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P423 Quantum Mechanics II

Instructor: [Adam Ritz](#)**Office:** Elliott 118**Office hours:** Mondays 2:30-3:30pm**Email:** aritz@uvic.ca**Lectures:** 11:30-1:00pm, Mon & Thurs**Prerequisites:** PHYS 321A, 323, MATH 301, 342, 346

This is a 4th year course on topics in quantum mechanics, and covering the following broad areas:

- Atoms and electromagnetism
- Scattering
- Path integrals
- Quantum information
- Relativistic QM and QFT

See the course syllabus for further details.

Territory Acknowledgement: We acknowledge and respect the Lək̓ʷəŋən (Songhees and Esquimalt) Peoples on whose territory the university stands, and the Lək̓ʷəŋən and W̓SÁNEĆ Peoples whose historical relationships with the land continue to this day.

Syllabus	Texts	Materials	Assessment	Learning Outcomes	Other Resources
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This is a 4th year course on quantum mechanics, and (time permitting) will cover the following topics.

- Overview (Week 1)
 - [Introduction, review of the hydrogen atom](#)
- Atoms and electromagnetism (Weeks 2-4)
 - [Perturbation theory](#)
 - [Fine structure](#)
 - [Atoms and electromagnetic interactions](#)
- Scattering (weeks 5-7)
 - [Scattering in 1D and resonances](#)
 - [Scattering in 3D](#)
 - [Lattices and Bragg scattering](#)
- Path integrals (Weeks 8-9)
 - [Transition amplitudes](#)
 - [Instantons and tunneling](#)
- Quantum information (Weeks 10-12)
 - [Entanglement](#)
 - [Density matrices](#)
- Relativistic QM and QFT (not examinable)
 - [Causality](#)
 - [Intro to QFT](#)

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The course will include a comprehensive set of lecture notes, and will not follow one specific textbook. However, there are many good texts that cover material relevant for this course. The book currently used for PHYS 323 is a good example, and will be a useful reference: ▪ Quantum Mechanics, D.H. McIntyre (parts of Ch. 4, 6, 10 - 16) The following text that was published just this year provides excellent coverage of a number of topics in this course: ▪ Quantum Mechanics, D. Tong (Ch, 9 - 17) The pre-cursor Cambridge Part II lecture notes are also available. There are a number of other good textbooks that cover similar material, although the approach varies, with some following a wave mechanics formalism, while others emphasize the operator approach: ▪ An Introduction to Quantum Mechanics, D.J. Griffiths & D.F. Schroeter ▪ A Modern Approach to Quantum Mechanics, J.S. Townsend ▪ Modern Quantum Mechanics, J.J. Sakurai & J. Napolitano There are also classic texts, that can be useful as references, and with content and varied applications that extend beyond the scope of this course: ▪ Quantum Mechanics, L.D. Landau & E.M. Lifschitz ▪ The Principles of Quantum Mechanics, P.A.M. Dirac					

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Syllabus	Texts	Materials	Assessment	Learning Outcomes	Other Resources
Further online material for the course, including: ▪ course notes ▪ assignment sheets ▪ sample solutions will be available at the PHYS 423 course page in Brightspace					

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The course will be assessed according to the following three components: ▪ Assignments: 35% ▪ Mid-term quiz: 25% ▪ Final exam: 40% There will be 5 assignments during the semester, and you will generally have ~1.5 weeks to complete each of them. The cumulative assignment grade will be computed from the top 4, with the lowest grade discarded. Assignments form an integral part of the course, used to expand on the material in the lectures in various ways. Investing time in them is beneficial for understanding the novel concepts involved in the theory of general relativity, and a key to success in this course. Dates for the mid-term quiz and final exam are TBA. The final grade will follow the University's percentage grading scheme given in the University Calendar, with the following universal conversion between letter and percentage grades: ▪ A+ (90-100) ▪ A (85-89) ▪ A- (80-84) ▪ B+ (77-79) ▪ B (73-76) ▪ B- (70-72) ▪ C+ (65-69) ▪ C (60-64) ▪ D (50-59) ▪ E (TBD) ▪ F (0-49) If the application of this scheme would result in grades deemed by the instructor to be inconsistent with the University's grading descriptions, percentages will be assigned which are consistent with them. Note on the use of calculators in exams: Calculators are not really required for this course, but a reminder about the general university policy; "On all examinations the only acceptable calculator is the Sharp EL-510R. This calculator can be bought in the Bookstore for about \$10. DO NOT bring any other calculator to the examinations."					

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After completing the course, you will: ▪ have detailed knowledge of how quantum mechanics explains features of atomic structure. ▪ be able to apply perturbative techniques to determine corrections to energy levels in hydrogenic systems. ▪ have detailed knowledge of how atomic systems interact with electrostatic and magnetostatic fields. ▪ have an understanding of quantum mechanical scattering and the properties of the scattering matrix. ▪ have acquired a basic understanding of the path integral formalism of quantum mechanics ▪ have acquired basic knowledge of quantum entanglement, density matrices, and quantum information. ▪ have acquired a basic understanding of relativistic quantum mechanics, and how the formalism of quantum field theory leads to particle states. ▪ be able to communicate basic principles and complex topics in quantum mechanics in a clear and pedagogical way.					

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This [document](#) contains some important information about the department, and a number of UVic resources and supports that could be relevant for your studies.

