======Part 1======

CHAPTER 2:

1. “Non-adiabatic effects are geometric in nature” Expand a bit on what you mean here? It’s a very abstract way to think about it [said on Page 13]

2. Assumes a non-degenerate ground state to discuss the adiabatic theorem. How do things change for degenerate systems? More generally, for classical systems how should we think about adiabaticity? [said on Page 13]

3. Around Eq. 2.22 in Sec. 2.1.2—lambda is inversely related to tau and therefore linear in t….but this comes out of nowhere. Does it have to be linearly dependent on t? [said on page 20] [consider looking at e.g. GDC Phys. Rev. B 88, 214106 (2013); Polkovnikov Phys. Rev. Lett. 101, 076801 (2008)]

4. Is there quantum chaos? Berry’s 1989 Physica Scripta calls it quantum chaology [mentioned on page 21]

5. Why U^dagger on page 21?

6. The AGP as the derivative operator, I don’t quite follow precisely. Perhaps walk me through it a little more carefully? [said on page 23]

7. In Eq. (2.38) the term related to the phases is there….so often this is completely neglected—is this ever relevant? Do you consider it? [said on page 27]

8. Eq. (2.40) is the CD term, but is it different from Eq. (2.37)? The notation gets a little jumbled. Suggest to concretely say when these expressions are equivalent. [page 28]

9. How impractical is the exact CD terms? Has it ever been experimentally implemented (YES!!) You should add some discussions and references, e.g. Nature Physics volume 8, pages147–152 (2012) & Phys. Rev. Lett. 110, 240501(2013)

10. The waiter analogy is probably older than ref 26. See e.g. https://youtu.be/a0biSmpGiW8?t=135 [said on page 28] (you can also see fun videos of waiter races from as far back as 1949)

11. The example of the waiter—does it truly capture how CD works? What does the addition of the CD field actually do? Consider it at the level of the spectral features of the new generator of the dynamics (i.e. the hamiltonian). [Page 29] Consider looking at NJP 21, 103048 (2019).

12. Does the choice of metric have any affect on determining the form of this AGP? [said on page 32]

13. You seem to use some “intuition” that allows to see the control term must be only sigma_y. If I were to start from complete ignorance, and define the anstaz with all Pauli’s, will I get the same answer? [said on page 33]

14. In the nested commutators, do we perform the minimisation for each value of k independently? [said on page 34]

CHAPTER 3:

1. Cost vs. Catalyst discussion. What is the "correct" way to view this additional control term? You mention cost in energy required to achieve final state—but look at the adiabatic dynamics, the energy is just the adiabatic energy. Does control have a cost? See Kosloff, Entropy 19, 135 (2017) and a bunch of my papers. [Hinted at on Page 39]

2. What metric do you choose for Eq. (3.4) to minimise w.r.t.? What about optimal control for multiple figures of merit? [said on page 40]

3. How would you define “controllable” in a general sense? Perhaps explain a little what Refs. 59 - 61 talk about. [said on page 41]

4. Analytical optimisation Sec. 3.1.2, will these approaches recover the same solutions as found via CD or inverse engineering? Basically how related are the two “camps” ? [said on page 42]

5. Particle swarm optimisation?? What is this. [mentioned on page 45]

6. Can you walk me through the needer-mead example to understand these triangles and how it works a bit more? Perhaps also state the problem. [shown on page 46]

7. In general, what sort of size of optimisation parameters can be handled in Nelder-Mead vs. other approaches? [mentioned on page 48]

8. The effective temperature in dual annealing interests me. Can we think about this more intuitively? We don’t have consider mixed states here right? How does it make the function jump “uphill”? What sort of landscapes can it handle? This effective temperature is then lowered….is optimisation like cooling then? Is optimisation constrained by some sort of 3rd law type argument? [said on page 51/52]

9. In eq. (3.11) is the drive term just the free evolution? The structure looks quite like the AGP if I compare with e.g. say Eq. (2.46) [said on page 53]

10. I haven’t seen the operator approach explore quite as much—but its a very interesting approach. Are there draw backs as to why it isn’t explored so much? [said on page 54]

11. In Eq. (3.17) you add the constraints it seems. How should we build cost functions? Is there a reason to have them additive rather than something else? [said on page 55]

12. When does the use of randomness really help in CRAB? Is it related to the complexity of the landscape? Perhaps I’ve just looked at simple problems, although my PRR looked at disorder. [said on page 57]

13. Eq. (3.25) confuses me a little. Why not usual fidelity for density matrices? Also why the h.c. ? [on page 60]

14. Perhaps a little harsh on the criticism of Krotov on page 61. Also worth adding some discussions about e.g. the use of ADAM or other approaches that exploit back propagation to get the gradient efficiently. [See Coopmans papers, e.g. PRR 4, 043138 (2022)]

======Part 2======

CHAPTER 4:

1. When you say "set of physical constraints" what are the most reasonable ones? How do we determine what is reasonable to consider? In the same sense "optimally" is mentioned, what is the right way to think about this? [on Page 65]

2. How does the control impact what we mean by "as fast as possible"? Does the LCD have a different QSL than the QSL I'm familiar with? How should we think about this notion of minimum time? Or time in QM in more a more general sense? [on Page 66]

