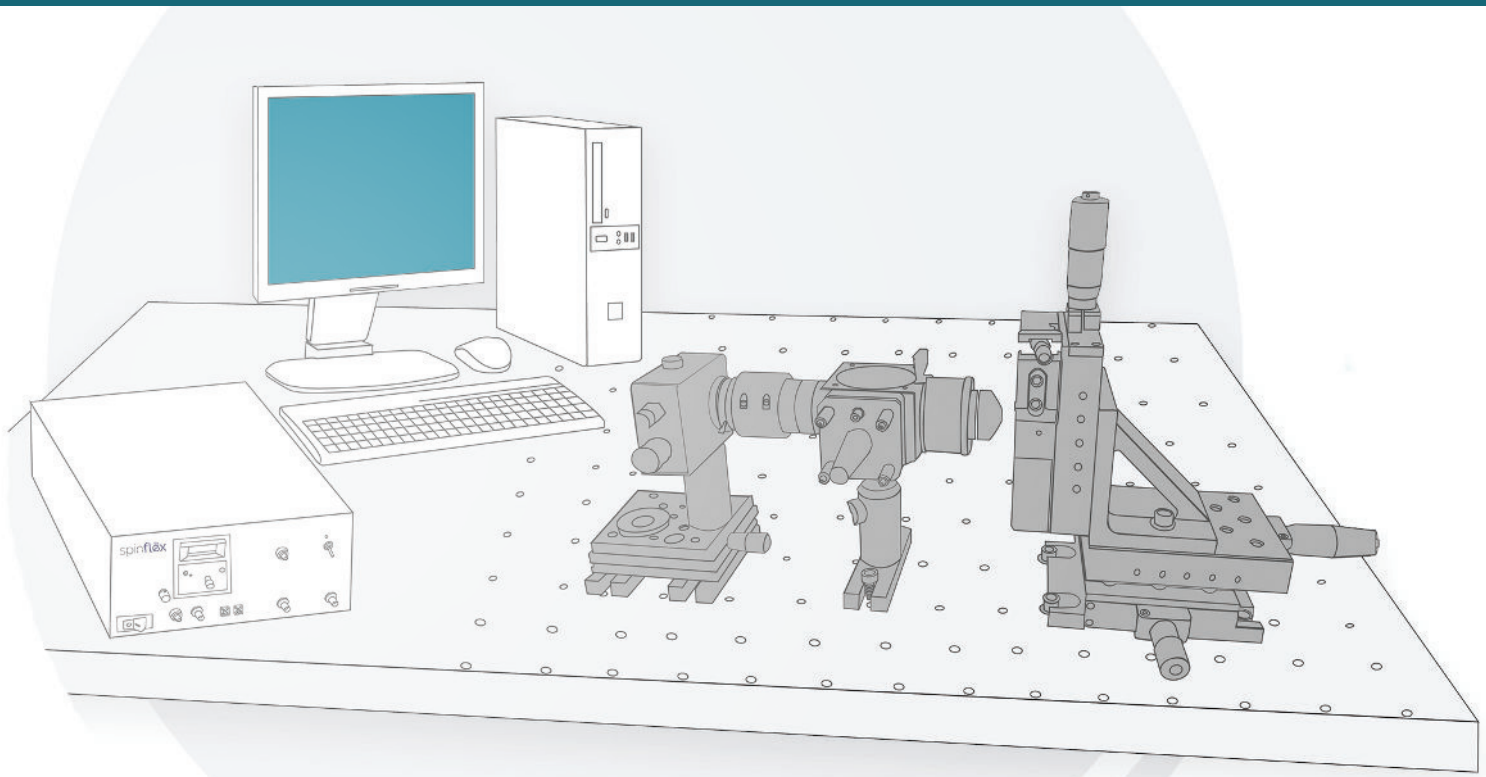
spinEDU ODMR educational kit

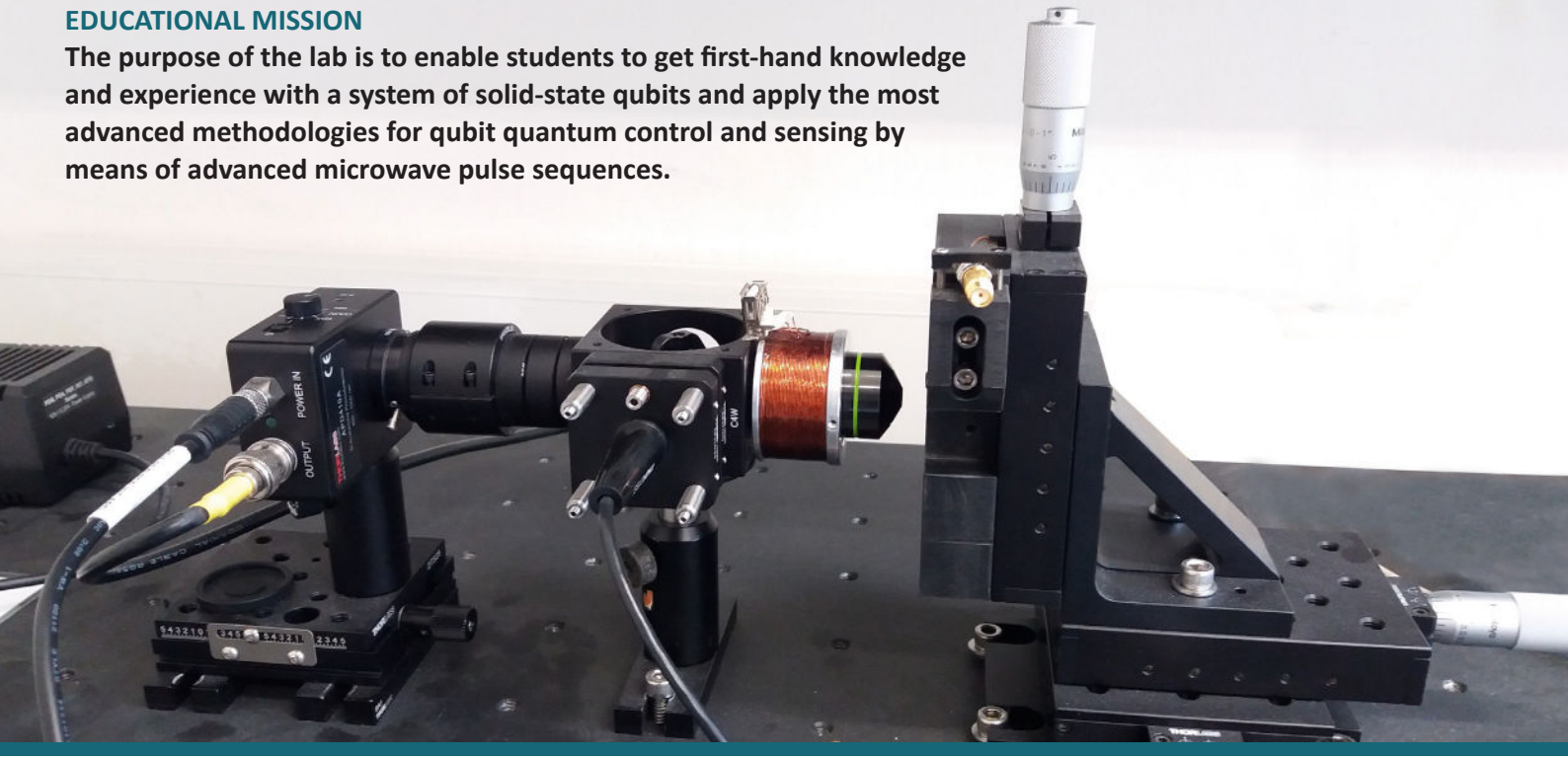
Solid-state spin qubits in diamond for quantum technology



spinEDU is a unique educational kit developed by the Technion – Israel Institute of Technology and is part of the student's coursework.
it is suitable for both undergraduate and graduate students who train in the field of quantum science and technology. The experimental system enables to setup, control, and readout the quantum data in solid-state spin qubits based on NV^- centers in diamond.
The kit allows students to explore and characterize Qubits at room temperature

EDUCATIONAL MISSION

The purpose of the lab is to enable students to get first-hand knowledge and experience with a system of solid-state qubits and apply the most advanced methodologies for qubit quantum control and sensing by means of advanced microwave pulse sequences.



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LAB SETUP

spinEDU setup is built from three sub-systems. Optical, microwave and data acquisition. spinEDU is supplied with a [1 1 1] diamond with ~10^{17} NV^- /cm^3. The NV^- (sometimes denoted simply as NV) is a defect in diamond made of a substitutional nitrogen atom and an adjacent lattice vacancy site (see figure). The NV^- has two unpaired electrons that are used as qubits. Owing to its energy levels structure, it exhibits a spin-dependent photoluminescence, making it suitable for optically detected magnetic resonance (ODMR).

