in well-ordered decagonal quasicrystals the atoms are largely arranged along quasiperiodically spaced planes ('quasilattice planes') running throughout the whole structure in five different directions. The decagonal quasicrystal structures themselves can be understood as quasiperiodic arrangements of, in a systematic way partially overlapping, decagonal clusters. Based on these findings, we define a cluster interaction model within the mean field approximation theory with effectively nonlocal and asymmetric interactions. In our Monte Carlo simulations, it leads to a long-range ordered quasiperiodic ground state. Two unlocking phase transitions are observed for the two different fundamental length scales in the system.