Demet Kırmızıbayrak

PhD. Postdoctoral Scholar Research Associate, Caltech, Pasadena, CA
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Research Interests

Compact objects, Black holes, Neutron stars, Astrostatistics, Accretion, Jets, Timing analysis, Spectral analysis, Polarimetry, Transient phenomena, Theoretical modelling, Multi-wavelength astronomy, Computational statistics, Large-scale data processing, Data Science

Education

2018 - 2025 | **Ph.D. in Physics**, University of British Columbia, BC, Canada
Supervisor: Jeremy Heyl, **Thesis Title:** "New tricks for old stars: studying compact objects through novel methodologies in timing, energy and imaging"

2015 - 2017 | **M.Sc. in Physics** Sabancı University, Istanbul, Turkey
Supervisor: Ersin Göğüş, **Thesis Title:** "Broadband Spectral Investigations of Magnetar Bursts"

2010 - 2014 | **B.Sc. in Physics and B.Sc. in Industrial Engineering (double major)**, Koç University, Istanbul, Turkey
Global Exchange Student, University of Miami, 2013
International Honors Program (IHP), Stanford University, 2012

Research Experience

2025 - Present | Postdoctoral Scholar Research Associate, High Energy Astrophysics Group, **Caltech**, Pasadena, CA, USA
Main projects: Novel timing methodologies in multi-wavelength astronomy and polarimetry.
Supervisor: Dr. Fiona Harrison

2018 - 2025 | Research Assistant, **University of British Columbia**, BC, Canada,
Projects: Developing and implementing novel timing methodologies in multi-wavelength astronomy. Studying lags and variability for accreting black holes and neutron stars using timing and spectral analysis. Probing neutron stars through theoretical modelling, time-resolved spectroscopy and spectro-polarimetry. Simulating for advancements in instrumentation.
Supervisor: Dr. Jeremy Heyl

2015 - 2017 | Research Assistant, **Sabancı University**, Istanbul, Turkey
Projects: Broadband spectral analysis of X-ray bursts (funded by TUBITAK: The Scientific and Technological Research Council of Turkey), timing and spectral analysis of X-ray binaries using RXTE and Chandra missions.
Supervisor: Dr. Ersin Göğüş

2014 | Research Intern, **IGBMC**, Strasbourg, France
Computational modeling of forces acting on cell elongation of C. Elegans using image processing
Supervisor: Dr. Michel Labouesse

2014 | Independent Study, **Koç University**, Istanbul, Turkey
For my B.Sc. thesis project, I implemented a model of neural connections in brain into a computer simulation in Julia to understand the formation of spatiotemporal patterns, and developed 3D visualization of the simulation. I approximated the criticality threshold in neuron activation probability for which resting state networks emerge within the brain.
Supervisor: Dr. Alkan Kabakçıoğlu

2013 | Research Assistant, **University of Miami**, FL, USA
I worked on the X-ray astrophysics project "Diffuse X-ray Emission from the Local Galaxy (DXL)" during my exchange semester. I implemented post-data analysis, digitized technical drawings and assisted with conduction of experiments. The project results were published in Nature.
Supervisor: Dr. Massimiliano Galeazzi

Awards and Fellowships

2020 - 2023 **Reginald and Annie Van Fellowship**, St John's College, University of British Columbia

2023 **Best Student Talk Prize**, Canadian Astronomical Society Annual General Meeting Board
For talk titled: "Time Lags in Astronomy Through Novel Timing Methodologies"

2020 **Physics and Astronomy Graduate Scholarship**, Department of Physics & Astronomy, University of British Columbia

2019 **Sir Quo-Wei Lee Fellowship**, St John's College, University of British Columbia

2017 **Regents Fellowship**, University of California, Irvine

2017 **Excellence in Teaching Award**, Faculty of Engineering and Natural Sciences, Sabancı University
This faculty-wide prize is awarded to a graduate student for outstanding teaching achievements. Awardees are nominated by instructors and elected taking evaluations of undergraduate students into account

2016 - 2017 **Full Scholarship with Stipend**, Sabancı University, Istanbul, Turkey

2015 **Best Senior Design Project Award**, Koç University, Istanbul
B.Sc. in industrial engineering graduation thesis selected as best in graduating class.
For this project, we developed a decision engine that automatically optimizes marketing decisions of Peak Games, a gaming start-up company. In Beta test, the engine proposed as a generic solution to big data and data mining problems increased the number of downloads of applications by 80%.

2011 - 2015 **Vehbi Koç Scholar Award**, **Koç University**, Istanbul
Received university-wide award for academic success five times.

2011 - 2015 **Dean's Honor Roll**, **Koç University**, Istanbul
Ranked in Dean's Honor roll for academic success for seven semesters.

