Zhaohui Yang

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Education

Department of Electrical and Computer Engineering, University of Arizona **Tucson, U.S.**
M.S. in Electrical & Computer Engineering *May 2022 (expected)*

Department of Modern Physics, University of Science and Technology of China **Hefei, P.R.China**
B.S. in Atomic & Molecular Physics, Physics *June 2021*
Thesis: *Characterization and Quantum Error Correction Codes for Correlated Phase-Flip Error in Spin Systems*
Thesis Advisor: Dr. Ya Wang

B.E. in Computer Science & Technology *June 2021*
Thesis: *Molecular Properties Prediction System Based on Graph Neural Networks*
Thesis Advisor: Dr. Qi Liu

Research Areas

My research interests are in the areas of quantum information, both theoretically and experimentally, such as *quantum sensing*, *quantum open systems*, etc. My recent works mainly involve *quantum computing algorithms* and *spin-photon interface*. What I am currently most interested in is theoretical research of quantum computing, especially *quantum algorithms* and *error correction*.

Publications & Patents

- Zhaohui Yang, Jianfu Zhu, Qi Liu. *Machine Learning Prediction of Quantum-Chemical Properties: Techniques from Deep Molecular Graph Convolutional Network*. *(manuscript)*
- Zhaohui Yang. *Physical interpretation of quantum Zeno effect*. College Physics, China, 2021.
- Kun Wang, Zhaohui Yang. *Schema of Quantum Error Mitigation with Quantum Control*. China Patent. *(filed)*

Project Experiences

Research Assistantship in Quantum Information and Materials Group, U Arizona *Sept. 2021 – Jan. 2022*
Supervisor: Dr. Zheshen Zhang, U Arizona
Assist the construction of experimental platforms about quantum repeaters and develop corresponding programs. Develop programs for UA Quantum Network project to link current routing modules of Entangled-Photons (EPs) and Single-Photon Detectors (SPDs) and support the Agilent iLab framework.

- ◇ Develop a universal Web operation software named *quagent* (Local Agent for Quantum Network) for application in practical local quantum networks, integrating functions of SPDs & EPs routing, multi-user switches & data acquisition.
- ◇ Develop the spin manipulation programs named *odmactor* (ODMR Actor) for electronic spin manipulation and, efficiently executing ODMR experiments and electronic spin state controlling.
- ◇ Assist experimental research on quantum repeater, i.e. spin-photon interface based on SiC systems.

R&D Internship in the Institute for Quantum Computing, Baidu Research *Apr. 2021 – Aug. 2021*
Mentor: Dr. Kun Wang & Dr. Xin Wang, Baidu
Explore feasible error-mitigation methods and programming frameworks for NISQ, and develop corresponding program modules building on Baidu Quantum Platform (BQP).

- ◇ Develop pulse-level Zero-Noise Extrapolation (ZNE) Error-Mitigation module building on Quanlse (pulse-control platform for QIP) and circuit-level ZNE module in Quantum Leaf (cloud environment of BQP).
- ◇ Co-build the Quantum Error Processing (QEP) project, a python SDK framework, providing software-level utilities of error mitigation and error correction for quantum computing.
- ◇ Propose a new pulse-level ZNE schema based on pulse infidelity and observable expectation. Research on a new pulse-level ZNE the effect of noise amplifying due to gate-level unitary folding.

Characterization and QECCs for Correlated Phase-Flip Error in Spin Systems *Apr. 2020 – June 2021*
Supervisor: Dr. Ya Wang, USTC
Explore an appropriate approach to characterizing the decoherence process of physical qubits influenced by relaxation of a common spin fluctuator, and then design corresponding schemes of fault-tolerant encoding and correction.

- ◇ Propose a formula of quantum channel that can describe the correlated decoherence scenario of multiple qubits suffering from one common fluctuator.
- ◇ Design and verify corresponding Approximate QEC channels using Semi-definite Optimization methods.
- ◇ Calibrate two-quit and three-qubit Hardware-Efficient QECCs against this decoherence scenario.
- ◇ Work out the experimental schema and simulate the process and result of two-qubit hardware-efficient QECCs for coupling system of electronic spin, ^{14}N and ^{13}C in diamond.

