

UNIVERSITY OF CALGARY
DEPARTMENT OF PHYSICS and ASTRONOMY
COURSE OUTLINE

1. **PHYS 303-01, Quantum Mysteries and Paradoxes**

Lecture Sections:

L01: MWF, 11:00-11:50, ST 135 **Christoph Simon**, Office SB 313, Tel. No. 220 7007, csimo@ucalgary.ca, Office Hours: W 1:30-2:30

2. **PREREQUISITES:** The course makes limited use of high-school algebra.

3. **GRADING:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Assignments (8)	40%
2 midterm tests	30% (15% each)
Final Examination (To be scheduled by the Registrar)	30%

Percentage grades will be given for all elements of term work and examinations. A weighted course percentage will be calculated for each student after the final exam is written. A table of conversion from final course percentage to final course letter grade will be made available later in the term. Assignments are due on time as announced. Late assignments will be considered only in well-documented emergencies (e.g. a doctor's note should be provided in case of illness).

4. **Missed Components of Term Work.** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in section 3.6: <http://www.ucalgary.ca/pubs/calendar/current/sc-3-6.html>. It is the student's responsibility to familiarize himself/herself with these regulations. See also <http://www.ucalgary.ca/pubs/calendar/current/e-3.html>.

5. **REGULARLY SCHEDULED CLASSES HAVE PRECEDENCE OVER ANY OUT-OF-CLASS-TIME-ACTIVITY.** If you have a clash with this out-of-class-time-activity, please inform your instructor as soon as possible so that alternative arrangements may be made for you.

6. **TEXTBOOK:** Valerio Scarani, Quantum Physics – A First Encounter (Oxford University Press, 2006)

7. **EXAMINATION POLICY:** The exams will be closed book, no aids allowed. Students are encouraged to read the Calendar, Section G, on Examinations: <http://www.ucalgary.ca/pubs/calendar/current/g.html>.

Department Approval _____

Date _____

Jan 2 / 17

Associate Dean's Approval for

out of regular class-time activity: _____

Date: _____

11. **OTHER IMPORTANT INFORMATION FOR STUDENTS:**

(a) **ACADEMIC MISCONDUCT** (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under K. Student Misconduct (<http://www.ucalgary.ca/pubs/calendar/current/k.html>) to inform yourself of definitions, processes and penalties

(b) **ASSEMBLY POINTS in case of emergency during class time.** Be sure to **FAMILIARIZE YOURSELF** with the information at <http://www.ucalgary.ca/emergencyplan/assemblypoints>.

(c) **ACADEMIC ACCOMMODATION POLICY.** Students with documentable disabilities are referred to the following links:
Calendar entry on students with disabilities: <http://www.ucalgary.ca/pubs/calendar/current/b-1.html>
Disability Resource Centre: <http://www.ucalgary.ca/drc/>

(d) **SAFEWALK:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.

- (e) **FREEDOM OF INFORMATION AND PRIVACY:** This course will be conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPPA). As one consequence, **students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page.** For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **STUDENT UNION INFORMATION:** VP Academic Phone: 220-3911 Email: suvpaca@ucalgary.ca.
SU Faculty Rep. Phone: 220-3913 Email: sciencerep@su.ucalgary.ca Website <http://www.su.ucalgary.ca/home/contact.html>.
Student Ombudsman: <http://www.su.ucalgary.ca/services/student-services/student-rights.html>
- (i) **INTERNET and ELECTRONIC COMMUNICATION DEVICE Information.** You can assume that in all classes that you attend, **your cell phone should be turned off.** Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.

Course Syllabus

The scientific method: progress through model building and falsification.

Introduction to physics: fundamental interactions and particles.

Principles of quantum physics: single-particle interference.

The indistinguishability principle.

Interaction-free measurement.

Waves and particles: early history of quantum physics.

Neutron interferometry, spin.

Interference with large molecules, decoherence.

Which-path information, Heisenberg mechanism.

Quantum cryptography: quantum key distribution.

Two-particle interference: quantum correlations.

Quantum eraser.

Impossibility of superluminal communication based on quantum correlations.

Einstein-Podolski-Rosen argument.

Bohm's theory.

Bell's theorem: quantum non-locality.

Polarization of photons.

Experimental tests of Bell's inequalities.

Interpretations of quantum physics: decoherence, many worlds.

Quantum information: qubits.

No-cloning theorem.

Photon bunching.

Quantum teleportation.

Entanglement swapping.

Quantum memories.

Long-distance quantum communication: quantum repeaters.

Quantum computing.