Şükrü Furkan Öztürk

Personal

Address: 52 Oxford Street, Cambridge, MA 02138
email: sukrufurkanozturk@g.harvard.edu
Personal Website: https://sukrufurkanozturk.owlstown.net

Research Interests and Skills

Origins of life, Origins of homochirality, Spin-selective chemistry, Photochemistry

- Studying the origins of homochirality and exploring the role of magnetic surfaces as potential chiral symmetry breaking agents due to the chiral induced spin selectivity (CISS) effect.
- Studying the spin-selective and enantiospecific crystallization of chiral molecules on magnetic surfaces. Investigating the interaction between chiral molecules and magnetic minerals avaliable on early Earth.
- Studying asymmetric chemical reactions controlled by electron spin due to the CISS effect.
- Studying the geochemical formation pathways of magnetic minerals on early Earth and their magnetic properties under weak geomagnetic fields.
- Exploring the role of triplet energy transfer and long-wavelength solar UV irradiation in the prebiotic synthesis of biomolecules.
- Designed and implemented electrochemistry experiments with magnetic electrodes. Fabricated smooth magnetic surfaces for being used as spin-polarized working electrodes.
- Performed ground state energy calculations for prebiotically relevant molecules with density functional theoretical methods and calculated singlet-triplet energy gaps.
- Experienced in computational chemistry, chemical visualization and analysis tools: Gaussian, HyperChem, Chemcraft, Chem 3D, ChemDraw, and MestReNova. Experienced in UV-VIS and circular-dichorism (CD) spectroscopy, and nuclear magnetic resonance (NMR).

Chiral-induced spin selectivity, Nitrogen-vacancy (NV) centers

- Studying the fundamentals of the CISS effect with NV centers in diamond.
- Designed and built a confocal microscope with an ultra-high-resolution objective, imaged single NV centers in diamond. Designed a large-area, low-scattering and uniform-field microwave antenna for optically-detected magnetic resonance of NV centers.
- Performed electron spin resonance (ESR), Rabi, Ramsey, Hahn Echo, CPMG, XY8-N, correlation spectroscopy, and double electron-electron spin resonance (DEER) experiments with shallow single NV centers in diamond.

Quantum gas microscopy, degenerate gases in optical lattices, dipolar BECs.

- Studied the theory of dipolar BECs using Hartree-Fock Bogoliubov method and the mean-field theory of dipolar bosons in optical lattices.
- Designed and implemented an ultra-low noise and disorder optical lattice for quantum simulation using a fast-analog PID controller.
- Worked on high-resolution imaging systems, interferometric methods, optics design, Fizeau interferometry, and diffraction limited optical microscopy.
- Custom built a high-power and low noise 532 nm laser using second harmonic generation.
- Experienced in optical design, ray-tracing tools, CAD, machining, ultra-high vacuum systems, and statistical data analysis.

Professional Experience

2024-Now Kavli-Laukien Fellow, **Harvard University**, Cambridge, MA, USA
2024-Now Junior Research Fellow, **King's College**, Cambridge, UK

Education

2018-2024 Doctor of Philosophy (Ph.D.) in Physics, **Harvard University**, Cambridge, MA
Origins of life | Advisor: Prof. Dimitar D. Sasselov

2018-2021 Master of Arts (M.A.) in Physics, **Harvard University**, Cambridge, MA
Atomic, molecular, and optical physics | Advisor: Prof. Markus Greiner

2014-2018 Bachelor of Science (B.Sc.) in Physics, **Bilkent University**, Ankara, Turkiye
Condensed matter physics | Advisor: Prof. Mehmet Ozgur Oktel
Cgpa: 3.99/4.00, *valedictorian*