3. You say a "limited set of physical operators are available" do we know what they are specifically for some experimental platforms? [on Page 66]

4. COMMENT: I don't see what you say in the first paragraph on Page 67 necessarily as a draw back. Rather gives some insight into controllability, no? [on Page 67]

5. You mention the "complexity of designing a new approach" — how do we define complexity in this case? Its a hot topic at the minute I think [on Page 67]

6. Is there a difference in performance is O_opt contains operators outside the LCD set? i.e. do we know if the relevance of going "outside" the set, a little bit like what Anto does in his PRR with Chris etc.? [Ref XX of thesis] [on Page 69]

7. Figure 4.1 is a little confusing to me. Does it assume the operators of the LCD term is strictly a subset of the full CD term? i.e. does this figure explicitly not correspond to the single qubit case? [on Page 70]

8. For the different optimisation approaches, do they lead to different control pulse shapes? Can we learn anything from this?

XX. **GENERAL Q**: We know CD works for all eigenstates equally well. If I use cold to do the same protocol but control a ground state vs. Excited state does the optimal path differ? Similar q—is controlling thermal states e.g. just as easy to do with COLD? [Inspired by P68 but a general Q about the protocol]

CHAPTER 5:

1. To do the adiabatic gauge potential as a cost function do we need to work out the exact CD term? If so it seems a bit tricky for general systems. Perhaps I missed something though! [on Page 75]

2. Will C_I in eq. 5.1 show some sort of kibble-zurek like scaling? Can I think of these losses exactly as defect formation in the system? [on Page 77]

======Part 3======

CHAPTER 6:

1. In this chapter you use the "typical" non-integrable model, Eq. 6.1, rather than the arguably simpler straight up Ising model. Why? I would expect the simpler Ising to allow for some extra analytical insights? [on Page 81]

2. Why that particular choice of ramping profile in Eq. 6.2? A general related question: how does the choice of X(lambda) throughout impact COLD's performance? Do we have choices of ramp that are better? [on Page 81]

3. Eq. 6.4, is that a stray h-bar? [on Page 82]

4. Fig 6.1: The flatness until tau~1 for all protocols is curious. Does this show some fundamental limit on the controllability/density of defects that can be suppressed using different orders of LCD? Does the orange points being above the blue imply the 2nd order terms are the slightly more important ones? Do we get the same improvement for the SO-COLD in panel (b)? The sharp increase around tau~1, is this a transition between dynamical regimes? [on Page 84]

5. In Eq 6.14 you choose sigma_z as the extra operators to optimise over. Would choosing sigma_x be equally as effective for this model (considering the interaction term is in z)? [on Page 86]

6. (Likely a repeated question) Did the randomisation implicit in Eq. (6.21) actually help? Did you try without this randomisation? [on Page 89]

7. Fig 6.2 seems to imply three dynamical regimes — and indeed there is some limit where a ramp is effectively a sudden quench, an intermediate regime, and then approaching adiabaticity. Is this what we're seeing? Also the dips are probably related to some natural resonances as discussed in Anto's NJP/ Davide's EPL [on Page 90]

8. COMMENT: the power discussion is formalised in the mentioned references by using arguments from the QSL. [on Page 91].

9. Fig 6.3b shows that we essentially lose any benefit from COLD, am I right? Does this indicate some limiting cases for the range of applicability? Computationally I guess both approaches are similar, COLD has the benefit of providing some insights. [on Page 92]

10. Fig 6.4 is for state transfer: Why the discontinuous jump in the BPO case? Also how come the FO-LCD performs worse as we approach the adiabatic limit? For the small size system I assume we're still looking at timescales far from needing to be concerned with edge effects? [on Page 95]

11. Entanglement structure is an interesting control question. You choose tangle but it isn't clear from the analysis that you were ever generating "W-type" entanglement. Is there a difference in the ability of COLD or other control approaches to create different entanglement structures? [Page 103 & generally Sec. 6.4]

CHAPTER 7:

1. Should Fig. 7.1 actually be for infidelities?? [on Page 106]

2. I'm not entirely following Eqs. 7.1 and 7.2 — the goal is to minimise the contribution from the LCD term. Are the functions gamma, alpha etc. constrained to be non-zero? (Otherwise I would have thought that the optimiser would just make them zero). Maybe explain a little more these terms to me. Which of them makes more sense to you? [on Page 107]

3. Fig. 7.2: c1 and c2 are in reference to Eq. 6.12? Should probably mention that. The achieved fidelities are very low though, much less than achieved in e.g. Fig. 6.1b where COLD(1) gets 99% fidelity. Help me understand the difference here. Is [on Page 109]

4. Fig 7.3 / General Qs: are the optimised pulses for different runs typically the same? What is the variance in what the optimised protocols look like? [on Page 112]

5. I agree that the use of fidelity is not always a good choice, especially for something like entanglement where a target like |000>+|111> but achieving |000>-|111> would appear to have failed, the entanglement is the same. [on Page 114]

======Minor Issues======

Bibliography has no article numbers for most references and check author names for refs 22 and 88.

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