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Sebastián Francisco Vázquez-Carson

Summary

Laser physicist and hardware engineer with a Ph.D. in AMO physics (Columbia, 2022) and 8+ years of hands-on laser system design and construction. Built complete laser systems from scratch for molecular laser cooling experiments: ECDLs, tapered amplifiers, injection locking amplifiers, Raman fiber amplifiers, full RF modulation chains, and custom UHV/cryogenic apparatus. Co-founded a hardware automation company and shipped four commercial products, applying precision hardware skills in a production engineering context. First-author publication on direct laser cooling of CaH molecules. U.S. Citizen.

Technical Skills

CW Laser Sources: ECDLs (Littrow & Littman-Metcalf), Injection Locking Amplifiers, Tapered Amplifiers.

Fiber Systems: Raman Fiber Amplifiers, Fiber Coupling, Single-Mode Fiber Networks.

Spectroscopy & Stabilization: Doppler-Free Saturation Absorption Spectroscopy, Fizeau Interferometer Locking, PDH Locking.

Electro-Optics: AOMs, AODs, EOMs, Scanning Fabry-Perot Cavities, DDS RF Signal Generators.

RF Electronics: RF Amplifiers, VCOs, Spectrum Analysers, PID Lock Boxes.

Detection & Imaging: EMCCD Single-Photon Cameras, Silicon Photomultipliers, Analogue PMTs, Imaging System Design, In-Vacuum Optics Design & Fabrication, Optomechanical Design.

Vacuum: Custom UHV Chamber Design, MOT Chamber Design, In-Vacuum Optics Fabrication.

Cryogenics: Custom 4K Cryogenic Cell Design, Charcoal Absorber Fabrication, Pulse Tube Refrigerator Maintenance.

Software: Python, C++, LabVIEW, MATLAB, LaTeX.

Simulation: COMSOL, LightTools, Mathematica.

Research Experience

2018–2022 **Lead Graduate Researcher**, *Zelevinsky Lab, Columbia University Physics Dept.*, New York, NY.

Directed the molecular laser-cooling experiment, responsible for the complete laser system from design through daily operation. Built from scratch: ECDL lasers in Littrow and Littman-Metcalf configurations, tapered amplifiers, injection locking amplifiers, Raman fiber amplifiers, and a full RF modulation chain (EOMs, AOMs, RF amplifiers, VCOs, DDS). Implemented Doppler-free saturation spectroscopy and Fizeau interferometer locking for sub-MHz laser frequency stabilization. Designed and fabricated custom UHV vacuum components and 4K cryogenic pulse tube refrigerator system; modeled cryostat thermal performance in COMSOL. Wrote LabVIEW, Python, and C++ experiment control and data acquisition software.

Summer 2017 **Graduate Researcher**, *Will Group, Columbia University*, New York, NY.

Built PID lock boxes for laser frequency stabilization. Constructed a Doppler-free absorption spectroscopy frequency reference for cesium.

2015–2017 **Undergraduate Researcher**, *Nagle Group, University of Colorado Boulder*, Boulder, CO.

Developed automated QC hardware and C++ analysis algorithms for the sPHENIX detector at Brookhaven National Lab.

Professional Experience

Jan 2022–Present **Co-Founder & CTO**, *Rooted Robotics (formerly Urban Farms Inc.)*, Boulder/Denver, CO.

Applied precision hardware engineering skills to design and ship four commercial automation products, growing revenue from $0 to $700K/year. Products achieved CE certification (EU market clearance); 3 patents pending. Designed all mechanical and electrical systems including PCBs, wiring harnesses, and enclosures. Wrote all firmware and motion control software (Python, C++). Deployed production computer vision pipelines. Managed full DFM, BOM, QC testing, and manufacturing operations. Raised $1.2M through USDA SBIR grants and private investors.

Publications

First-author S. Vázquez-Carson et al., *Direct laser cooling of calcium monohydride molecules*, New Journal of Physics, 2022. arXiv:2203.04841

Co-author R. McNally, I. Kozyrev, S. Vázquez-Carson et al., *Optical cycling, radiative deflection and laser cooling of barium monohydride (BaH)*, New Journal of Physics, Vol. 22, 2020. arXiv:2004.09570

Full publication list (22 papers, 1315 citations): `Google Scholar`

Education

2017–2022 **Doctor of Philosophy, AMO Physics**, *Columbia University*, New York, NY.

Thesis: *Transverse Laser Cooling of Calcium Monohydride Molecules*
Advisor: Prof. Tanya Zelevinsky, Zelevinsky Lab

2013–2017 **Bachelor of Arts and Science, *Magna Cum Laude***, *University of Colorado*, Boulder, CO.

Major: Physics

Languages

English Native (U.S. Citizen) Spanish Native