2015 **3rd Ranking Student Award**, Koç University
For ranking 3rd in graduating class

2010 - 2014 **Merit Scholarship**, Koç University

Publications

2026 **Kırmızıbayrak, D.**, Compact Objects through Novel Timing Methodologies, AAS HEAD Session, American Astronomical Society Meeting, Pasadena, CA

2026 **Kırmızıbayrak, D.**, Caiazzo, I. and Heyl, J., Studying the compact jet in MAXI J1820+070 with novel timing methodologies, **in prep.**

2026 **Kırmızıbayrak, D.**, Caiazzo, I. and Heyl, J., Estimating time lags and reverberation response using Wiener Deconvolution, **in prep.**

2025 Koss, M., [...], **Kırmızıbayrak, D.** et al., The Advanced X-ray Imaging Satellite Community Science Book
arXiv:2511:00253

2025 **Kırmızıbayrak, D.**, New tricks for old stars: studying compact objects through novel timing methodologies, **PhD Dissertation, University of British Columbia**
DOI: 10.14288/1.0448226

2025 González-Caniulef, D., [...], **Kırmızıbayrak, D.** et al. Crab pulsar: IXPE observations reveal unified polarization properties in the optical and soft X-ray bands, **Astronomy & Astrophysics**, 693, A152

DOI: 10.1051/0004-6361/202451815

2024 Heyl, J., [...], **Kırmızıbayrak, D.** et al., Complex rotational dynamics of the neutron star in Hercules X-1 revealed by X-ray polarization, **Nature Astronomy** 8, 1047–1053
DOI: 10.1038/s41550-024-02295-8

2024 Heyl, J., [...], **Kırmızıbayrak, D.** et al., The detection of polarized X-ray emission from the magnetar 1E 2259+586, **Monthly Notices of the Royal Astronomical Society** 527(4), 12219–12231
DOI: 10.1093/mnras/stad3680

2023 **Kırmızıbayrak, D.** and Heyl, J., Time lags in astronomy through novel timing methodologies, **Canadian Astronomical Society Annual General Meeting**
Best Talk Award from CASCA Board

2023 **Kırmızıbayrak, D.** and Heyl, J., Probing magnetars using spectral lines with future telescopes, **Proceedings IAU Symposium** No. 363
DOI: 10.1017/S1743921322000692

2023 **Kırmızıbayrak, D.** and Heyl, J., Probing magnetars using spectral lines with future telescopes, **IAUS 363: Neutron Star Astrophysics at the Crossroads: Magnetars and the Multimessenger Revolution**
Conference link

2023 Safi-Harb, S., [...] , **Kırmızıbayrak, D.** et al., From stellar death to cosmic revelations: zooming in on compact objects, relativistic outflows and supernova remnants with AXIS, **White Paper part of a series commissioned for the AXIS Probe Concept Mission**
arXiv:2311.07673

2022 Taverna, R., [...] , **Kırmızıbayrak, D.** et al., Polarized x-rays from a magnetar, **Science**, 378(6620):646–65
DOI: 10.1126/science.add0080

2022 **Kırmızıbayrak, D.**, Exploring compact objects with spectral lines: then, now And beyond, **Invited Talk, Istanbul University Observatory**
Talk link

2022 **Kırmızıbayrak, D.** for the Colibrí Team., Taking the pulse of neutron stars and black holes, **Canadian Space Exploration Workshop**
CSEW e-poster presentation

2022 Chatterjee, A., [...] , **Kırmızıbayrak, D.** et al., Broad-band X-ray spectral temporal features of MAXI J1728-36 during its 2019 outburst: Implications on the accretion geometry through reflection spectroscopy, **44th COSPAR Scientific Assembly** volume 44, page 2348
Abstract E1.8-0004-22

2022 Chatterjee, A., [...] , **Kırmızıbayrak, D.** et al., Understanding the enigmatic microquasar SS 433 through High-Resolution X-ray Timing and Spectroscopy: Prospects for Colibrì, **44th COSPAR Scientific Assembly** volume 44, page 2054
Abstract E1.2-0032-22

2022 Gallagher, S., [...] , **Kırmızıbayrak, D.** et al., Black hole astrophysics with Colibrì, **44th COSPAR Scientific Assembly** volume 44, page 2024
Abstract E1.2-0002-22

2019 **Kırmızıbayrak, D.** and Heyl, J., Probing black holes through reverberation mapping, **Testing Gravity 2019**
Conference link

2019 Caiazzo, I., [...] , **Kırmızıbayrak, D.** et al., Unveiling the secrets of black holes and neutron stars with high-throughput, high-energy resolution X-ray spectroscopy. **In Canadian Long Range Plan for Astronomy and Astrophysics White Papers**, volume 2020, page 36,
10.5281/zenodo.3824441

2019 Hoffman, K., [...] , **Kırmızıbayrak, D.** et al., The Colibrí Mission: Canada's flag-ship X-ray telescope, **In Canadian Long Range Plan for Astronomy and Astrophysics White Papers**, volume 2020, page 31,
10.5281/zenodo.3765587

2019 Heyl, J., [...] , **Kırmızıbayrak, D.** et al., The Colibrí High Resolution X-ray Telescope, **Astro2020: Decadal Survey on Astronomy and Astrophysics**, instrument white papers, no. 175; Bulletin of the American Astronomical Society, Vol. 51, Issue 7, id. 175,
https://baas.aas.org/pub/2020n7i175/release/1

