

Exercises for nonlocality, entanglement und geometry of quantum systems

Sheet 9

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Exercise 30

Calculate the entanglement witness in Bloch decomposition given by the BNT-Theorem (Bertlmann, Narnhofer, Thirring) for the Werner state $\rho_W(p)$

$$A_{opt} = \frac{\rho_0 - \rho_W(p) - \langle \rho_0 | \rho_0 - \rho_W(p) \rangle \mathbb{1}}{\| \rho_0 - \rho_W(p) \|}$$

Exercise 31

Check with the entanglement witness A_{opt} from exercise 30 the entanglement witness inequality (EWI) for a general separable state and the Werner state

$$\begin{aligned} \langle \rho_{sep} | A_{opt} \rangle &\geq 0 \quad , \quad \forall \rho_{sep} \in \mathcal{S} \\ \langle \rho_W(p) | A_{opt} \rangle &< 0 \end{aligned}$$

Exercise 32

Calculate the maximal violation of the EWI given by the BNT-Theorem for the Werner state $\rho_W(p)$

$$B(\rho_W(p)) = \max_A \left[\min_{\rho \in \mathcal{S}} \langle \rho | A \rangle - \langle \rho_W(p) | A \rangle \right]$$

Show that the maximal violation equals the Hilbert-Schmidt measure (BNT-Theorem)

$$B(\rho_W(p)) \equiv D(\rho_W(p))$$