Dear Harvard Students,

The Harvard-Smithsonian Center for Astrophysics (CfA, http://www.cfa.harvard.edu/), located at 60 Garden Street opposite the Quadrangle, is one of the world's great centers for research in astrophysics, with over 300 scientists and access to powerful astronomical observatories worldwide and in space. The following is a partial list of CfA research opportunities for undergraduates. I encourage students to contact these scientists directly to inquire about these opportunities. In addition, you should feel free to reach out to any SAO scientist and faculty (some of which are listed here: https://astronomy.fas.harvard.edu/book/astrophysics-advisors) and inquire if they or someone in their group are interested in advising you — not all prospective undergraduate research advisors put down a project in this document.

In addition to a project description, some of the research advisors have indicated within which framework (e.g. senior thesis, paid semester work, summer research internship) that their research project can be carried out, as well as recommended prerequisites. I want to make two comments on this. First, if you identify a research project that you would like to pursue as a paid position during the semester, but the advisor does not have resources to support this financially, please reach out to me. We have some limited departmental resources set apart for students eligible for work-study as well as those with commensurate financial need (regardless of citizenship) who want to do astronomy research. For the summer there are many opportunities to apply for your own funding to carry out a research project (https://astronomy.fas.harvard.edu/research-opportunities-undergraduates). Second, remember that the recommended prerequisites are *recommended,* i.e. if you do not have them I would still encourage you to reach out to the advisor if you find a project you are really excited about.

Finally, Harvard has several programs to provide support for student research, described at: http://uraf.harvard.edu/ We also provide a list of useful links for internal and external undergraduate research programs here: https://astronomy.fas.harvard.edu/research-opportunities-undergraduates

If you have questions about getting involved in research at the CfA, please do not hesitate to contact me.

Best wishes,

Karin Öberg,
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P-346

Quantitative measurement of H2O from the Jovian moon Europa

Advisor: Dr. Kelly Chance (kchance@cfa.harvard.edu)

Open for Junior Thesis (AY98), Senior Thesis (AY 99)

Dr. Kelly Chance is happy to supervise undergraduate research on the possibility for small satellite based measurements of water vapor on the Jovian moon Europa. This research will employ a combination of planetary science, spectroscopy and radiative transfer, and optical instrumentation in order to optimize a measurement approach for long-term monitoring of global H2O emission from the surface of Europa. The proposed method is the measurement of the strong A2Σ+ - X2Πi electronic transition of OH near 308 nm. H2O is quickly and efficiently photolyzed by solar UV to OH + H and much more slowly further to O + H + H, likely in a time longer than planetary escape. Thus, OH is a quantitative proxy for H2O. The intensity for the F1 component of the transition, Δv = 0, is 3.4×1026 cm (i.e., huge!) [1]. The F2 component will be comparable, although it is not yet as well determined. In short, ultraviolet OH measurements provide an extremely sensitive and highly quantitative way to measure water vapor from Europa.

Background

Measurements of OI emissions from the Hubble Space Telescope at 135.6 and 130.4 nm in Europa's atmosphere have been taken as indicators of H2O emitted from the surface. The ratio of OI 135.6 nm/OI 130.4 nm is taken to "imply a stable H2O abundance in the central sunlit trailing hemisphere with an H2O/O2 ratio of 12–22. On the leading hemisphere, the emissions are consistent with a pure O2 atmosphere [e.g., no H2O] everywhere across the moon disk." [2]

Infrared searches for H2O were conducted with the ground-based Keck observatory near ~2.9 µm and ~5.5 µm [3]. Measurements near 2.9 µm (a weak hot band region) showed a water vapor detection on one of 17 dates, on the leading hemisphere. The ~5.5 µm measurements showed no potential detections.

References

[1] McGee, and T.J. McIlrath, Absolute absorption cross sections (for LIDAR measurements), JQSRT 32 (2), 179-184, 1984

[2] A stable H2O atmosphere on Europa's trailing hemisphere from HST Images, Roth, L., Geophys, Res. Lett., 10.1029/2021GL094289, 2021.

[3] L. Paganini et al., A measurement of water vapour amid a largely quiescent environment on Europa, Nature Astronomy, 4, 266-272, 2020.

