

Baran Bodur

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Education

- 2017 – 2023 **Ph.D. in Physics, Duke University**
Specialized in Particle and Nuclear Experiment - CGPA: 3.93
Thesis title: *Measurement of Atmospheric Flux-Weighted Charged-Current ν_e - ^{16}O Cross Section with the Super-Kamiokande Experiment*
- 2013 – 2017 **B.Sc. in Physics, Middle East Technical University**
Specialized in Particle, Nuclear and Atomic Physics - CGPA: 3.89
- 2012 – 2016 **B.Sc. in Electrical-Electronics Engineering, Middle East Technical University**
Specialized in Telecommunications - CGPA: 3.83

Research Experience

PhD. Candidate at Duke University

- 2018 – 2023 **Measurement of ν_e - ^{16}O Cross Section Below 125 MeV**
Performed the first measurement of atmospheric neutrino flux-weighted charged-current ν_e - ^{16}O cross section below 125 MeV neutrino energy with over 20 years of data from Super-Kamiokande detector. The measured cross section can be used in supernova burst detection, Diffuse Supernova Neutrino Background searches, atmospheric neutrino and WIMP dark matter physics.
- 2020 – 2022 **Energy Scale Error Estimation for Super-Kamiokande Detector**
Estimation systematic error related to energy reconstruction in Super-Kamiokande. I used stopping cosmic ray muons and neutral pion samples for this work.
- 2018 – 2022 **Outer Detector Photomultiplier Tube (PMT) Calibrations of Super-Kamiokande**
I calibrated time and charge calibration of PMTs using cosmic rays and dark hits respectively. In addition, I modelled saturation behaviour of PMTs by using laser data at various intensities. I have also helped in the detector refurbishment process onsite prior to gadolinium loading to Super-Kamiokande.

Student Researcher at Middle East Technical University

- 2016 – 2017 **Measurement of Flux and Uniformity at a 30 MeV Proton Irradiation Facility**
I worked in the design and construction of a 30 MeV Proton Irradiation Facility Complying to ESA-ESCC 25100 Standards in Ankara. This facility was built in collaboration with CERN for the purpose of testing electronics under space radiation conditions. I focused in the system that will measure the flux and uniformity of proton flux at the target area using a Silicon Pixel Detector (Timepix 3) and a diamond particle detector. In addition, I performed FLUKA simulations to design radiation shields for beamline components.
- 2016 **Correlations Between Space Radiation and Electronic Failures of Turksat**
I investigated correlations between solar and cosmic ray radiation measurements and recorded electronic failures (Electrostatic discharge related service interruptions and failures of travelling wave tube amplifiers) of Turksat satellites.

Research Experience (continued)

- 2014 – 2016 **Time of Flight Detector and Trigger System of a Spark Chamber**
Built a time of flight detector with scintillators, photomultiplier tubes and an oscilloscope readout into MATLAB. Later, the system was integrated with NIM electronics and a high voltage thyristor switch to be used as the trigger system of a spark chamber. Since then, the spark chamber displayed in various science centers and outreach activities in Turkey.

Summer Student at CERN

- 2015 **Muon Background Measurement at the North Area Experimental Hall**
I designed a real-time read-out for a two scintillator and photomultiplier tube system, and took measurements to find time and position dependence of the muon background in the North Area Experimental Hall at CERN.

Teaching Experience

Instructor of Record at Duke University

- 2021 **Optics and Modern Physics**
A course designed as a first glimpse to special relativity, quantum physics and the ground breaking observations that lead to their development in the early 20th century. I delivered the lectures, prepared homework problems and exams, held office hours and assigned letter grades.

Teaching Assistant at Duke University

- 2019 **Optics and Modern Physics**
A course designed as a first glimpse to special relativity, quantum physics and the ground breaking observations that lead to their development in the early 20th century. I led the recitation sessions, graded quizzes, homeworks and exams, substituted four lectures covering quantum physics.
- 2018 **Introductory Laboratories for Physics Majors**
A series of laboratories in which students practice coding, data and error analysis, making scientific conclusions, keeping laboratory notebooks and collaborating in a team over multi-week mechanics and electromagnetism experiments that build on each other. I guided students in laboratory sessions as well as grading laboratory notebooks.
- 2017 **Introductory Laboratories for Non-physics Majors**
I led laboratory sessions designed for hands on experience about mechanics and electromagnetism concepts covered in lectures, as well as grading laboratory reports, midterm and final examinations.

