

$$\begin{aligned}\langle \vec{x}_i \cdot \vec{x}_j \rangle^2 &= (x_{i1}x_{j1} + x_{i2}x_{j2})^2 \\ &= x_{i1}^2x_{j1}^2 + x_{i2}^2x_{j2}^2 + 2x_{i1}x_{i2}x_{j1}x_{j2} \\ &= (x_{i1}^2, x_{i2}^2, \sqrt{2}x_{i1}x_{i2}) \cdot (x_{j1}^2, x_{j2}^2, \sqrt{2}x_{j1}x_{j2})\end{aligned}\tag{1}$$