Papers

7. Su, L., Douglas, A., Szurek, M., Groth, R., **Ozturk, S. F.**, Krahn, A., ... & Greiner, M. (2023). Dipolar quantum solids emerging in a Hubbard quantum simulator. *Nature* 622, 724–729 (2023).
6. **Ozturk, S. F.**, Bhowmick, D. K., Kapon, Y., Sang, Y., Kumar, A., Paltiel, Y., Naaman, R. & Sasselov, D. D. (2023). Chirality-induced avalanche magnetization of magnetite by an RNA precursor. *Nature Communications*, 14(1), 6351.
5. **Ozturk, S. F.**, Sutherland J. D., & Sasselov, D. D. (2023). The central dogma of biological homochirality: How does chiral information propagate in a prebiotic network? *Journal of Chemical Physics*, 159(6), 061102.
    - *Research Highlight*
      Cover story of the issue and selected as a featured article by the editor.
4. **Ozturk, S. F.**, Liu, Z., Sutherland, J. D., & Sasselov, D. D. (2023). Origin of biological homochirality by crystallization of an RNA precursor on a magnetic surface. *Science Advances*, 9(23), eadg8274.
    - *Research Highlight*
      Service, Robert. (2023). 'Breakthrough' could explain why life molecules are left- or right-handed. *Science*, 380-6650.
    - *Research Highlight*
      Saplakoglu, Yasemin. (2023). Magnetism May Have Given Life Its Molecular Asymmetry. *Quanta Magazine*
3. **Ozturk, S. F.** & Sasselov, D. D. (2022). On the origins of life's homochirality: Inducing enantiomeric excess with spin-polarized electrons. *PNAS*, 119(28), e2204765119.
    - *Research Highlight*
      Greed, S. (2022). The dawn of asymmetry. *Nature Reviews Chemistry*, 1-1.
    - *Commentary*
      Bloom, B. P., Waldeck, A. R., & Waldeck, D. H. (2022). Homochirality and chiral-induced spin selectivity: A new spin on the origin of life. *PNAS*, 119(34), e2210505119.
2. **Ozturk S. F.**, Aybar E., Oktel M. Ö. (2020). Temperature dependence of the density and excitations of dipolar droplets. *Physical Review A*, 102(3), 033329.
1. Phelps, G. A., Hébert, A., Krahn, A., Dickerson, S., **Ozturk, S. F.**, Ebadi, S., Su, L., & Greiner, M. (2020). Sub-second production of a quantum degenerate gas. *arXiv preprint arXiv:2007.10807*.

Patents

1. *Chiral separation*. Attorney Docket No. 51198-044001, Filed on Feb 9th, 2023. (pending)

Research Experience

2023 February-March

Sutherland Group, MRC Laboratory of Molecular Biology
PhD Thesis Research

Studied the photochemistry of aldehyde-bisulfite adducts and reduction reactions facilitated by iron-oxide surfaces. Investigated the crystallization of an RNA precursor on magnetite surfaces, in the presence of various other prebiotically relevant compounds.

Host: Prof. John D. Sutherland

2023 February-March

The Tosca Lab, University of Cambridge
PhD Thesis Research

Synthesized authigenic magnetite minerals under various conditions by oxidizing ferrous iron. Explored the green rust pathway as a plausible scenario to produce magnetite on early Earth. Analyzed the magnetite crystals by Raman spectroscopy and x-ray diffraction. Magnetic properties of the samples will be analyzed to elucidate their magnetic domain size and remanent magnetization.

Host: Prof. Nicholas Tosca

2022 October-November

Naaman Research Group, Weizmann Institute of Science
PhD Thesis Research

Studied chirality induced magnetization of magnetic surfaces due to the CISS effect. Performed crystallization experiments with an RNA precursor on magnetite and analyzed the induced magnetization by CD spectroscopy, SQUID, and Magneto-optical Kerr effect microscope. Measured the intrinsic spin-polarization of an RNA precursor using magnetic-conductive AFM.

Host: Prof. Ron Naaman

2022 April-May

Naaman Research Group, Weizmann Institute of Science
PhD Thesis Research

Studied spin-selective reduction of chiral molecules due to the CISS effect on magnetite surfaces. Performed electrochemical reduction experiments using magnetic working electrodes and studied the enantioselective reduction of aldehyde cyanohydrins.

Host: Prof. Ron Naaman

2017 September-2018 August

Oktel Research Group, Bilkent University
Senior Thesis Work

Worked on the modified Gross-Pitaevskii Equation for self-bound droplets. Created a computational scheme based on GP Equation to describe self-bound droplets. Examined the effect of temperature, studied the expansion dynamics and oscillation modes of the droplets.

Advisor: Prof. Mehmet Ozgur Oktel

2017 June - August

Greiner Lab, Harvard University
Undergraduate Internship

Developed digital PID system to control the intensity fluctuations of a laser beam using an FPGA. Ultra low noise laser is then used to create optical lattices as a part of the Fermi Gas Microscope

Advisor: Prof. Markus Greiner

2016 June - August

Quantum Photonics Group, ETH Zurich
Undergraduate Internship

Studied the photon statistics of polariton condensates and examined the optimization of the second-order coherence function for intrinsically squeezed polaritons.

Advisor: Prof. Atac Imamoglu

2015 June - August

Tait Research Laboratory, Indiana University Bloomington
Undergraduate Internship

Developed MatLab code for 2D supramolecular packing interactions on a surface. Generated input files for calculations via Spartan and developed optimization algorithms.

