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## Statistical Mechanics of Dimers on a Plane Lattice

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### 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  $m \times n$  plane square lattice with edges which is completely filled with  $\frac{1}{2}mn$  dimers (close-packed limit). In terms of the activities  $x$  and  $y$

of horizontal and vertical dimers, the configurational partition function  $Z_{mn}(x, y)$  is given in the limit of a large lattice by limit

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$\ln Z_{mn}(x, y) \text{ as } m, n \rightarrow \infty = 2 \ln y + \dots$

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limit of  $(mn)^{-1} \ln Z_{mn}(x, y)$  as  $m, n \rightarrow \infty = \frac{1}{2} \ln y + \frac{1}{\pi} \int_0^{\frac{\pi}{2}} \frac{1}{v} \ln \tan v \, dv$ .

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.

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