☆EVENT　インタラクティブ物質科学・カデットプログラム講演セミナー☆

2014 年 5 月 15 日(木) 14:40～16:10

場所：基礎工学研究科　B 棟 B300（大講義室）

講師をお招きしてセミナーを開催しました

講師名：　Dr. Philipp Neumann

講師所属：3. Physikalisches Institut, Stuttgart University, Germany

講演タイトル：　NV centers in diamond – solid state spins applied in quantum registers and as multipurpose nanoscale probes

要旨：　Single nitrogen-vacancy (NV) defect centers in diamond are extraordinary color centers with a remarkable set of properties. First, they are optically addressable at the single level. The latter gives access to the ground state electronic spin triplet, which can be optically initialized and read out. Furthermore, at room temperature coherence times (a few milliseconds) are long compared to manipulation times (down to nanoseconds) mainly due to recent advances synthetic diamond quality.

In recent years, NV center spins were used to detect tiny magnetic fields and proximal electron and nuclear spins. While the first application opens up many possibilities for quantum metrology especially at the nanometer scale, the second application has led to

small, functional quantum registers. Particularly, 13C nuclear spins in the diamond lattice and near NV centers were used to create non-local quantum states. [1, 2]
Here, we are going to present novel knowledge about the NV center's electronic and spin properties which allows improving sensing capabilities. As an example, the NV electron spin can be made sensitive to further quantities like temperature, electric fields and lattice strain. Very recently, we achieved the detection of a single elementary charge at room temperature. [3]
Furthermore, we presenting recent achievements in scaling our solid state spin registers. On the one hand, we couple and entangle proximal NV electron spins via their mutual magnetic dipole interaction. On the other hand, individual NV centers are equipped with several nuclear spins to demonstrate essential quantum algorithms. As a prominent example, we protect stored quantum coherences against dephasing via quantum error correction. [4] The latter is essential for any scalable architecture of quantum computation or long-range quantum communication via quantum repeaters.
As the high fidelity spin control becomes challenging in continuously growing registers we started applying optimal control techniques. We will show recent applications and discuss the scalability of this approach.

[1] P. Neumann, N. Mizuochi, et al., Science 320, 1326 (2008).
[2] P. Neumann et al., Science 329, 5991 (2010).
[3] F. Dolde, P. Neumann et al., Phys. Rev. Lett. 112, 097603 (2014).
[4] G. Waldherr, P. Neumann et al., Nature, 506, 7487 (2014).

＜主催した先生から＞

近年、ダイヤモンド中の NV 中心に非常に関心が持たれている。室温において固体中では唯一、単一の電子及び核スピンを操作及び検出が行える。講演では最近、演者らによって行われた単一核スピンの量子非破壊測定や、NV 中心を用いた超高感度・超高分解能の磁気センサーに関する研究などが紹介された。実際に実験に携わった演者による講演であり、非常にエキサイティングな内容で、予定時間を過ぎても講演が続いたが、あっという間に時間が過ぎたという感じであった。講演に対し、活発な討論が行われた。

（水落憲和准教授）