

Physics

Lancaster
University



Research Assistant/Senior Research Assistant/Research Fellow in condensed-matter atomic clocks
JOB DESCRIPTION

Job Title: Research Fellow	Present Grade: 6-8
Department/College: Physics	
Directly responsible to: Prof Edward Laird	
Supervisory responsibility for: Partial responsibility for graduate and MPhys students	
Other contacts	
Internal: members of the Physics Department	
External: Industrial collaborators at LocatorX; other scientific collaborators	

This post is to carry out an intensive research programme in support of our development of a condensed-matter atomic clock based on nitrogen endohedral fullerenes. The goal is to raise the technology readiness level (TRL) from its current status of TRL3 to TRL5. The research is supported by LocatorX, Inc. and by EPSRC, and builds on prior research in collaboration with the University of Oxford.

The proposed clock uses the extremely sharp spin resonance transitions of the endohedral fullerene molecule $^{15}\text{N}@C_{60}$ as its frequency reference. Most spin transitions are unsuitable as clock references because their frequencies are affected by magnetic field noise. However, we have recently identified and measured a transition in this molecule at which the frequency is insensitive to magnetic fields to first order. This project will exploit this discovery by developing a prototype suitable for industrial development.

We are seeking to recruit one or two researchers. To reach TRL5, several tasks must run in parallel and will be divided among team members depending on individual expertise and the needs of the project. A high degree of collaboration is expected in order to make rapid progress.

The objectives are approximately as follows. One task is to develop a working benchtop clock in our laboratory with the aim of reaching TRL4, i.e. component validation in a laboratory environment. This task requires:

- Integration of frequency feedback into our existing spin resonance detection spectrometer
- Integration of magnetic field feedback in order to mitigate magnetic noise
- Validation of the benchtop clock by measuring the Allan deviation.

The next task is to improve the fidelity of the clock in order to reach TRL5, i.e. component validation in a relevant environment. This task requires

- Improvement of the spin coherence time, using pulsed spin resonance to identify decoherence mechanisms in order to mitigate them.
- Implementation of a temperature-compensation scheme to prevent thermal drift.
- Characterisation of a benchtop prototype stabilized against field and temperature fluctuations.
- Validation of the prototype under simulated real-world fluctuations of temperature and magnetic field.

For more information about this technology, see:

- [Spin resonance clock transition of the endohedral fullerene \$^{15}\text{N}@C_{60}\$](#)
Physical Review Letters **119** 140801 (2017)
- [Keeping Perfect Time With Caged Atoms](#)
IEEE Spectrum **54** 34 (2017)

Major Duties

The appointment may be made at one of three grades, depending on the expertise of the researcher.

For a role as Research Fellow (Grade 8)

- Play a leading role in development of an endohedral-fullerene atomic clock by designing, constructing, and testing tabletop prototypes.
- Identify and correct the sources of clock inaccuracy by developing improved measurement schemes informed by the relevant physics and materials science.
- Analyse measurement results and present them within the project team at Lancaster, to collaborators in other universities and at companies including LocatorX, and at conferences.
- Ensure that the project objectives are achieved according to schedule.
- Write technical documents to capture results and publish papers in peer-reviewed journals.
- Support the protection of arising IP.
- Support students working on the endohedral-fullerene clock.
- Travel occasionally, if required to meet project partners in the UK or US.

For a role as Senior Research Assistant (Grade 7)

- Play a leading role in development of an endohedral-fullerene atomic clock by designing, constructing, and testing tabletop prototypes.
- Identify and correct the sources of clock inaccuracy by developing improved measurement schemes informed by the relevant physics and materials science.
- Analyse measurement results and present them within the project team at Lancaster, to collaborators in other universities and at companies including LocatorX, and at conferences.
- Ensure that the project objectives are achieved according to schedule.
- Write technical documents to capture results and publish papers in peer-reviewed journals.
- In liaison with your line manager, support the protection of arising IP.
- In liaison with your line manager, support students working on the endohedral-fullerene clock.
- Travel occasionally, if required to meet project partners in the UK or US.

For a role as Research Assistant (Grade 6)

- Contribute to development of an endohedral-fullerene atomic clock by designing, constructing, and testing tabletop prototypes.
- Identify and correct the sources of clock inaccuracy by developing improved measurement schemes informed by the relevant physics and materials science.
- Analyse measurement results and present them within the project team at Lancaster, to collaborators in other universities and at companies including LocatorX, and at conferences.
- Ensure that the project objectives are achieved according to schedule.
- Contribute to technical documents to capture results and publish papers in peer-reviewed journals.
- In liaison with your line manager, support the protection of arising IP.
- In liaison with your line manager, support students working on the endohedral-fullerene clock.
- Travel occasionally, if required to meet project partners in the UK or US.