Talks and Posters

Talks

- 2021 **Search for ν_e -¹⁶O Interactions From Low Energy Atmospheric Neutrinos**
APS-DNP (American Physics Society - Division of Nuclear Physics), Virtual Meeting
- 2021 **ν_e -¹⁶O Interactions From Low Energy Atmospheric Neutrinos**
APS April Meeting, Virtual Meeting
- 2021 **ν_e -¹⁶O Interactions from Low Energy Atmospheric Neutrinos**
2nd Workshop for Atmospheric Neutrino Production, Virtual Meeting

Talks and Posters (continued)

- 2020 ν_e - ^{16}O Interactions From Low Energy Atmospheric Neutrinos
APS-DNP, Virtual Meeting
- 2019 ν_e - ^{16}O Interactions From Low Energy Atmospheric Neutrinos
APS-DNP, Arlington/Virginia

Posters

- 2022 **Status of Atmospheric Flux-Weighted ν_e - ^{16}O Cross-Section Measurement Below 125 MeV in Super-Kamiokande**, NEUTRINO 2022, Virtual Seoul
- 2019 **Outer Detector Calibrations of Super-Kamiokande Detector**
INSS 2019 (International Neutrino Summer School) Batavia/Illinois
- 2016 **Correlations Between Space Radiation Measurements and Electronic Failures of Turksat**, GEFIK (Young Physicists) Conference, Izmir/Turkey
- 2016 **Defocusing Beamline and Irradiation Center for Space Applications**
Aeroex Fair, Kayseri/Turkey
- 2016 **Dueling Robot with a Coilgun**
METU Engineering Day, Ankara/Turkey

Awards and Honors

- 2022 **Newson Fellowship** awarded by Duke Physics Department.
- 2020 **Bass Instructional Fellowship** awarded by Duke Graduate School.
- 2019 **Goshaw Family Endowment Fellowship** awarded by Duke Physics Department.
- 2016 **Best Poster Award** at GEFIK 2016 -Turkish Young Physicists- Conference.
- 2015 **Most Educational Project Award** at CERN Webfest
- 2015 **4th Place Award** at the International CANSAT Competition organized by AAS
- 2015 **Bülent Kerim Altay Award** by METU Electrical-Electronics Engineering Department
- 2013 – 2017 **Double Major Scholarship**
by TÜBİTAK -Scientific and Technological Research Council of Turkey

Service and Outreach

Service

- 2019 – 2020 **Class Representative** Duke Physics Graduate Student Organization
- 2020 – 2021 **Vice President** Duke Physics Graduate Student Organization
- 2021 – 2022 **Class Representative** Duke Physics Graduate Student Organization

Outreach

- 2020 **Presentation on Discovery of Positron** at North Carolina School of Science and Math
- 2018 **Volunteer for Science under the Stars** at Duke University
- 2016 **Volunteer for International CERN Masterclass** at Konya Science Center, Turkey

Service and Outreach (continued)

2016 **Participant at METU Science Festival** at ATO Congressium, Ankara, Turkey

Translations

2016 **A Mathematical Theory of Communication** by Claude Shannon to Turkish.
This translation is edited into a book “Respects to Shannon” (Turkish: “Shannon’a Saygı”) by Turkish Chamber of Electrical Engineers (TMMOB-EMO).
ISBN No: 978-605-01-0887-3

2016 **Symbolic Analysis of Switching and Relay Circuits** by Claude Shannon to Turkish.
This translation is edited into a book “Respects to Shannon” (Turkish: “Shannon’a Saygı”) by Turkish Chamber of Electrical Engineers (TMMOB-EMO).
ISBN No: 978-605-01-0887-3

Projects

2015 – 2016 **ARMUT by DEBSA - A projectile avoiding and shooting robot with a coilgun**
A robot that can locate opponent robots with ultrasound sensors, evade their projectiles with tiny Doppler sensors, and shoot the opponents with a small coilgun. This was my Electrical & Electronics Engineering graduation project, I worked on all parts of this project in a team of five students.

