PHY 303, I-Semester 2022/23, Tutorial 1

9. Aug 2023

Discuss on your table in AIR on your allocated table number. When all teams finished a stage, make sure all students at your table understand the solution and agree on one by using the board.

This tutorial sheet is intentionally more voluminous than later ones will be. Within your team, feel free to skip content that you are less interested in or everyone is familiar with. However I want you to take care of each and every member *of your team and then your table. Hence if only one of you does not fully feel aware of one topic, I want all others to explain as best they can. This will in the end benefit all, since the best exercise in some topic is attempting to explain it!!! Should you not have enough time to complete the sheet in the tutorial session, please meet later to finish it.*

Stage 1 *(math review)* Review your knowledge about complex numbers, vectors and matrices from old course notes, books or the internet. Make sure you would be comfortable to answer the following questions:

(i) Draw the following complex numbers in the "complex plane". Then write them in the form $z = re^{i\varphi}$, for <u>real</u> r and φ:

$$z_1 = 2 - 4i, \qquad z_2 = -1 + \frac{i}{2}, \qquad z_3 = 1 - 5i \tag{1}$$

Make a drawing (sketch) of the function $f(x) = e^{zx}$ for $z = -0.1 + 3i$.

(ii) What is a vector? How do you find the length of a vector? How can you tell if two vectors orthogonal?

(iii) What is a vector space? What is a basis of a vector space? How do you change basis in a vector space?

(iv) How do you add or substract vectors, multiply them with a scalar, or multiply two vectors?

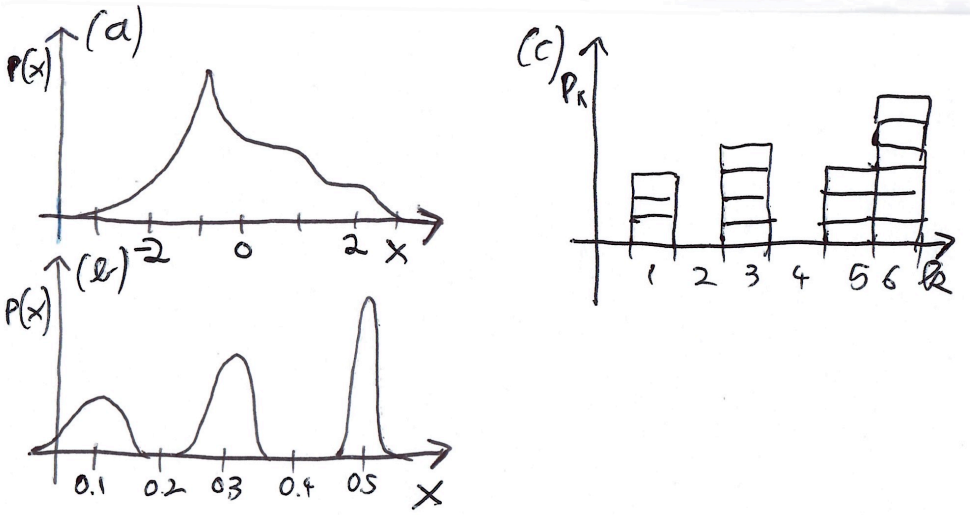
(v) What is a matrix? How do you multiply a matrix with a vector? How do you multiply two matrices? What is the inverse of a matrix?

(vi) Find the eigenvectors and eigenvalues of the following matrix (*try just by "watching". If that does not work, use the usual calculation*). Normalize the eigenvectors:

$$\underline{\underline{M}} = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 4 & 0 \\ 1 & 0 & 0 \end{bmatrix}. \tag{2}$$

(vii) In the following drawings of probability distributions, indicate where you would expect the mean value, the most likely value and how large you

would expect the standard deviation:



Stage 2 *(physics review)* Review your knowledge about quantum physics PHY106 from old course notes, books or the internet. Make sure you are comfortable with the answer to the following questions:

(i) List at least three key experimental observations that cannot be reconciled with classical physics and thus required the development of quantum mechanics. Discuss why classical physics cannot explain them and (if you know) how quantum mechanics can.

(ii) What would you say is the key difference between classical mechanics and quantum mechanics?

(iii) Recall the expressions for (i) Schrödinger's equation, (ii) Heisenberg's uncertainty principle and (iii) the de-Broglie wavelength, then discuss in your team what they mean and what they can be used for.

Stage 3 *(Your expectations)* Within your team, make a list of everything you were told in PHY106 for which you had found the earlier, "low-mathematics-content" explanations unsatisfactory and for which you hope to gain deeper insight in this course. Keep that list and then look at it at the end of the course again.