Observing Exoplanets

Advisor: Prof. Dave Charbonneau (dcharbonneau@cfa.harvard.edu)

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester Research for Credit (AY 91R), Paid semester work for work-study eligible students, Paid semester work for non-work-study eligible students, Summer research paid by advisor, Summer Research with external stipend

I would welcome working with undergraduate students on a variety of observational or instrumentation projects related to exoplanets. My primary activities are as follows:
(1) The Tierras Observatory is a recently commissioned ultra-precise automated photometer located atop Mt. Hopkins Arizona. Tierras is designed for follow-up of nearby, small stars that host transiting exoplanets, to search for rings, moons, and the presence of additional planets.
(2) The HARPS-N Project is an ultra-stable, high-resolution spectrograph located on the Italian National Galileo Telescope in the Canary Islands. Our international team is gathering data to measure the masses and hence learn something about the composition of small planets.
(3) NASA TESS Mission is scouring the sky to find the nearest transiting exoplanets, which are optimal for characterization. I participate in efforts to confirm and characterize these newly found worlds.
(4) My team is conducting a census of nearby M-dwarfs to deduce their fundamental properties and develop methods to facilitate their characterization. M-dwarfs outnumber Sun-like stars 12:1, and so if they too host habitable planets, then likely the closest and most observationally accessible Earth-like planets orbit M-dwarfs in our census.

Please reach out if any of these projects interest you!

These projects have no prerequisites and are open to all undergraduate students.

Searching for Planets and Flares at X-ray Wavelengths

Advisor: Dr. Rosanne Di Stefano (rdistefano@cfa.harvard.edu)

During the past several years, my group has been studying the short-time-scale behaviour of X-ray sources across the sky. These explorations represent the first systematic mining of scientifically rich data sets, and has led to the first discovery of a candidate planet in an external galaxy. Ongoing research is finding more candidates as well as high-energy flares due to a range of physical phenomena, possibly including gravitational lensing.

Students who join these efforts will be able to participate in the analysis of a range of data sets and discover and study diverse phenomena. Theoretically-minded students can model binary, triple, and planetary systems with the aim of understanding the discovered phenomena and potentially making new predictions. Whatever their choice of specific project, students will start with a foundation built largely by student efforts during the past year, and will also have a chance to work with others.

Cosmological large-scale structure and galaxy formation

Advisor: Daniel Eisenstein (deisenstein@cfa.harvard.edu)

Open for Ay98, Ay99, or summer work

My group focuses on the study of large-scale structure in the Universe, combining observation, theoretical, and computational methods. The large-scale clustering of galaxies results from tiny imperfections in the early moments of the Big Bang, which then grow in contrast due to gravity. The clustering reflects the role of dark matter and dark energy. Modern surveys make beautiful maps of multi-Gpc volumes of the Universe and then generate statistical measurements of the clustering to compare to the results of analytic perturbation theories and cosmological simulations.

Observationally, my focus is on the Dark Energy Spectroscopic Instrument, a major new facility now operating at Kitt Peak National Observatory in Arizona. DESI has already collected over 15 million spectroscopic redshifts in its first year of operation. The coming year will be a key period for the analyses of the initial maps.

Theoretically, I consider new ways to use the data, for example using cross-correlations and improved statistical methodologies, including applications of machine learning to cosmology.

Numerically, my group has produced a vast set of cosmological N-body simulations, named AbacusSummit, with nearly 60 trillion particles, 97 separate cosmologies, and 2 PB of data products. This provides a testing ground for new methods and generation of mock catalogs for DESI. Students interested in high-performance computing and data processing could get involved with this massive data set.

Separately, my group is active in the James Webb Space Telescope (JWST) Advanced Deep Extragalactic Survey (JADES), which will be observing this fall to produce super-deep imaging and spectroscopy of faint galaxies, particularly at $z>3$. In the coming academic year, we will be working on the initial reductions and analyses of this data set!

I would be happy to discuss student projects on any of these topics.