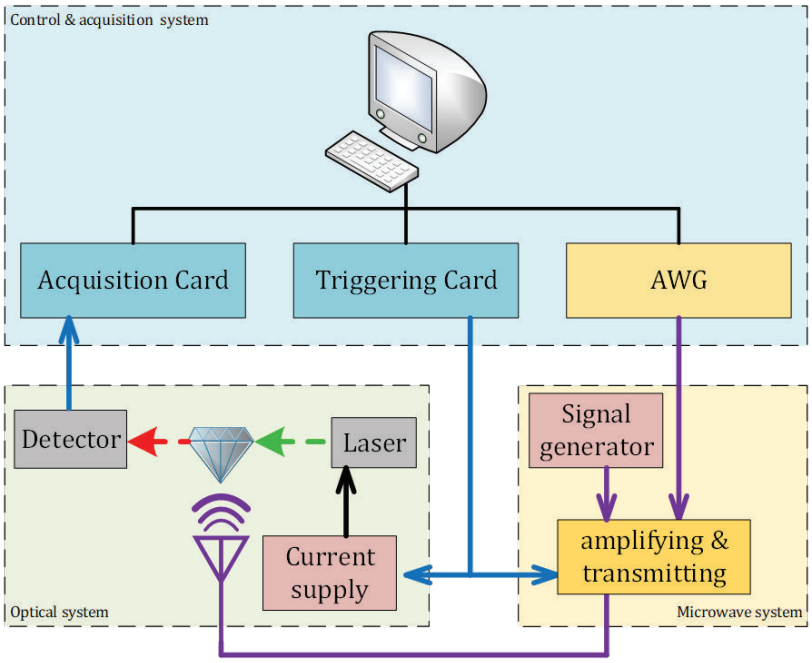
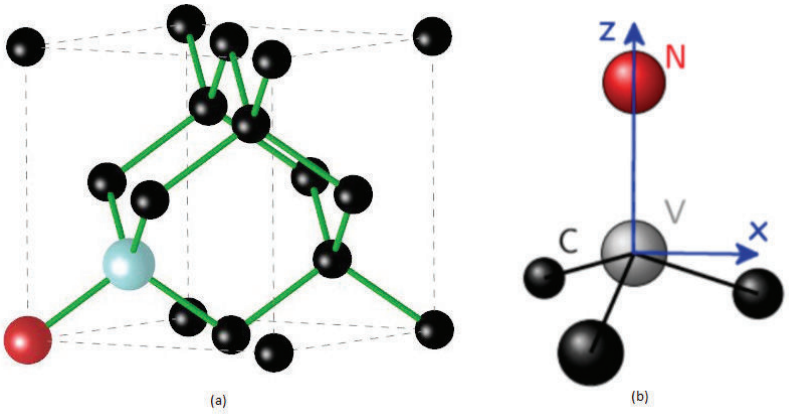


Figure: (a) A schematic representation of the diamond lattice with the N (red) and vacancy (light blue)

Figure: (b) The principal axes of an NV are defined with z parallel to the N-V axis, and x in a plane that consists of the N, V and one of the nearest carbons.



LAB ACTIVITES

- **Lab 1 – Introduction**
  Familiarize the students with the physical system (NVs in diamond), the experimental setup, and the acquisition software.
- **Lab 2 - ODMR measurements**
  Perform microwave frequency swept ODMR measurements at various magnetic fields and find the NV's resonance frequency.
- **Lab 3 - ODMR Rabi oscillations**
  Observing and measuring Rabi oscillations both as a function of MW pulse length, and as a function of microwave pulse amplitude.
- **Lab 4 - Relaxation times**
  Measuring the relaxation times (T_2^*, T_2, T_1) of the NV centers in the diamond sample used in this setup.
- **Lab 5 - Dynamical decoupling**
  Experiment with various dynamic decoupling sequences, such as Carr-Purcell-Meiboom-Gill, XY8 and measuring the coherence times in these sequences.
- **Lab 6 - Single qubit operations and quantum state tomography**
  Perform single qubit operation (rotations in Bloch sphere) and measure the fidelity of gates using quantum state tomography.