My greatest personal interests are on the boundary between physics and pure mathematics. I find most fascinating the subtle ways in which simple ideas like counting, or theories about abstract mathematical objects like sets, numbers, and functions, reveal important and observable properties of the physical world we live in. I enjoy mathematical modelling of physical phenomenon because it gives me a chance to see this interface directly and observe how changes in the mathematics shape the physical results demonstrated in experiment. I have explored this interface through both theoretical and computational physics.

My fascination with the relationship between pure mathematics and physics became well-defined while I was a student in an experimental research group studying liquid crystal materials. A primary focus of our group was the study of how uniquely-shaped particles, such as figure-8s and 3-dimensional knots, interacted with the liquid crystal medium. In a branch of geometry that studies the intrinsic properties of shapes, a coffee cup and a doughnut are mathematically the same shape because they have one hole (the hole in your coffee cup is its handle). An interesting result of our experiments was that the properties of an object in liquid crystal are determined by its abstract mathematical shape (its number of holes) rather than by its apparent physical shape. Such surprising relationships have turned up with increasing frequency as I have continued my studies in physics and mathematics, and demonstrate the applicability of pure mathematics to theories about nature. These correspondences keep me always excited about my future in physics and mathematics.

I am a member of a research group that studies a newly-discovered material of great theoretical interest, quark-gluon plasma, which is created in high-energy collisions between heavy nuclei like lead and gold. Quark-gluon plasma is exceptionally difficult to study experimentally, so theory and computer modelling are of great importance to the progress of the discipline. Our group studies the material properties of quark-gluon plasmas theoretically and develops new methods in fluid dynamics that can be used to simulate them on the computer. In my current work, I am writing simulations of a similar fluid in order to more precisely determine the viscosity of quark-gluon plasma.

I thoroughly enjoy the opportunity to study the mathematics underlying fluid mechanics and numerical methods, and to apply these to an open problem in physics. I am excited to contribute to research in high-energy physics because the study of high-energy matter, and quark-gluon plasma in particular, is very young and has many important consequences in modern physics. The fluid properties of quark-gluon plasma in particular are supposed to convey important information about the forces governing quarks, which are thought to be the most fundamental constituent of matter. I am also interested in applications of high-energy physics to the study of the early universe, and to the development of nuclear fusion energy.

My academic goal is to enter a PhD program in theoretical physics after my graduation from the University of Colorado. I hope to spend my career doing fundamental high-energy physics or nuclear fusion energy research at a university or national laboratory.

~~Research has given me a chance to get closer to this interface than I have been able to in either my physics or mathematics courses.~~ Maybe add another sentence, but don’t start talking about research yet…

I developed a strong interest in topology while involved in this group, which was strengthened in the future by coursework in combinatorics and graph theory. This is a concrete example of the ability of abstract mathematical constructs to explain non-intuitive aspects of physical reality. These types of ~~stunning~~ relationships have turned up more and more often as I have continues my studies in physics and mathematics, and keep me excited about my future in the discipline (hopefully developing physical theories!).

Most of the essays I see for the ASF tend to focus about half the page on research activities—for a lay audience, and the other on motivation or a personal research/intellectual journey—with maybe a few sentences at the end about other interests and activities.

I work in a research group that studies a novel material of great theoretical interest, quark-gluon plasmas. These materials are incredibly difficult to collect data on, and as such, simulations and computer modelling are of great importance to the discipline to try to determine experimental parameters. Then discuss how you develop simulations to model fluids, from which you can determine fluid properties of quark-gluon plasma. Talk about what you do in particular, why you like it, what you get out of it, and what you feel that you contribute to the physics community.

Maybe keep the first paragraph, and either develop the motivation or stretch a few of the examples in the next paragraph into well-developed ideas instead of a list.

My fascination with physics and mathematics, and the content covered in courses for each, have both fed and been fed by each other (i.e. I am more interested in physics because of math, and I am more interested in math because of physics). I would say that my interest in physics became defined (i.e. I decided to switch majors) because of research, including the final independent research project in Honors 1120 and our professor’s frequent remarks about research and graduate school in physics. My interest in mathematics became defined (i.e. I began spending all of my free time / credits taking math classes) during my time in Ivan’s lab, when I began reading research papers (albeit in experimental physics) and became really interested in the theoretical / mathematical backing that described the non-intuitive physical phenomenon that we observed in experiments. I also think back often on Mike’s thesis presentation, which began to explore (albeit not in a ton of mature theoretical detail) the topological implications of the formation of defect structures in liquid crystal. I remain fascinated by the beautiful and subtle relationship between the abstract constructs of pure mathematics and the physical world.

~~The activities that have been most important to me are my research, and I have been particularly involved in mathematical modelling using computers.~~ I am currently studying fluid dynamical models for a material called quark-gluon plasma that is created in high-energy collisions between lead and gold nuclei and was first observed at CERN in 2000. This research is very interesting and important to me for a few reasons. First, it is theoretical / computational work and has given me the chance to learn and use a number of mathematical and numerical techniques that I had not seen before. It also provides the opportunity, through computational relativistic hydrodynamics, for me to contribute to using mathematics to develop completely new theoretical and numerical methods to describe a phenomenon (relativistic fluids) that is fairly new. The discipline at large is important to me because high-energy physics is a very young field with a lot of important consequences in the progress of modern physics, that has a huge number of open problems and unanswered questions, and a lot of room for theoretical and experimental advancements.