Generating Images of the Interstellar Medium with Non-Gaussianity

Advisor: Prof. Doug Finkbeiner (**dfinkbeiner@cfa.harvard.edu**), Andrew Saydjari (**andrew.saydjari@cfa.harvard.edu**)

Open for Junior Thesis (AY98), Senior Thesis (AY 99)

Project Description: The complex interplay of magnetohydrodynamics, gravity, and turbulence in the interstellar medium (ISM) introduces "non-Gaussian" structure that is beautiful and diverse, but difficult to describe with concise statistics. Recent work in our group has enabled synthetic image generation with some degree of non-Gaussianity using a form of conditional Gaussian Process Regression (https://arxiv.org/abs/2201.07246). This project would aim to quantitatively measure and describe the non-Gaussianity in these synthetic images using summary statistics such as the Wavelet Scattering Transform (https://arxiv.org/abs/2010.11963).

Students can expect to gain exposure to high performance computing, "classical" machine learning, and statistical image analysis. Project focus and extensions will cater to student interest in astronomy, math/statistics, and/or computer science. Please reach out if you are interested and want to discuss/learn more!

Recommended prerequisites: This project was constructed with (rising) junior and senior students in mind. Some basic coding experience (python or otherwise) is required.

Cosmic Microwave Background Instrumentation

Advisors: Prof. John Kovac (jmkovac@cfa.harvard.edu), for some projects in combination with Dr. Clara Verges (clara.verges@cfa.harvard.edu) or other senior group members.

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester Research for Credit (AY91R), Paid semester work for work-study eligible students, Paid semester work for non-work-study eligible students, Summer research paid by advisor, Summer Research with external stipend

The Kovac Group's Cosmic Microwave Background (CMB) Lab at the CfA works to design, build, operate, and analyze data from some of the most sensitive microwave telescopes ever built, currently including BICEP3, the BICEP Array, the 10m South Pole Telescope, and instruments of the large CMB-Stage 4 project currently under delopment. Our telescopes observe the CMB from the South Pole, searching for signatures of Inflation that may be imprinted as a specific pattern of polarization in the CMB, while also using the maps we make to study gravitational lensing, dark matter, and our own galaxy. This year, we are gearing up for another season at the South Pole, while running a full testing programs of new microwave optics technologies and cryogenic telescope systems here at Harvard.

We have current projects potentially suited to committed undergraduates ranging from design, development, construction, and testing of optics and calibration instrumentation for CMB telescopes operating at the South Pole to analysis of data returned by these telescopes to constrain inflationary observables and simulation of CMB lensing observations. Our group is also focused on analysis of calibration data from these telescopes, and exploring new analysis techniques to mitigate systematic effects that can be applied to current and future datasets. Projects in these areas offer opportunities to directly improve the design and performance of some of the world's leading current and planned cosmology experiments. Visit the group website (https://www.google.com/url?q=http://www.cfa.harvard.edu/CMB/&source=gmail-imap&ust=1659137672000000&usg=AOvVaw1mBVuFGJkZB3wC9vfQkEYk) to see a little more about what we do or contact us to come by and check out what is going on in the lab.

Observing Exoplanets: follow-up of TESS objects of interest

Advisors: Dr. Dave Latham (dlatham@cfa.harvard.edu) and group members

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester Research for Credit (AY 91R), Paid semester work for work-study eligible students, Paid semester work for non-work-study eligible students, Summer research paid by advisor, Summer Research with external stipend

My group is actively involved in the confirmation and characterization of exoplanets discovered by photometric surveys for transiting planets. Our main focus now is on follow-up observations of candidate transiting planets identified by NASA's Transiting Exoplanet Survey Satellite (TESS), although we are also still working on interesting candidates from NASA's Kepler and K2 missions.

We use KeplerCam on the 1.2-m telescope at SAO's Whipple Observatory, for high-quality light curves of transit events, and the Tillinghast Reflector Echelle Spectrograph on the 1.5-m telescope, also on Mount Hopkins, both for spectroscopic determinations of host star parameters and for orbital solutions and mass determinations for giant planets. This is an opportunity to learn about astronomical photometry and/or spectroscopy while working to follow up recently discovered TESS Objects of Interest.

We also have guaranteed access to HARPS-N on the 3.6-m Telescopio Nazionale Galileo located on La Palma in the Canary Islands. This is a state-of-the-art facility for precise radial-velocity observations suitable for measuring masses of small planets.

We'd be happy to talk to any interested students about possible projects.

This project has no prerequisites and is open to all undergraduate students.

