Measuring spin and spinning in the international networks

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"There is plenty of room at the bottom", the famous words of the Nobel Laureate Richard P. Feynman in 1959, well before the nanoage, when he was emphasizing that the laws of physics allow enormous amounts of information to be stored in the tiniest volumes. He gives an example: if a single bit of information can be stored in 100 atoms, all the information in all of the books in the world at that time could be stored in the size of a tiny dust particle barely visible to a naked human eye. Ironically, his title "there is plenty of room at the bottom" also implies that there is a bottom, that is, information density does have a limit set by the fundamental laws of physics. What is this bottom? Can it be reached?

Recently, I and my fellow physicists in Australia have demonstrated experimentally a way to measure at high fidelity the spin state of a single electron in real time (News on UMK web pages). This electron is trapped in the tight potential well formed by a single deliberately implanted phosphorus donor in silicon. Thus we have not accessed the bit of information stored in 100 atoms as Prof. Feynman allowed in his example but the bit of information stored in the spin-½ state of the electron stored in a single atom. As amazing as it sounds, it is true in a way and has been published in the October 7th 2010 issue of Nature [M. Morello et al., Nature 467, 687 (2010)]. However, to build up an error-tolerant memory out of these single-atom blocks is orders of magnitude more challenging problem and the information density will drop dramatically because of the need of individual read-out and control gates for each bit. Thus we are still far from Feynman's bottom.

Another idea of Feynman was to use controllable quantum systems to simulate other many-body quantum systems which are out of the reach of classical modeling tools. Later, this type of thinking led to the concept of quantum information processing and quantum computing which utilizes controllable quantum systems to perform computational tasks very efficiently. In fact, the spin read-out scheme discussed above, was not built to process classical information but to work as a stepping stone to a computer utilizing quantum degrees of freedom - the quantum computer. Whether a large-scale quantum computer ever sees daylight is uncertain, but I think that we have a good chance here to revolutionize information processing, and we should take that chance.
An individual researcher may now think how one can get involved with such a high-level research. In this case, it was purely because of taking a post doc period at UNSW and maintaining the collaboration. Although everything was going well at my home institution and I had a lot of international collaborators, the trip to Sydney was extremely useful. When you go and work for a group strangers, you are forced to get to know them and to learn their research. Thus a year abroad can be worth of several spent at home. There is only a certain interval in your research career when you can take a post doc position - do not miss it, and plan it well since a visit to a bad group can be just a waste of your time.

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