2019 Caiazzo, I., [...] , **Kırmızıbayrak, D.** et al., Testing general relativity with accretion onto compact objects, **Astro2020: Decadal Survey on Astronomy and Astrophysics**, science white papers, no. 516; Bulletin of the American Astronomical Society, Vol. 51, Issue 3, id. 516
https://baas.aas.org/pub/2020n3i516/release/1

2019 Heyl, J., [...] , **Kırmızıbayrak, D.** et al., Exploring the physics of neutron stars with high-resolution, high-throughput X-ray spectroscopy, **Astro2020: Decadal Survey on Astronomy and Astrophysics**,science white papers, no. 491; Bulletin of the American Astronomical Society, Vol. 51, Issue 3, id. 491
https://baas.aas.org/pub/2020n3i491/release/1

2017 **Kırmızıbayrak, D.** et al., Broadband spectral investigations of magnetar bursts, **The Astrophysical Journal Supplement Series** Vol., 232 Number 1
DOI: 10.3847/1538-4365/aa88b7

2017 **Kırmızıbayrak, D.**, Broadband spectral investigations of magnetar bursts, MSc. Thesis, **Sabancı University**
Link to thesis

2016 **Kırmızıbayrak, D.** et al., Broadband spectral study of magnetar bursts, **In 41st COSPAR Scientific Assembly** Vol. 41
abstract E1.4–23–16

Teaching Experience

- Since 2015, I have served as an instructor teaching assistant, lead teaching assistant (training and coordinating graduate TAs), and teaching assistant for a wide range of undergraduate and graduate courses in astronomy, physics, mathematics, and statistics at:
  - University of British Columbia (2018–2024)
  - University of California, Irvine (2017–2018)
  - Sabancı University (2015–2017)
- I was Instructor TA (instructor responsibilities under faculty supervision) for ASTR 311 at UBC between 2022-2025, responsible for course delivery across online and in-person formats, including lectures, assessments, student support, and course operations.
- I was a guest lecturer for several astronomy and physics courses, including the graduate observational astronomy course (ASTR 514) at UBC.
- I received the Excellence in Teaching Award from Sabancı University (2017).
- I completed formal TA and pedagogy training workshops and courses at Caltech, UBC and UCI, as well as extensive active-learning–focused Lead TA training at Sabancı University.

Academic Service

- Reviewer Panelist, **NuSTAR** 12th General Observing Cycle, 2026
- Reviewer Panelist, NASA **IXPE** 3rd General Observing Cycle, 2025
- Session Chair, **AAS HEAD Meeting**, Pasadena, CA, 2026
- Chambliss Poster Judge, **AAS HEAD Meeting**, Pasadena, CA, 2026
- Proposal Reviewer, **Caltech SURF Program**, 2026
- Member, **NuSTAR Science Team**, 2025–Present
- Member, **IXPE Science Team**, 2022–Present
- Member, **AXIS** Compact Objects Supernova Remnants Science Working Group, 2022–2026
- Member, Canadian Space Agency (**CSA**) Space Astronomy Topical Team: High Energy Astrophysics Gravitational Waves, 2022–2025
- Member, **Colibrí** X-ray Telescope Science Working Group (concept mission), 2018–Present

Outreach

Here are some activities of mine on science outreach, wellness, equity and inclusion related topics.

- I am a member of the Caltech Astronomy Outreach team, volunteering at public events and festivals to operate telescopes and teach visitors about space. Most recently, I joined the Death Valley Dark Sky Festival.
- Between 2020-2023, I was the Residence Community Coordinator at St. John's College, University of British Columbia: an international residential community and inter-disciplinary research hub of 200+ graduate students, postdocs and faculty. I was the main organizer for numerous academic events (e.g. guest speakers, 3-Minute-Thesis competition) and wellness related activities. Here is my interview with UBC Office of Global Engagement, where I discussed our efforts in building a stronger and inclusive graduate community during the COVID-19 pandemic.
- Some of my public talks: "A Journey Through the Life of the Sun", H.R. MacMillan Space Centre, Vancouver, Canada in 2019 and "Living and Zombie Stars", St. John's College Residence, University of British Columbia in 2020
- I have been Wellness Representative and Member of UBC Physics and Astronomy Department Equity and Inclusion Team from 2019-2023.
- I am a founding member and mentor in UBC Physics and Astronomy Launchpad. We secured funding and orchestrated the launch of this initiative, hosting undergraduate students from equity-deserving backgrounds keen on physics and astronomy at our university.

Programming and Software Skills

- Proficient: Python, IDL, Bash, XSPEC, XSELECT, LaTeX, R, Minitab, astronomical data analysis and reduction (e.g. HEASARC software), data visualization
- Experience with: JAVA, Julia, machine learning (PyTorch), C++, MATLAB, ixpeobssim, VBA, SolidWorks, database management (MySQL, Microsoft Access)