Supermassive Black Holes

Advisor: Dr. Peter Maksym (walter.maksym@cfa.harvard.edu)

Open for: Junior Thesis, Senior Thesis, Semester Research for Credit, and paid semester work.

I am involved in a variety of research projects primarily related to ground- and space-based observations of supermassive black holes and their interactions with their environments. I am happy to discuss how best to tailor a project to a student's abilities and interests. Data that I am currently working with include:

Spectroscopic observations of tidal disruption events (TDEs; stars ripped apart by supermassive black holes). I am using data from the Hubble Space Telescope (ultraviolet), XMM-Newton and Swift (X-rays), and MMT (Harvard-Smithsonian's large ground-based optical telescope) to study how the powerful winds generated by TDEs change with time.

X-ray observations of galaxies across cosmic time: one of the most versatile fields currently scheduled for the James Webb Space Telescope is also the target of deep complementary Chandra observations which will allow us to study (for example) the X-ray counterparts to energetic events discovered in one of the only deep fields accessible to James Webb all year round.

Black hole-galaxy interactions: actively accreting black holes play a key role in the "ecosystems" of galaxies, and I study the effects of powerful feeding frenzies that can light up the gas in the host galaxy. With high-resolution observations from space (Chandra in X-rays and Hubble in optical) and the ground (Magellan, optical), we can study the impact of powerful black hole-driven winds which may regulate the growth and evolution of both the black hole and host galaxy, or we may study the imprints of past outbursts captured in "light echoes" across the host galaxies. Such observations may also be used to inform future observations by the James Webb Space Telescope.

Characterizing atmospheric turbulence above the Magellan Telescopes

Advisor: Brian McLeod (bmcleod@cfa.harvard.edu)

Open for: Senior thesis

The goal of this instrumentation project is to characterize the atmospheric turbulence at Magellan to determine what fraction of the atmospheric seeing could potentially be corrected in the future with a ground layer adaptive optics system. The student will be involved in assembling and testing the optics of a Shack-Hartmann wavefront sensor before it is installed at Las Campanas Observatory, writing and testing the software to collect and process the data, and analyzing the results. No instrumentation experience is needed, but a knowledge of Python is.

Astrochemistry and Planet Formation

Advisor: Prof. Karin Öberg (koberg@cfa.harvard.edu), Alexia Simon and other group members

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester Research for Credit (AY 91R), Paid semester work for work-study eligible students, Paid semester work for non-work-study eligible students, Summer research paid by advisor, Summer Research with external stipend

Star and planet forming regions present a rich chemistry, which regulates which kind of planets are formed where, including the likelihood delivering prebiotic material to rocky planets. Molecules can also be used to trace the star and planet formation process through observations of molecular lines that are sensitive to e.g. the details of the radiation fields, temperature and density profiles. In the astrochemistry group we combine laboratory experiments and radio observations of protostars and planet-forming disks to characterize this often exotic chemistry that results in the formation of molecular probes and prebiotic molecules. Undergraduate projects are available in the areas of spatially resolved molecular line observations ('astrochemical imaging') of different astronomical objects, interpretation of radio astrochemical spectra, and in laboratory astrochemistry, exploring the physics and chemistry of interstellar ices. If this seems fascinating to you, please reach out — I am always happy to meet with interested students.

On particular project that we would be excited top pursue this fall is a laboratory investigation into the entrapment of volatiles in ices, when there are multiple volatiles that can compete for good entrapment spots. This is directly relevant for predicting the composition of ices in protoplanetary disks at different distances from the star, and therefore to the composition of planets and planetesimals that assemble in the disk.

These projects are open to undergraduate students at all levels.

Black holes

Advisor: Dr. Fabio Pacucci (fabio.pacucci@cfa.harvard.edu)

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester research for credit (AY 91R), Summer Research with external stipend

My research focuses on "all things black holes", from local ones to the farthest ever discovered, from the small to the super-massive ones. Overall, my work aims at addressing crucial questions about the nature and demography of black holes, their relevance for gravitational wave events, and ultimately how black holes helped to shape the Universe as we observe it now. With expertise in both theoretical modeling and observations, I developed some of the most advanced growth models for black holes and contributed to the discovery and understanding of the first lensed quasar at redshift higher than 6.