My goals for my career are to enter a PhD program in theoretical physics after my graduation from the University of Colorado~~, and I am particularly interested in programs at MIT, Princeton, Stanford, and Caltech. After a PhD and postdoc~~, I hope to do fundamental high-energy physics or nuclear fusion energy research at either a university or national laboratory.

I consider my hobbies to be the academic areas that I study outside of my degree program. Several classes in pure mathematics have shaped my approach to physics, and have fundamentally changed the way I understand the world around me. I believe that a strong mathematical background will be centrally important to a career in theoretical physics, and furthermore that the deductive creativity that proof-based mathematics encourages will continue to improve the way I think and solve problems in all analytical endeavors. I found Combinatorics and Linear Algebra to be particularly enlightening. As Penrose, a famous mathematical physicist, said, “A sign of a good physical theory is that, at its core, it relies on nothing more than combinatorial principles,” that is, than the principles of counting. I also think that my experience with computational methods will serve me well as a physicist, because the computer is one of our most powerful tools to advance the work of previous generations.

My earlier research at the University of Colorado led me to my current research. I did some simulations, which I really enjoyed. Also while in the group I became really interested in theoretical topology, which (I think) is an important aspect of high energy physics.

Students must compose and submit a short statement of personal interests, activities, hobbies and goals, not to exceed one page of 12 point type.

I am interested in pursuing a career in either theoretical high-energy, or plasma physics (theoretical fusion energy) research. The reasons that I am interested in high-energy physics are:

* The discipline is young, and so there remains a huge amount of uncharted terrain and room for theoretical and experimental advancement;
* The theory is currently intractable, and the experiment relies very heavily on theory, so a simpler theoretical backing is necessary to quicken experimental methods;
* Particle physics is centrally important to our understanding of the beginning of the universe;
* Unification of the forces of nature and unification of the theories of nature tend to hinge around the Standard Model.

The reasons that I am interested in fusion energy research are:

* Nuclear fusion, besides being physically interesting, seems to be one of the few promising methods for providing long-term sustainable energy to meet the needs of present / future culture.

What has my research meant to me, and why? What attracted me to it and got me hooked?

* I was attracted to research maybe by the question “what does what I’m learning have to do with the real world?”
* I got hooked on research by the question “why does what I’m learning have to do with the real world?” – What reasons do we have the mathematics would be such a faithful model of nature? But if we had just all the right physics in place, could we perfectly predict nature with mathematics, or is there something a little more sinister at play? I became interested in theoretical topology in Ivan’s lab, and QCD, plasma physics, and high-energy physics while working with Paul.
* I am excited about the close relationship between abstract / pure mathematics and theoretical physics. I hope to solve fundamental problems in physics by approaching them from the perspective of pure mathematics.

Talk about my current research, and the mathematical/modelling aspects of my previous research. (and talk about what they mean to me)

Talk about my “hobbies”, i.e. extracurricular interests in mathematics and computer science.

Talk about how my current research and extracurricular interests lead into my career goals, PhD studies, etc.

My activities and hobbies demonstrate my personal interests, and all lead into and have helped to develop my goals.

My research activities have been shaped by my academic interests and have also shaped them.

Meld the ‘personal interests’ into the ‘activities, hobbies, and goals’… Or meld the ‘activities, hobbies, and goals’ into a discussion of personal interests…

The thread that ties together my undergraduate research, my future interests, hobbies, and goals is mathematical modelling of non-intuitive or unobservable physical phenomenon.

In my current research, I am using fluid dynamics to model a plasma, called quark-gluon plasma, which is created in high-energy collisions between lead and gold nuclei at heavy-ion colliders like CERN. This is meaningful to me (WHY?) and is related to the research I hope to do in the future.

I became involved in this research through previous research activities in experimental physics and engineering. These both exposed me to mathematical modelling as a tool for solving problems, and guiding design and experimental research.

My current academic hobbies are my studies of pure mathematics and computer science outside of my degree program at the university.

Meld the ‘activities, hobbies, and goals’ into a discussion of personal interests…

Something broad about how/why I am interested in using mathematics to model complicated/non-intuitive physical scenarios.

Decide what all you want to talk about, then find a common thread and make that the intro.

I like looking at mathematical modelling in a more abstract sense and seeing how the math impacts / describes physical systems.

Talk about how your interest in mathematics and its role in nature impacts your research interests and hobbies/academics/etc.

The extra classes you’re not taking for a degree or anything kinda count as hobbies.

**What ideas, theories, classes, books, and research have shaped you?**

Ideas:

* Counting underlies all things
* There are constituents of atomic particles (protons and neutrons) which we don’t understand

Classes:

Combinatorics, Linear Algebra, Classical Mechanics II (i.e. the demonstrations), Honors 1120

Students must compose and submit a short statement of personal interests, activities, hobbies and goals, not to exceed one page of 12 point type. The narrative letter supporting the nomination form should give examples of the involvement and commitment of the student to their studies beyond the formal classroom setting as shown on the transcript. Creativity is an important attribute, and should be documented.

