

## **ARC Centres of Excellence Program**

### **ARC Centre of Excellence for Quantum-Atom Optics**

**Interim Director: Professor H A Bachor**

**Collaborating Institutions:**

The Australian National University  
The University of Queensland  
Swinburne University of Technology  
Universitat Hannover  
Université Pierre et Marie Curie  
Vrije Universiteit  
University of Otago  
University of Auckland  
Imperial College

Using delicately controlled laser light beams to nudge individual atoms together, scientists have recently learned how to make a new state of matter called the Bose-Einstein Condensate (BEC). In a BEC, the matter-waves of individual atoms overlap, producing unusual and unexpected properties and behaviours. The Centre brings together an extremely strong, balanced, international team that aims to develop a quantum toolbox for atoms and photons, and to apply this to conduct fundamental research on the quantum nature of multi-particle states comprising atoms, photons or both.

Australia is particularly well placed to build a world-class Centre in this emerging field, which has already seen the award of two Nobel prizes in the past five years. The Centre research team will combine pre-eminent quantum theorists with experimenters who have a powerful armoury of techniques for producing squeezed states of light and BECs.

The five-year research program of the Centre aims to develop a pumped, continuous-wave atom laser as a direct analogy to an optical laser, to study atom-light entanglement which is a potential storage process for quantum computing, to explore BECs in optical lattices as a way of controlling matter waves, to investigate 'superchemistry' using molecular BECs, and to produce a BEC on an electro-magnetic microtrap on a chip. Each one of these aims has the potential to lead to a range of novel and innovative applications over the next few decades, in a manner analogous to the way that the optical laser has become the basis for many commercial and social applications since its invention approximately 50 years ago.

Research conducted by the Centre's team has already captivated the attention of the Australian community (the optical teleportation experiment) and it will continue to excite and inspire young Australians' interests in scientific frontiers. The education programs of the Centre will train a generation of R & D staff and technology experts who will be key personnel in the industries that emerge from atom-optics, advanced photonics, and quantum computing.