TRINITY COLLEGE
UNIVERSITY of OXFORD

Further Particulars for Fixed-Term, Part-Time Stipendiary Lecturership in Physics

Trinity College invites applications for a Stipendiary Lecturership in Physics, for Michaelmas Term 2024 and Hilary Term 2025. The Lecturer will primarily liaise with Dr Sam Vinko, the Tutorial Fellow and Subject Tutor in Physics. The Lecturer will take on an average of 2 weighted hours teaching per week for students at Trinity College, for 2nd year students of Physics.

Teaching of Physics at Trinity College
Trinity College admits around 6 students a year to read Physics. The teaching required is for 2nd Year Quantum Mechanics [See Appendix A. at the end of the job description], and is to cover for Professor Justin Wark, whilst he is on sabbatical leave.

Duties of the Lecturer

- to be responsible for teaching Quantum Mechanics to Trinity 2nd Year Physics students;
- to teach 2 weighted hours a week, averaged over the two eight-week terms. Due to the timing of lectures this will be spread unevenly between the terms – the Quantum Course does not start until mid-term in Michaelmas. The number of contact hours is somewhat reduced where the teaching is in pairs or larger groups. For example, teaching a pair for one hour counts as 1.25 weighted hours, and teaching a group of three counts as 1.5 weighted hours;
- to undertake other duties connected with the Physics course, such as participating in the undergraduate admissions exercise, which takes place annually in December, and taking part in college Open Days.

Selection Criteria

- education to degree level in Physics; research in a relevant area, a doctorate or substantial progress towards a doctorate.
- some experience of tutorial teaching in the relevant subject areas would be an advantage;
- ability and willingness to undertake the associated duties as specified above.

Term of appointment
This is a fixed-term appointment for two terms for Michaelmas Term 2024 and Hilary Term 2025.

Stipend
The starting salary is pro rata at point 23-27 (depending on experience) on the HE single pay spine. The current annual salary will be £4,960- £5,558 for the 2 weighted hours.

Marking and preparation, attendance at Open Days, admissions interviews and similar duties are covered by the stipend.

Other benefits

- The appointed lecturer will be able to book a pooled teaching room in Trinity College for tutorials.
- Membership of the Senior Common Room (SCR) will be provided free of charge.
- The appointed lecturer will be entitled to two lunches and one dinner, free of charge, per week at the Common Table (SCR) during term time and vacation, except when the kitchens are closed.

Please note that this post does not carry a housing allowance, and no College accommodation would be available.

Right to work

The appointment will be subject to the provision of proof of the right to work in the UK.

How to apply

Candidates should submit the following documents electronically to the Academic Administrator (academic.administrator@trinity.ox.ac.uk):

- a short letter outlining how they believe they meet the criteria set out for the post;
- an academic CV;
- the names of two referees who should be asked by the candidate to email their references directly to the Academic Administrator**. It is the responsibility of the candidate to ensure that the references arrive by the closing date.**

The closing date for applications is **12 noon (UK time) on Monday 20th May 2024.**

Appointment Process

We expect to hold **interviews on Thursday 6th June 2024.** Candidates invited for interview will be asked to give a brief teaching presentation on a topic from the current 2nd Year course in Quantum Mechanics. Further details will be given to those shortlisted.

Trinity College is an equal opportunities employer. Entry into employment within the Colleges and progression within employment will be determined only by personal merit and the application of criteria that are related to the duties of each particular post and the relevant salary structure. Subject to any statutory provisions, no applicant or member of staff will be treated less favourably than another because of their age; colour; disability; ethnic origin; marital status; nationality; national origin; parental status; race; religion or belief; gender or sexual orientation. In all cases, ability to the job will be the primary consideration.

Appendix A: A3 Quantum Physics

Probabilities and probability amplitudes. Interference, state vectors and the bra-ket notation, wavefunctions. Hermitian operators and physical observables, eigenvalues and expectation values. The effect of measurement on a state; collapse of the wave function. Successive measurements and the uncertainty relations. The relation between simultaneous observables, commutators and complete sets of states.

The time-dependent Schroedinger equation. Energy eigenstates and the time-independent Schroedinger equation. The time evolution of a system not in an energy eigenstate. Wave packets in position and momentum space.

Probability current density.

Wave function of a free particle and its relation to de Broglie's hypothesis and Planck's relation. Particle in one-dimensional square-well potentials of finite and infinite depth. Scattering off, and tunnelling through, a one-dimensional square potential barrier. Circumstances in which a change in potential can be idealised as steep; *[Non examinable: Use of the WKB approximation.]*

The simple harmonic oscillator in one dimension by operator methods. Derivation of energy eigenvalues and eigenfunctions and explicit forms of the eigenfunctions for n=0,1 states.

Amplitudes and wave functions for a system of two particles. Simple examples of entanglement.

Commutation rules for angular momentum operators including raising and lowering operators, their eigenvalues (general derivation of the eigenvalues of L^2 and L_z not required), and explicit form of the spherical harmonics for l=0,1 states. Rotational spectra of simple diatomic molecules.

Representation of spin-1/2 operators by Pauli matrices. The magnetic moment of the electron and precession in a homogeneous magnetic field. The Stern–Gerlach experiment. The combination of two spin-1/2 states into S=0,1; *[non-examinable: Derivation of states of well-defined total angular momentum using raising and lowering operators]*. Rules for combining angular momenta in general (derivation not required). *[Non-examinable: term symbols.]*

Hamiltonian for the gross structure of the hydrogen atom. Centre of mass motion and reduced particle. Separation of the kinetic-energy operator into radial and angular parts. Derivation of the allowed energies; principal and orbital angular-momentum quantum numbers; degeneracy of energy levels.

Functional forms and physical interpretation of the wavefunctions for $n<3$.

First-order time-independent perturbation theory, both non-degenerate and degenerate (questions will be restricted to systems where the solution of the characteristic equation can be obtained by elementary means). Interaction of a hydrogen atom with a strong uniform external magnetic field. The linear and quadratic Stark effects in hydrogen.

Exchange symmetry for systems with identical fermions or bosons; derivation of the Pauli principle. Gross-structure Hamiltonian of helium. Implications of exchange symmetry for wavefunctions of stationary states of helium; singlet and triplet states. Estimation of the energies of the lowest few states using hydrogenic wavefunctions and perturbation theory.

The variational method for ground-state energies; application to helium.

The adiabatic and sudden approximations with simple applications.

Time-dependent perturbation theory. The interaction of a hydrogen atom with an oscillating external electric field; dipole matrix elements, selection rules and the connection to angular-momentum conservation. Transition to a continuum; density of states, Fermi's golden rule.

[Non-examinable -Classical *uncertainty in quantum mechanics: pure and impure states. The density matrix and trace rules. Time-evolution of the density matrix. Measurement and loss of coherence.]*