Projects are available in these broad research topics:
1) Formation, cosmological evolution and observational signatures of the first population of black holes formed at redshift higher than 6, a yet undetected and fundamentally important class of black holes.
2) The formation and evolution of high-redshift quasars, the population of farthest and heaviest supermassive black holes ever detected. Why did they grow so fast, and what makes them special?
3) The elusive population of intermediate-mass black holes, nowadays found in dwarf galaxies. Were they remnants of the first population of black holes, or did they form more recently? Also, are there intermediate-mass black holes in the Milky Way galaxy, and how do we find them?

These topics are very timely, given the upcoming commission of new observatories to probe the high-redshift Universe, such as the James Webb Space Telescope, the 30-meter class telescopes, WFIRST, Euclid and, farther in the future, new X-ray and gravitational wave observatories. Theoretical models and simulations are needed now more than ever to: (i) plan new observations, and (ii) interpret the unprecedented amount of high-quality data that current and future facilities will provide. Research projects are always available in the fantastic world of black holes, and I would be glad to meet with interested undergraduates to discuss possible common research interests.

Recommended prerequisites: Basic python coding experience and astronomy knowledge (AY 16 and 17) are recommended, but the project is open to all undergraduate students.

Laboratory Characterization of Benzene and Benzene Derivatives Ices

Advisor: Dr. Elettra Piacentino (elettra.piacentino@cfa.harvard.edu) and Prof. Karin Öberg

Open for Junior Thesis (AY98), Senior Thesis (AY 99), Semester Research for Credit (AY 91R), Paid semester work for work-study eligible students, Paid semester work for non-work-study eligible students, Summer research paid by advisor, Summer Research with external stipend

Small aromatic molecules have been found in meteorites samples and benzene and toluene have recently been detected on comet 67P. In the ISM, the detection of small aromatic molecule such as benzonitrile is also very recent. Such molecules were detected in cold and dense molecular cloud with abundances higher than expected. The detection of benzonitrile in the ISM suggests that its parent molecule benzene should be abundant as well and that it may undergo derivatization to form phenol, benzaldehyde, and toluene in addition to benzonitrile.

The broad aim of this project is to study and characterize ices of benzene, toluene, phenol, benzaldehyde, and benzonitrile in the laboratory. The work will be carried out at in the Öberg lab, where the student will be using one of the experimental set ups. These set ups consist of an Ultra High Vacuum (UHV) chamber designed to perform Infrared Spectroscopic (IR) detection and characterization in icy samples. The set-ups also allow for collecting Mass Spectrometry (MS) data of gas-phase molecules during ice desorption. For this project the student will be preparing benzene ice samples at cryogenic temperature (~10K), followed by a temperature programmed desorption (TPD) experiment. For the whole length of the experiment both IR and MS data will be collected. The collected IR data will be used to determine and characterize the IR signature of the molecule at 10K as well as any changes due to increasing temperature. The MS information will be used to precisely determine the desorption temperature of benzene and its associated physisorption energy.

Dependent on the length of the project, the student project will either focus on the experimental characterization of benzene ices, or if the time allows also on the characterization of ices of functionalized benzene molecules (benzene derivatives).

This work will provide the community with state-of-the-art experimental data on benzene ice (and its derivative) which will be useful for the detection and for the prediction of the chemistry of such molecules in astrochemical environments.

How did the Solar System form and evolve?

Advisor: Dr. Rosemary Pike (rosemary.pike@cfa.harvard.edu)

The outer Solar System beyond Neptune is populated with small, icy objects, which are the remnants of planet formation. These Trans-Neptunian Objects (TNOs) are the least thermally altered bodies in the Solar System, but their orbits have been significantly altered by the migration of the giant planets. The outward migration of Neptune transported many of these objects out to their current locations. These small TNOs have a large variety of orbit types, including some nearly-primordial TNOs and some which have been dynamically excited by Neptune. These dynamically excited objects include TNOs in resonance with Neptune- their orbital periods have an integer ratio with Neptune's orbital period. For example, Pluto is in the 3:2 resonance with Neptune, so it is protected from close encounters with Neptune when it comes to pericenter inward of Neptune's orbit. The characteristics of resonant TNO populations can provide a unique insight into the specifics of Neptune's migration, because different numbers and types of objects are trapped into resonance depending on the mode of Neptune's migration. Our team has recently discovered ~150 objects in the Large inclination Distant Object Survey (LiDO). We are tracking these objects to constrain and classify their orbits.

