

IOP Optical Group Travel Grant – Travel Report Melbourne

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I always thought of physics in two ways: there is one side of hard work behind the computer and in the lab, with long days (and nights) of work that eventually produce a handsome result. And there is the other side of it – meeting other physicists, presenting your results, discussing your progress, and listening to the opinions and ideas of experienced gurus in your field. Thankfully, these two sides seem to correlate strongly, at least this is the experience I had as a DPhil student in physics at the University of Oxford. After more than two years into my course, and achieving interesting data on NV centre ensembles and quantum optics with diamonds, I was invited to give a talk at a quantum memory workshop at the University of Melbourne.

The workshop brought together many of the leading researchers in the field, and every talk visualised what a promising material diamond is for quantum optics and quantum information processing. Out of all optically active defects in diamond, the nitrogen vacancy (NV) centre is the most famous, and many interesting optical schemes have already been realised in experiment: spin state initialisation using off-resonant laser pulses, spin state manipulation using microwave pulses, the read-out of spin states at room temperature, and entanglement of the electronic spin state with nearby nuclei. While most of these schemes regard single NV centres, our work at Oxford focusses on ensembles, constituted of millions of NV centres. Ensembles of atoms have already been proven reliable absorbers for high efficiency quantum memories. Could such a scheme also be realised using NV centres? Our analysis showed that, due to the large inhomogeneous broadening of a high density ensemble (as is typical for solid state absorbers), the usage of the narrowband spin state splitting is impractical for storage. However, using localised phonons of the NV centre, off-resonant storage of broadband pulses is possible. Attending the workshop allowed me to present this scheme to the NV community and expand our knowledge thanks to their feedback: What storage efficiency can a quantum memory achieve? How can the NV centre density in a diamond sample be increased? What progress has been made on the creation of micro-structures in diamond, e.g. microcavities and waveguides?

It was very instructive to discuss these questions at the workshop in Melbourne and at subsequent conversations with collaborators and researchers at other universities in Australia. Diamond is a rather exotic semiconductor, so that the community is comparatively small – which made the atmosphere very friendly and the discussions very fruitful. Having come back with some interesting answers and many new ideas, I would like to thank the IOP Optical Group for their financial support that made my visit to such a distant conference possible.