Molecular Properties Prediction System Based on Graph Neural Networks *Dec. 2020 – Mar. 2021*
Supervisor: Dr. Qi Liu, USTC
Implement a new architecture of Graph Neural Network (GNN) to predict organic molecular quantum-mechanical properties with better accuracy, explainability and efficiency. Integrate

- ◇ Implement the Deep Molecular Graph Convolutional Network (DMGCN), efficiently modeling the topological & spatial information and atomic interaction of chemical molecules, which requires less computational resources while models more reasonably.
- ◇ Building on the framework of PyTorch, DGL and Qt, implement an end-to-end molecular prediction software system for universal application of Molecular Chemistry.

Quantum Emitters embedded in Optical Cavities for Quantum Network Nodes *July 2020 - Oct. 2020*
Supervisor: Dr. Zheshen Zhang, U Arizona
Study on the architecture and effectiveness of solid-state quantum repeater nodes. We aim to analyze and optimize the coupling schema of solid-state defects centers and an integrated photonics platform.

- ◇ Investigate physical properties and coupling schemes of varieties of color centers in micro/nano-cavities.
- ◇ Simulate coupling schema of diamond-PhCs nanocavity embedded with SiV centers and schema of SiN-based Microring Resonator microcavity with SiV (FEM & FDTD methods).
- ◇ Assist to build an Optically Detected Magnetic Resonance (ODMR) experimental platform.

Thermometry of Diamond Quantum Probe Controlled by Optical Tweezer in vivo *July 2019 – Apr. 2021*
Supervisor: Dr. Fazhan Shi, USTC
Use NV centers of diamond to realize high-sensibility and flexible thermometry in vivo, by integrating optical tweezers and diamond-based quantum sensing. Attempt to use all-optical thermometry and ODMR methods.

- ◇ Co-build the ODMR platform, including confocal system, RF & MW module and electronic controlling system.
- ◇ Co-design microfluidic chips for micro/nano-diamonds and cells delivering. Optimize the microfluidic parameters (channel shape & size, particle concentration, solution viscosity) to achieve stable optical trapping.
- ◇ Verified the feasibility of integration of optical tweezers and ODMR platforms. Obtain a high sensitivity of spectroscopy thermometry ($0.1035\mathrm{K}/\sqrt{\mathrm{Hz}}$).

Selected Awards

Undergraduate Science & Technology Innovation Training Program, University-level Outstanding Award *May 2021*
Excellent Individual for 2019 College Students' Social Practice, Communist Youth League (C.Y.L.) Anhui Provincial Committee *Oct. 2019*
Outstanding Student Scholarship, Silver Award, USTC *Sept. 2018 & Sept. 2019*
Chung-Yao Chao Talent Program in Applied Physics Scholarship, USTC *Sept. 2019*
1st National College Students' Youth and Health Stage Drama, Third Prize, Chinese Family Planning Association (CFPA) *Dec. 2018*
10th Chinese Mathematics Competitions, Preliminary contest, First Prize, CMS *Oct. 2018*
Cyrus Tang Scholarship, USTC *May 2018*

Skills

- ◇ **Optics** Photoluminescence and electroluminescence imaging and spectroscopy, Single-photon detection, Time-correlation photon counting, Fiber sensing
- ◇ **Solid-state quantum systems** Solid-state qubit detection and control with MW & RF, Optically Detected Magnetic Resonance, Dynamical Decoupling
- ◇ **Electronics** Time-domain sampling average, Lock-in, Shot noise, 1/f noise and quantum measurements
- ◇ **Programming** Software development with C/C++/C#/Python, Data science and scientific programming with Python/R/SQL/Mathematica/Matlab, Deep learning with PyTorch/Keras/DGL, Web development with Python, Linux system administration and scripting, MIPS assembly programming
- ◇ **Software and Tools** LabVIEW data automation and acquisition, Photonics simulation with FEM (Comsol) and FDTD (Meep) methods, Quantum dynamics simulation and circuit algorithm design with Qutip and Qiskit, 3-D mechanical design with Solidworks, Supercomputer usage with Slurm

Leadership & Activities

♢ **Leadership**

Executive director, Youth Data Research Center of C.Y.L. USTC Committee *Mar. 2019 - Mar. 2020*
Campaign co-manager, Second Classroom Initiative of USTC *Aug. 2019 - Mar. 2020*
Campaign director, College Students' Summer Social Practice of USTC *June 2019 - Sept. 2019*

♢ **Volunteer Work**

Deputy secretary-general, Jinyeqinghuai Welfare Team, Local Municipal Community NGO *Apr. 2021 - Present*
Co-initiator & co-manager of School Hospital Volunteer Service Team, USTC *2018 - 2019*