Famous physicist John von Neumann said “If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is.” I am interested in the mathematical modelling of non-intuitive, unexpected, or unobserved physical phenomenon.

The most important thing I realized when I was younger was that there remained uncharted territory, and things that no one understood yet. I think it was that, as a child, I could only wrap my head around finite things. Surely if the universe had a finite number of problems then someone would have solved them all already. Maybe it’s the greatest gift nature could give us humans, that our universe has an infinite number of unanswered questions. It was certainly important to me to realize that I was not born too late to contribute to the improvement of science and society. I became interested in research as a byproduct of the realization that there remained things to research. *(This is sort of tied as well to Devin’s grandpa’s research, which provided some concrete examples of what research involved… It happened sometime in high school)*

I became interested in physics in college, when the subtle and beautiful relationship between nature (physics) and mathematics began to become clear. Provide a concrete example! Seemingly every subject I study in physics and mathematics enforces this relationship, and keeps me excited about my future in physics. (Specifically, linear algebra and combinatorics have reinforced this. Why did Honors 1120 make me decide to study physics? Was it that final project?)

Many aspects of physics fascinate me, and I often think that I could be happy in almost any discipline of physics. The common thread in my research pursuits and my academic interests is that I love the way that mathematics is a faithful model of the physical world. (“If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is.” John Louis von Neumann) I enjoy mathematical modelling of physics (one of the modern synonyms for which is computer simulations, although not the only…) and have done it in several research venues.

Talk about my current research, and the mathematical/modelling aspects of my previous research. (and talk about what they mean to me)

Talk about my “hobbies”, i.e. extracurricular interests in mathematics and computer science.

Talk about how my current research and extracurricular interests lead into my career goals, PhD studies, etc.

We have a strong intuitive grasp of the physical phenomenon that we observe regularly, but mathematics guides us through non-intuitive physics and shows that logic holds there, too.

In my research I am involved in solving the problem in high energy physics of how plasmas flow in the aftermath of nuclear collisions. My involvement is in numerical (computational) methods for solving fluid dynamics equations under high-energy conditions.

The importance of my research to me (the personal part of the statement…) is…

The future of my research / my career goals are…

My other interests (academically) are…

And my other interests (outside of academics) are music, maybe philosophy

My interests and career goals are in researching theoretical physics.

In 2000, CERN announced that the first quark-gluon plasmas had been created in collisions between lead and gold nuclei [1]. This discovery is of fundamental importance to high-energy physics and is revolutionizing modern physical thought. However, progress has been slowed by the difficulty of experimental procedures and data analysis, which make it challenging to study the physical and material properties of quark-gluon plasma. I am exploring a relationship between the fluid properties of quark-gluon plasma and a similar fluid, the cold Fermi gas, which may allow us to calculate values for the material properties of quark-gluon plasma with more precision than experimental data for quark-gluon plasma itself would allow.

Quarks are bound together with gluons to form protons and neutrons, which in turn are bound in the atomic nuclei that form molecules and macroscopic matter. At temperatures of trillions of degrees however, matter is too high in energy for even neutrons and protons to be stable and they break apart into free quarks and gluons; the resulting state of matter is called quark-gluon plasma. Quark-gluon plasma provides a unique opportunity for the study of individual quarks, as opposed to the study of composites of several quarks. Quark-gluon plasma is also important to the study of the early universe because it is thought to have been the state of all matter shortly after the Big Bang.

Graduate school in physics and mathematics promises exciting new opportunities to explore my interests in high-energy matter and plasma. Relativistic hydrodynamics is an important field with promising applications in high-energy and plasma physics, but there are also many other approaches to understanding these problems. My undergraduate research has given me a unique perspective on high-energy physics, as well as a strong background in computational methods and theoretical mathematics that will be great assets as a graduate student and researcher. Most importantly, it has given me the opportunity to contribute to an important and fascinating problem in physics. I look forward to further research and education as an opportunity to explore these issues on a deeper level, and to use this depth of knowledge to help solve some of these exciting problems in high energy physics.

Following a PhD, my career goals are to do research in fundamental particle physics or fusion energy research at a university of national laboratory. The importance that research in fundamental particle physics holds for me is that it seeks to answer some of the most essential questions about the universe and its origin, and is one of the great open problems in physics, which my generation has the exciting position of entering the discipline in the infancy of experimental research into fundamental particles, when the landscape of the discipline is changing rapidly. The importance that fusion energy research holds for me is that this is a promising lead for the energy future of the world.

My greatest academic interests are in physics, mathematics, and computer science, and besides studying both mathematics and computer science outside of my degree program, I also do computer programming for research and for fun. Outside of my academic endeavors, I am a musician as well as a jazz and instrumental funk enthusiast. I am a percussionist, and specialize in mallet instruments (particularly the marimba). I also play jazz and funk drum set, and jazz saxophone. I participated heavily in the College of Music until my coursework in physics and math became too time-consuming to make time for private lessons and ensembles.