

ABSTRACT

This document discusses the work written by the educational group in the Summer of 2020.

1 ASSIGNMENTS

One of the focusses of our work has been rewriting the handouts from N. Avidor, A.P. Jardine, and D. Ward. We have significantly expanded the original 4 "tutorials" into 8 standalone documents, each aiming to teach specific skills. In addition, 7 further assignments have been written. These, as of present, are:

1. Graph Plotting
2. Fourier Transforms
3. Hard Wall Potentials
4. Eikonal Approximation
5. The Chudley-Elliott Model
6. Monte Carlo Simulations
7. Molecular Dynamics
8. Intermediate Scattering Function
9. Adsorbates
10. The Wavelength Intensity Matrix
11. Bayesian Fitting
12. Spin Precession
13. Potential Energy Surfaces
14. Rotating Molecules
15. Radial Distribution Function

We opt for the use of the term "assignment" over "tutorial", reflecting that the document does not intend to spoon-feed the student - it remains their job to figure out most of the processes. These are each accompanied by a solution file, which lucidly describes the process involved to solve the problems at hand. We recommend to minimise the use of the solution file, using it only for minimal assistance when stuck.

2 THEORY HANDBOOK

In addition to the assignments, we have written a "Theory Handbook". We believe this contains all of the relevant theory for completing the assignments. The content in this document assumes the typical first year undergraduate content of a maths course in a physical sciences degree (in the UK). It is also aimed to operate from a teaching perspective; it reduces the content down into very processable chunks, with rich explanations of as many concepts as possible.

The chapters in this handbook are:

1. Fourier Transforms
2. Convolution

3. Crystal Structures
4. Verlet Integration
5. Langevins
6. Bulk Scattering
7. Surface Scattering
8. Adsorbates
9. Scattering Functions
10. Spin Echo
11. Radial Distribution Function
12. Conclusions

3 STRUCTURE OF THE PROGRAM

This project creates a program that future students can follow. We aim that this program reaches approximately a month's length (when we have finished). The general process we have aimed to create is for a student to first read approximately 5 pages of theory from the Handbook, followed by the completion of a tutorial. This is structured in such a way that the student does not need to refer to external literature. Even if they did refer to external literature, we hope that our resources, being from a heavily teaching-based perspective, would serve them equally as well as the literature.

Alongside completing the assignments, if the programme is led by a research group, then there should be a number of lectures and seminars to accompany them. Upon completion, you should discuss with your supervisor your individual research project.

4 OTHER RESOURCES

An assignment on producing Penrose tilings has been produced as an aside. This is not part of the main stream at present, but may be integrated in the future.

5 FUTURE WORK

The number of topics we can write about is limited by time. The list of topics we would consider with sufficient time is:

1. Interference due to scattering from different particles
2. Diffusion of molecules on surfaces (as opposed to particles)
3. Pseudocode, compiled languages, and optimisation (*i.e.* a place to put all the guides on general coding)
4. LaTeX and mathematical writing
5. Helium microscopy simulations
6. Time-of-flight methods

6 OTHER: SURVEY RESULTS

Survey results from early in the program showed that students relied on the solutions to the pre-existing “tutorials” more than we desired. One of the objectives of this project is to allow students to be able to do the work without having the necessity to look at the solutions as frequently.

7 FEEDBACK

Please message a member of the educational group on google chat if you have found any errata. Also message if you have found any regions that are poorly explained, or have regions that cut off a topic too early. Feel free to send any more general feedback or comments, too. If you aren’t familiar with google chat, please email. If you have found a mistake, please assume that nobody else has spotted it! There are a very large number of pages, so it will probably be just you who has noticed the mistake. We are especially grateful for any feedback that we receive, regardless of whether from students or supervisors.

8 ACKNOWLEDGEMENTS

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The authors, in good faith, do not believe they have violated copyright during the writing and typesetting of the resources in this project.

This project is open access.