Week 11: Theory Solutions

Solutions

1. True
2. Yes, density operators the Liouville Equation given by

$$\frac{\partial \rho}{\partial t} = -\{\, \rho, H \,\}$$

$$\mathrm{i}\widehat{\mathbf{L}} = \sum_{i=1}^{n} \left[\frac{\partial H}{\partial p_i} \frac{\partial}{\partial q^i} - \frac{\partial H}{\partial q^i} \frac{\partial}{\partial p_i} \right] = \{\cdot, H\}$$

3. Poor SNR ratio, not scalable since for a N-bit quantum computer, the signal scales as $N \times 2^{-N}$
4. A system where all but one level has equal populations.
5. Spectral bandwidth is 94 nm.
6. Peak intensity $\propto N^2 E_0^2$, pulse width $=\frac{2\pi}{N\delta\omega}$, time separation$=\frac{2\pi}{\delta\omega}$
7. The pump power is 1 W.
8. False, it's the reverse.
9. No
10. True
11. Quantum phenomenon shows dual nature and entanglement.
12. Due to strong coupling among molecular degrees of freedom.
13. We can control through intramolecular vibrational relaxation through ultrafast pulse shaping which results in Adiabatic Rapid Half Passage.
14. a) undergoes Adiabatic rapid passage and complete population inversion with all the excited states, b) undergoes Adiabatic rapid half-passage and the two quantum states remain in coherence till the pulse shows resonance.
15. 4
16. More motional modes become possible with the increase in number of trapped ions leading to excessive noise in the system.
17. Be+, Ca+, Hg+, Yb+
18. True
19. Exchanging vibrational excitations
20. Coherent superposition of $|0\rangle$ and $|1\rangle$.
21. Strong coupling between molecular DOFs, ion's electronic quantum state and intramolecular vibrational relaxation.

22. Tiny loops of Niobium metal acing as superconducting loops with resistance free currents.
23. NMR deals with nuclear spin and Spintronics deal with electronic spin.
24. It increases the relative spin interactions and help in facing with relative opposing current flow which produces drastic changes in GMR.
25. Atoms in adjacent lattice sites are not optically resolved.
26. Release the cold atoms non-adiabatically from the lattice state.
27. Magnetic Resonance Force Microscopy
28. Scalable, 3 qubit architectures, minimum decoherence among solid state implementations.
29. Absorption due to Rabi flopping and description of resonant excitation in a two-level system.
30. Try to solve on your own. It is a very good question. You can discuss with TA.