2015 **Universe Maker - An educational physics game**
A simple game where the player assists the creation of the universe by controlling electric and magnetic fields, coded with Processing.js during the 2 day CERN Webfest in a team of 4.

2015 **Dipole Game on an FPGA**
A game in which the player is trying to avoid incoming objects by rotating two dots fixed on the opposite sides of the circle. The game is implemented on an FPGA by using Verilog Hardware Description Language. It received the Best Project Award in a competition of FPGA games within METU Electrical & Electronics Engineering department.

2014-2015 **METUSAT - A can satellite for the International CANSAT Competition**
CANSAT competition involves building a probe that will be sent to about 700 meter altitude. The probe should then descend to Earth in a controlled fashion; during which it should record a video of the descent, gather sensor data (temperature, altitude) and send this data as telemetry to a ground station in real time. As a member of 10 student team, I was specifically responsible from the telemetry and ground station systems, but worked on flight software system as well.

Skills Summary

Languages	Turkish: Native, English: Fluent (TOEFL Score 108)
Programming	C++ (ROOT, TMVA), MATLAB, Python (numpy, scipy, pandas, shiny, scikit-learn, pytorch), Perl, Verilog, LabVIEW, SQL, HTML.
Development Tools	Git, Docker, AWS, Linux shell
Simulation	LTspice, KeyCreator, QUARTUS-2, FLUKA
Typesetting	LaTeX and Office Suite
Operating Systems	Linux and Windows

Research Publications

Journal Articles and Preprints

Abe, K. et al. (2024). Second gadolinium loading to Super-Kamiokande. arXiv: 2403.07796 [physics.ins-det]

Kashiwagi, Y. et al. (2024). Performance of SK-Gd's Upgraded Real-time Supernova Monitoring System. arXiv: 2403.06760 [astro-ph.HE]

Kitagawa, H. et al. (2024). Measurements of the charge ratio and polarization of cosmic-ray muons with the Super-Kamiokande detector. arXiv: 2403.08619 [hep-ex]

Sakai, S. et al. (2024). Measurement of the neutrino-oxygen neutral-current quasielastic cross section using atmospheric neutrinos in the SK-Gd experiment. *Phys. Rev. D*, 109(1), L01101.

[doi:10.1103/PhysRevD.109.L01101](https://doi.org/10.1103/PhysRevD.109.L01101). arXiv: 2311.03842 [hep-ex]

Abe, K. et al. (2023a). Solar neutrino measurements using the full data period of Super-Kamiokande-IV. arXiv: 2312.12907 [hep-ex]

Abe, K. et al. (2023b). Search for Periodic Time Variations of the Solar ^8B Neutrino Flux Between 1996 and 2018 in Super-Kamiokande. arXiv: 2311.01159 [hep-ex]

Wester, T. et al. (2023). Atmospheric neutrino oscillation analysis with neutron tagging and an expanded fiducial volume in Super-Kamiokande I-V. arXiv: 2311.05105 [hep-ex]

Abe, K. et al. (2023c). Search for Cosmic-Ray Boosted Sub-GeV Dark Matter Using Recoil Protons at Super-Kamiokande. *Phys. Rev. Lett.*, 130(3), 031802. [Erratum: *Phys.Rev.Lett.* 131, 159903 (2023)].

[doi:10.1103/PhysRevLett.130.031802](https://doi.org/10.1103/PhysRevLett.130.031802). arXiv: 2209.14968 [hep-ex]

Harada, M. et al. (2023). Search for Astrophysical Electron Antineutrinos in Super-Kamiokande with 0.01% Gadolinium-loaded Water. *Astrophys. J. Lett.*, 951(2), L27. [doi:10.3847/2041-8213/acdc9e](https://doi.org/10.3847/2041-8213/acdc9e). arXiv: 2305.05135 [astro-ph.HE]

Shinoki, M. et al. (2023). Measurement of the cosmogenic neutron yield in Super-Kamiokande with gadolinium loaded water. *Phys. Rev. D*, 107(9), 092009. [doi:10.1103/PhysRevD.107.092009](https://doi.org/10.1103/PhysRevD.107.092009). arXiv: 2212.10801 [hep-ex]

