Physics 285a Problem Set 6

posted October 21, 2023, due October 25, 2023

Problem 1. Rydberg atoms and music?

Here is a somewhat entertaining application for Rydberg atoms: Download this paper:

https://pubs.aip.org/aip/adv/article/9/6/065110/22158/A-real-time-guitar-recording-using-Rydberg-atoms

a) While the paper's abstract is somewhat informative, I needed to read through the whole paper to get an idea what they are doing. Rewrite the abstract in your own words (or use ChatGPT – this should be a task it is well up to if you give it a good prompt). Alternatively, imagine you give a journal club talk about the paper and make one or two good intro or motivation slides.

b) Assume there is only one guitar that needs to be recorded. What would you do? How could you simplify the experimental setup?

c) What are the core concepts here? In particular:

   1. How are the acoustic guitar frequencies translated into the atomic transitions?
   2. What role does EIT play? (Look at the HW 4 solution of EIT to learn about EIT or check out wikipedia or ask ChatGPT....)
   3. What does "recording" exactly mean in the context of this paper?

d) This is a somewhat advanced paper that probably deals with some concepts that you did not learn yet. What questions are still open for you after working through the paper?

Problem 2. Blockade radius Approximately what principal quantum number n do you have to use for an ^{87}Rb Rydberg state in order to get a 20 μm blockade radius? Assume $\Omega = 2\pi \times 2$ MHz. Note that the blockade radius is defined by equating the two main energy scales of the system; namely, the Rabi frequency and the interaction potential, yielding:

$$R_b = \left(\frac{|C_6|}{\Omega}\right)^{1/6} \tag{1}$$