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The Ising Model

Spins have only two states, $+1$ (\uparrow) or -1 (\downarrow). Energy is given by

$$E = -J \sum_{(i,j)} S_i S_j$$

S_i = spin at site i of crystalline lattice

(i, j) = nearest neighbors in the lattice

J = interaction strength

$$\uparrow\uparrow, \downarrow\downarrow \quad \text{spins aligned} \quad \Rightarrow E = -J$$

$$\uparrow\downarrow, \downarrow\uparrow \quad \text{spins not aligned} \quad \Rightarrow E = +J$$

If $J > 0$, the state of lowest energy is when all spins are aligned. This is called a ferromagnet.

$J < 0$ is an antiferromagnet, which also occurs in real systems (will come back to this later).

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