Okamoto, K. et al. (2022). Searching for neutrinos from solar flares across solar cycles 23 and 24 with the Super-Kamiokande detector. arXiv: 2210.12948 [astro-ph.SR]

Weatherly, P. et al. (2022). Testing Non-Standard Interactions Between Solar Neutrinos and Quarks with Super-Kamiokande. arXiv: 2203.11772 [hep-ex]

Abe, K. et al. (2022a). First gadolinium loading to Super-Kamiokande. *Nucl. Instrum. Meth. A*, 1027, 166248. [doi:10.1016/j.nima.2021.166248](https://doi.org/10.1016/j.nima.2021.166248). arXiv: 2109.00360 [physics.ins-det]

Abe, K. et al. (2022b). Neutron tagging following atmospheric neutrino events in a water Cherenkov detector. *JINST*, 17(10), P10029. [doi:10.1088/1748-0221/17/10/P10029](https://doi.org/10.1088/1748-0221/17/10/P10029). arXiv: 2209.08609 [hep-ex]

Abe, K. et al. (2022c). Search for solar electron anti-neutrinos due to spin-flavor precession in the Sun with Super-Kamiokande-IV. *Astropart. Phys.*, 139, 102702. [doi:10.1016/j.astropartphys.2022.102702](https://doi.org/10.1016/j.astropartphys.2022.102702). arXiv: 2012.03807 [hep-ex]

Machado, L. N. et al. (2022). Pre-supernova Alert System for Super-Kamiokande. *Astrophys. J.*, 935(1), 40. [doi:10.3847/1538-4357/ac7f9c](https://doi.org/10.3847/1538-4357/ac7f9c). arXiv: 2205.09881 [hep-ex]

Matsumoto, R. et al. (2022). Search for proton decay via $p \rightarrow \mu^+ K^0$ in 0.37 megaton-years exposure of Super-Kamiokande. *Phys. Rev. D*, 106(7), 072003. [doi:10.1103/PhysRevD.106.072003](https://doi.org/10.1103/PhysRevD.106.072003). arXiv: 2208.13188 [hep-ex]

Mori, M. et al. (2022). Searching for Supernova Bursts in Super-Kamiokande IV. *Astrophys. J.*, 938(1), 35. [doi:10.3847/1538-4357/ac8f41](https://doi.org/10.3847/1538-4357/ac8f41). arXiv: 2206.01380 [astro-ph.HE]