Here are some additional resources and educational supports:

- Important Dates
 - <https://www.uvic.ca/calendar/dates/>
- Academic Supports
 - <https://onlineacademiccommunity.uvic.ca/LearnAnywhere/academic-supports/>
- Accommodations (Centre for Accessible Learning)
 - <https://www.uvic.ca/accessible-learning/students/accommodations/index.php>
- Learning Strategies
 - <https://onlineacademiccommunity.uvic.ca/LearnAnywhere/learning-strategies/>
- Well-being
 - <https://onlineacademiccommunity.uvic.ca/LearnAnywhere/well-being/>
- Policy on Academic Integrity
 - <https://www.uvic.ca/students/academics/academic-integrity/index.php>

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DEPARTMENT OF PHYSICS AND ASTRONOMY INFORMATION

- Department Website: uvic.ca/science/physics/index.php
- Department General Office: physgen@uvic.ca
- Department Undergraduate Advisor: phast_advising@uvic.ca
- Department Graduate Advisor: pkovtun@uvic.ca
- Department Graduate Program Assistant: physgrad@uvic.ca

UNIVERSITY STATEMENTS & POLICIES

- Academic Calendar: [Information for All Students](#)
- [Creating a respectful, inclusive, and productive learning environment](#)
- [Accommodation of Religious Observance](#)
- [Accommodation and Access for Students with Disabilities](#)
- [Student Conduct](#)
- [Non-academic Student Misconduct](#)
- [Accessibility](#)
- [Diversity / EDI](#)
- [Equity Statement](#)
- [Sexualized Violence Prevention and Response](#)
- [Discrimination and Harassment Policy](#)

STUDENT RESOURCES

POSITIVITY AND SAFETY

The University of Victoria is committed to promoting, providing, and protecting a positive and safe learning and working environment for all its members.

[Student Groups & Resources](#)

ACADEMIC RESOURCES

UVic Library - *UVic Library offers many services and resources for undergraduate and graduate students.*

uvic.ca/students/academics/library-services

Learning Resources - *UVic Learn Anywhere is the primary learning resource for students that offers many learning workshops and resources to help students with academics and learning strategies.*

onlineacademiccommunity.uvic.ca/uviclearn/

Centre for Academic Communication - *Offers online and in-person one-on-one tutorials, workshops, and more.*

uvic.ca/learningandteaching/cac

Math & Stats Assistance Centre - *Offers drop-in, face-to-face tutoring and a friendly, collaborative study space for 100- and 200-level math and stats courses.*

uvic.ca/science/math-statistics/current-students/undergraduate/msac

MENTAL HEALTH & WELLNESS

A note to remind you to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress. All of us benefit from support during times of struggle. You are not alone.

Student Wellness Centre - *Our team of practitioners offers a variety of services to support students' mental, physical, and spiritual health.*

uvic.ca/student-wellness

Counselling Services - *Counselling Services can help you make the most of your university experience. They offer free professional, confidential, inclusive support to currently registered UVic students.*

uvic.ca/student-wellness

Health Services - *University Health Services (UHS) provides a full-service primary health clinic for students and coordinates healthy student and campus initiatives.*

uvic.ca/student-wellness

ACCESSIBILITY

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a documented disability or health consideration that may require accommodations, please feel free to approach me and/or the Centre for Accessible Learning (CAL) as soon as possible.

Centre for Accessible Learning - *The CAL staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.*

uvic.ca/accessible-learning

ADVISING

For academic advising-related questions, students in Physics and Astronomy are also encouraged to meet with one of the PHAST Undergraduate Advisors (phast_advising@uvic.ca) as well as an academic advisor in the Academic Advising Centre early in their studies to help map out a plan to declare a major and complete university program requirements.

Academic Advising Centre - *Academic advice and support is currently available by phone, email and virtual or in-person appointments.* uvic.ca/services/advising



Ombudsperson - *The ombuds office is an independent, impartial, and confidential resource for undergraduate and graduate students and other members of the University of Victoria community. The ombudsperson helps resolve student problems or disputes fairly.* uvicombudsperson.ca

ACADEMIC CONCESSION

You can request an academic concession if your course requirements are affected by unexpected and unavoidable circumstances, or conflicting responsibilities. Concession requests can be for an in-course extension, deferral, withdrawal under extenuating circumstances, or an aegrotat. Please speak to an advisor at the Academic Advising Centre if you have questions on how requesting a concession will affect your academic program.

Undergraduate Academic Concessions - uvic.ca/students/academics/academic-concessions-accommodations

EQUITY AND HUMAN RIGHTS AT UVIC

EQHR is a resource for students, staff, and faculty who have experienced sexualized violence, discrimination, and/or harassment and are looking for informal and/or formal resolution options as well as advice, coaching, and/or education. We are available for confidential consultations so that you can ask questions and learn your options.

EQHR – By email at eqhr01@uvic.ca or in-person (Sedgewick C115). uvic.ca/equity

Sexualized Violence Resource Office – *If you have been directly or indirectly impacted by sexualized violence, reach out to the SVRO for information, advice, and resolution options (restorative and disciplinary) as well as support options and referrals. The SVRO is both survivor-centred and trauma-informed in their approach. You can reach us by phone at 250-721-8021 or by email at eqhr01@uvic.ca to book either an in-person (Sedgewick C119) or online appointment.* uvic.ca/sexualizedviolence

RESOURCES FOR INTERNATIONAL STUDENTS

International Centre for Students - *The primary office supporting international students on campus at the university-wide level.* uvic.ca/international-experiences

UVic Global Community Initiative - *Provides various supportive programming, including a Mentorship Program and Conversation Partner Program.* uvic.ca/international-experiences/get-involved/uvic-global-community

RESOURCES FOR INDIGENOUS STUDENTS

Indigenous Student Support - *UVic offers holistic services to Indigenous students throughout their academic journey.* uvic.ca/students/info-for/indigenous-students

Elders in Residence - *The Office of Indigenous Academic and Community Engagement (IACE) has the privilege of assembling a group of Elders from local communities to guide students, staff, faculty, and administration in Indigenous ways of knowing and being.* uvic.ca/iace/