

Introduction to Quantum Computation

Übung 4

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- 4.1 Prove that $\{(e^{2\pi in\alpha}, e^{2\pi in\beta}) \mid n \in \mathbb{Z}\}$ is dense in the torus $S^1 \times S^1 = \{(z_1, z_2) \in \mathbb{C}^2 \mid |z_1| = |z_2| = 1\} \subset \mathbb{C}^2$ if and only if α , β and α/β are irrational.
- 4.2 Show that three CNOT gates (alternating the orientations, *i.e.*, alternating the roles of the control and “active” lines) implement a qubit swap operation. Write this out in matrices (it’s probably not what you first expect it to be!).
- 4.3 Show how to use gates from the “standard universal family” to implement an arbitrary permutation matrix.