- Locke, S. et al. (2021). New Methods and Simulations for Cosmogenic Induced Spallation Removal in Super-Kamiokande-IV. arXiv: 2112.00092 [hep-ex]
- Abe, K. et al. (2021a). Diffuse supernova neutrino background search at Super-Kamiokande. *Phys. Rev. D*, 104(12), 122002. [doi:10.1103/PhysRevD.104.122002](https://doi.org/10.1103/PhysRevD.104.122002). arXiv: 2109.11174 [astro-ph.HE]
- Abe, K. et al. (2021b). Neutron-antineutron oscillation search using a 0.37 megaton-years exposure of Super-Kamiokande. *Phys. Rev. D*, 103(1), 012008. [doi:10.1103/PhysRevD.103.012008](https://doi.org/10.1103/PhysRevD.103.012008). arXiv: 2012.02607 [hep-ex]
- Abe, K. et al. (2021c). Search for neutrinos in coincidence with gravitational wave events from the LIGO-Virgo O3a Observing Run with the Super-Kamiokande detector. *Astrophys. J.*, 918(2), 78. [doi:10.3847/1538-4357/ac0d5a](https://doi.org/10.3847/1538-4357/ac0d5a). arXiv: 2104.09196 [astro-ph.HE]
- Abe, K. et al. (2021d). Low energy radioactivity BG model in Super-Kamiokande detector from SK-IV data. *PoS, ICRC2021*, 1046. [doi:10.22323/1.395.1046](https://doi.org/10.22323/1.395.1046)
- Giampaolo, A. et al. (2021). Diffuse Supernova Neutrino Background search at Super-Kamiokande with neutron tagging. *PoS, ICRC2021*, 1154. [doi:10.22323/1.395.1154](https://doi.org/10.22323/1.395.1154)
- Lamoureux, M. et al. (2021). Follow-up of GWTC-2 gravitational wave events with neutrinos from the Super-Kamiokande detector. *PoS, ICRC2021*, 947. [doi:10.22323/1.395.0947](https://doi.org/10.22323/1.395.0947)
- Orii, A. et al. (2021). Search for tens of MeV neutrinos associated with gamma-ray bursts in Super-Kamiokande. *PTEP*, 2021(10), 103F01. [doi:10.1093/ptep/ptab081](https://doi.org/10.1093/ptep/ptab081). arXiv: 2101.03480 [astro-ph.HE]
- Abe, K. et al. (2020). Indirect search for dark matter from the Galactic Center and halo with the Super-Kamiokande detector. *Phys. Rev. D*, 102(7), 072002. [doi:10.1103/PhysRevD.102.072002](https://doi.org/10.1103/PhysRevD.102.072002). arXiv: 2005.05109 [hep-ex]
- Takenaka, A. et al. (2020). Search for proton decay via $p \rightarrow e^+ \pi^0$ and $p \rightarrow \mu^+ \pi^0$ with an enlarged fiducial volume in Super-Kamiokande I-IV. *Phys. Rev. D*, 102(11), 112011. [doi:10.1103/PhysRevD.102.112011](https://doi.org/10.1103/PhysRevD.102.112011). arXiv: 2010.16098 [hep-ex]
- Tanaka, M. et al. (2020). Search for proton decay into three charged leptons in 0.37 megaton-years exposure of the Super-Kamiokande. *Phys. Rev. D*, 101(5), 052011. [doi:10.1103/PhysRevD.101.052011](https://doi.org/10.1103/PhysRevD.101.052011). arXiv: 2001.08011 [hep-ex]
- Hagiwara, K. et al. (2019). Search for Astronomical Neutrinos from Blazar TXS 0506+056 in Super-Kamiokande. *Astrophys. J. Lett.*, 887(1), L6. [doi:10.3847/2041-8213/ab5863](https://doi.org/10.3847/2041-8213/ab5863). arXiv: 1910.07680 [astro-ph.HE]
- Jiang, M. et al. (2019). Atmospheric Neutrino Oscillation Analysis with Improved Event Reconstruction in Super-Kamiokande IV. *PTEP*, 2019(5), 053F01. [doi:10.1093/ptep/ptz015](https://doi.org/10.1093/ptep/ptz015). arXiv: 1901.03230 [hep-ex]
- Simpson, C. et al. (2019). Sensitivity of Super-Kamiokande with Gadolinium to Low Energy Anti-neutrinos from Pre-supernova Emission. *Astrophys. J.*, 885, 133. [doi:10.3847/1538-4357/ab4883](https://doi.org/10.3847/1538-4357/ab4883). arXiv: 1908.07551 [astro-ph.HE]
- Wan, L. et al. (2019). Measurement of the neutrino-oxygen neutral-current quasielastic cross section using atmospheric neutrinos at Super-Kamiokande. *Phys. Rev. D*, 99(3), 032005. [doi:10.1103/PhysRevD.99.032005](https://doi.org/10.1103/PhysRevD.99.032005). arXiv: 1901.05281 [hep-ex]
- Sussman, S. et al. (2018). Dinucleon and Nucleon Decay to Two-Body Final States with no Hadrons in Super-Kamiokande. arXiv: 1811.12430 [hep-ex]

Conference Proceedings

- Asaadi, J. et al. (2022). Physics Opportunities in the ORNL Spallation Neutron Source Second Target Station Era. In *Snowmass 2021*. arXiv: 2209.02883 [hep-ex]

Akimov, D. et al. (2022). The COHERENT Experimental Program. In *Snowmass 2021*. arXiv: 2204.04575 [hep-ex]

Gencer, A. et al. (2017). Preliminary Test Setup of the Metu Defocusing Beam Line, an Irradiation Test Facility in Turkey. In *8th International Particle Accelerator Conference*. [doi:10.18429/JACoW-IPAC2017-THPVA128](https://doi.org/10.18429/JACoW-IPAC2017-THPVA128)