Statistical Mechanics of Dimers on a Plane Lattice

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Phys. Rev. **124**, 1664 – Published 15 December 1961

ABSTRACT

This paper considers the statistical mechanics of hard rigid dimers distributed on a lattice (each dimer occupying two nearest neighbor lattice sites). The problem is solved in exact closed form for a finite m×n
$m \times n$
plane square lattice with edges which is completely filled with 12mn
$\frac{1}{2}\mathrm{mn}$
dimers (close-packed limit). In terms of the activities x
x
and y
y
of horizontal and vertical dimers, the configurational partition function Zmn(x, y)
is given in the limit of a large lattice by limit
1lnZmn(x, y)asm,n→∞=12lnγ+(1
)∫0xy(1v)invtanvdv.

$\lim$ of $(mn)^{-1} \ln Z_{mn}\ x,\ y$ as$m, n \to \infty = \frac{1}{2}\ln y + \int_0^{\frac{x}{y}} \frac{1}{v}\ \text{invtan}\, v\, dv.$

It follows that the free energy and entropy of the system are smooth continuous functions of the densities of horizontal and vertical dimers. The number of ways of filling the lattice with dimers is calculated exactly for m=n=8 and is given asymptotically by [exp(2G■)]12mn=(1.791623)12mn . The results are derived with the aid of operator techniques which reduce the partition function to a Pfaffian and hence to a determinant. Some results are also presented for the more general case with monomers present.

Received 3 August 1961

DOI: https://doi.org/10.1103/PhysRev.124.1664

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REFERENCES (SUBSCRIPTION REQUIRED)

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Issue

Vol. 124, Iss. 6 — December 1961

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