Liquid crystals
and interacting dimers

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joint with Elliott H. Lieb

Nematic liquid crystals
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- **Long range orientational order**: molecules tend to align, and maintain their alignment over macroscopic distances.

- **No positional order**: the locations of the centers of the molecules are decorrelated.
Heilmann-Lieb model

[Heilmann, Lieb, 1979]
Heilmann-Lieb model

- Probability of a configuration (grand-canonical Gibbs distribution):

\[
\text{Prob}(\text{conf}) = \frac{1}{\Xi} z^{\#\text{particles}} e^{J \#\text{interactions}}
\]

- \(\Xi\): partition function
- \(z \geq 0\): activity
- \(J \geq 0\): interaction strength

- Regime \(J \gg z \gg 1\).
• **Theorem:** given $x, y \in \mathbb{Z}^2$, the probability that there is a horizontal dimer attached to $x$ and no horizontal dimer attached to $y$ tends to 0 as $J, z \rightarrow \infty$. (**Orientational order.**)

• **Conjecture:** given to edges $e$ and $e'$, the probability of finding a dimer on $e$ and another on $e'$ is independent of $e$ and $e'$, up to a term that decays exponentially in $\text{dist}(e, e')$. (**No positional order.**)