Possible projects include: determining the color and surface type of TNOs from photometry data in order to constrain their formation location; Measuring the precise position of TNOs in telescope data, determining their orbits, and predicting their orbital classification; N-body simulations of resonant TNO orbits to determine their stability and robust classification, population modeling for TNO sub-populations and testing using a survey simulator.

Asteroid families: a powerful tool to understand our Solar System

Advisor: Dr. Federica Spoto (federica.spoto@cfa.harvard.edu)

Asteroids are bits of building material remaining from the formation of the Solar System, which means that they have witnessed all the different phases of the formation and evolution of our system. The study of the asteroid population is thus the key to better understand our Solar System and as a consequence also other planetary systems, how the life formed on our planets, how collisions happen in space and how to mitigate hazards given by possible collisions of the so-called Near Earth Asteroids (NEAs) with our planet. A powerful tool to turn back time and understand what happened during the early phases of the formation of the Solar System is given by asteroid families. These are groups of objects generated by past collisions between asteroids that now shares similar dynamical (or physical properties). My research focus on the identification of the largest number of families and on the computation of the time of their initial collision (or age of the family) to obtain the most accurate chronology of the impacts in the Solar System.

Recent improvements in orbit accuracy (the Gaia mission) and number of objects discovered presented new and exciting challenges in the characterization of asteroid families. Undergraduate projects are available in both areas of identification and characterization of asteroid families: we want to use new machine learning techniques to identify new families or update existing ones, we would like to include physical properties from the Gaia mission into the algorithms of identification of families, and improve methods to compute asteroid family ages using high-precision astrometry.

If all or some of the previous arguments seem fascinating to you, please reach out. I am always to meet interested student and the fields is evolving so quickly that more and more discoveries of asteroids are making the research even more exciting.

Black Holes and 100 kpc Jets: Two Ends of One Phenomena

Advisor: Dan Schwartz (das@cfa.harvard.edu), with participation by collaborators.

Open for Senior Thesis (AY 99),

1. X-ray structure of a supermassive black hole.
Use gravitational lensing to probe milli-arcsec X-ray structure and astrometry in high redshift quasars. Analyze archival Chandra X-ray data of strongly lensed, quadruply imaged quasars. Many sources have 10 Chandra observations spanning more than 10 years. The student will use existing GAIA or VLBI data to construct a lens mass model and compare the X-ray location(s) to the resulting radio or optical position.

2. Physical parameters of 100 kpc X-ray Jets. Studies of archival Chandra X-ray jets in quasars. These jets are detected on scales of a few arcsec, which correspond to > 10 kpc at the quasar redshift, and are inferred to be at a small angle to our line of sight and thus have de-projected lengths of order 100 kpc. Details of their emission mechanisms and derivation of physical parameters remain to be clarified: Synchrotron emission from Lorentz factor 10^8 electrons, or inverse Compton scattering on the cosmic microwave background from 100 MeV electrons?

Basic python coding experience, and familiarity with Mathematica will be useful and needed, but are not formal prerequisites.

Are you interested not just in astronomy itself but in the tools we use to do modern science? Are you an experienced coder?

Advisor: Dr. Peter Williams (pwilliams@cfa.harvard.edu)

The world deserves excellent technical documents, filled with beautiful equations, abundant cross-references, interactive graphics, and runnable code. And with the digital displays that we use every day, all of these things and more are possible. But most of the documents created by scientists are designed using centuries-old approaches — approaches that assume that a document's "true" form is a bunch of ink printed on little rectangles of dead tree.

Dr. Williams (https://newton.cx/~peter/) is the lead developer of Tectonic (https://tectonic-typesetting.github.io/), an open-source project that aspires transform technical communication for the 21st century. In particular, it aims to bring the power of the venerable TeX typesetting software — still the world's best for authoring demanding technical documents — to the Web. In this project, you will develop the systems that will coax HTML output from the classical TeX engine. You will learn about the guts of TeX (mind-expanding), modern Web technologies (useful!), the Rust language (totally awesome), and open-source software development (noble!). You don't need to believe that you're a programming ninja, but given the time constraints, substantial previous coding experience is required.