Advisor: Prof. Steven L. Tait

Invited Talks

11. *A New Spin on the Origin of Homochirality* Computations in Science Seminar; May 8th, 2024; Chicago University
10. *A New Spin on the Origin of Homochirality* Leverhulme Centre for Life in the Universe Seminar; May 1st, 2024; Cambridge University
9. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Astrobiology Colloquium; April 16th, 2024; University of Washington
8. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Consensed Matter Theory Kid's Seminar; March 19th, 2024; Harvard University
7. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Centre for Origin and Prevalence of Life; December 15th, 2023; ETH Zurich
6. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Life in the Universe II; September 14th, 2023; American Academy of Arts and Sciences
5. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Prebiotic Chemistry and Early Earth Environments Consortium; July 20th, 2023; Online
4. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Center for the Origins of Life; June 29th, 2023; Chicago University
3. *Origin of Biological Homochirality by Crystallization of an RNA Precursor on a Magnetic Surface* Origins of Life Initiative; April 6th, 2023; Harvard University
2. *Magnetization and Solving the Chirality Problem* Leverhulme Centre for Life in the Universe Annual Meeting; March 10th, 2023; Cambridge University
1. *Magnetization and Solving the Chirality Problem* Leverhulme Centre for Life in the Universe Coffee Meetings; March 2nd, 2023; Cambridge University

Awards and Scholarships

2024	Ataturk Science Prize by the Ataturk Society of America
2024	Innovation Prize at AI Tomorrow Summit 2024 by AIPA
2024	Certificate of secondary concentration by the Origins of Life Graduate Consortium at Harvard University
2024-2027	Kavli-Laukien Prize Fellowship by the Origins of Life Initiative at Harvard University
2024-2028	Junior Research Fellowship (JRF) by King's College, Cambridge
2024	Gertrude and Maurice Goldhaber Prize by Harvard Physics Department
2023	First place in Turkey's JCI 'Ten Outstanding Young Persons of the World' competition, in the scientific and technological development category
2018	Purcell Fellowship by Harvard University
Spring 2016	Best Project Award by Bilkent University Physics Department
2015	Finalist in Turkish Intelligence Foundation's (TZV) countrywide exam, 'Oyun'
All Semesters	High Honor Student at Bilkent University
2014-2018	Comprehensive Scholarship by Bilkent University
2014-2018	National Undergraduate Scholarship Program (2205) by TUBITAK
2014-2018	National Scholarship by Turkish Prime Ministry
2014	Ranked 37^{th} in Nationwide University Entrance Exam (LYS) among 2 million high school students in Turkey
2013	Finalist in Turkish Intelligence Foundation's (TZV) countrywide exam, Oyun

Teaching and Mentoring

- Fall 2023, Harvard University Physics Department
  Teaching fellow for the lab component of PHYSCI 2: Mechanics, Elasticity, Fluids, and Diffusion
- July 2023, Harvard University, Sasselov Lab
  Assisted biochemistry Ph.D. student *Sreekar Wunnava* (email) from Dieter Braun's lab at LMU in experimental work. Sree worked on enantioselective polymerization of RNA nucleotides on magnetic surfaces.
- June 2022 - June 2023, Harvard University, Sasselov Lab
  Mentored astrophysics Master's student *Victor Loi* (email) in experimental work. Victor worked on separating chiral compounds relevant to prebiotic chemistry and used analytical tools like XPS, AFM, and SEM to analyze magnetic surfaces.
- January 2023, Harvard University, Sasselov Lab
  Assisted chemistry Ph.D. student *Jinhan Yu* (email) from Donna Blackmond's lab at The Scripps Research Institute in experimental work. Jinhan worked on the enantioseparation of dipeptides on magnetite surfaces.
- Summer 2022, Harvard University, Sasselov Lab
  Mentored biochemistry undergraduate intern *Cindy Zhou* (email) in experimental work. Cindy built a potentiometer with an ion-selective electrode and measured the concentration of sulfite anions in water.
- Spring 2020, Harvard University, Greiner Lab
  Mentored physics Master's student *Robin Groth* (email) in experimental work. Robin built a Fizeau interferometer to align an optical lattice to a high resolution objective.
- Spring 2017, Bilkent University Physics Department
  Solved problem sets and assisted term projects for PHYS212: Modern Physics

Computer Skills

Advanced Knowledge:	Python, Zemax, CAD (Inventor and Solid Works), MatLab, Mathematica
Basic Knowledge:	COMSOL, Verilog, LaTeX

Language Skills

Turkish:	Native	German:	B1
English:	Fluent, TOEFL: 114/120	Latin:	1 Year of Roman Latin

Science Outreach

I have a YouTube channel with more than **75.000 subscribers** and **2.5 million views** to advise high-school and college students on their careers in science. I put educational videos to teach basic physics, coding and other auxiliary skills. I join meetings and interviews to share my experiences with students from diverse backgrounds to increase their involvement with basic sciences.

Participated in Cracking Chirality, a twelve-minute film for a general audience by Chemistry Shorts, exploring how the essential molecules of life, such as DNA, RNA, and proteins, acquired their homochiral structures and how magnetic rocks at the bottom of a prebiotic lake may have set the stage for life as we know it.