Jasmine Brewer

My greatest personal interests are on the boundary between physics and pure mathematics. I am fascinated by the subtle ways in which simple ideas like symmetry and shape reveal important and observable properties of the physical world in which we live. Symmetries in the properties of space and time provide that the laws of nature are true regardless of where you are or how you observe them. Likewise, shape and geometry describe the paths that objects in our universe follow when they move, and have played a central role in developing our modern understanding of gravity. I find mathematical modelling exciting because it is a unique opportunity to see directly how physics and mathematics interact, and to explore the fundamentally mathematical properties of nature. My research experiences and coursework have inspired my interest in the physical relevance of pure mathematics and continue to embolden my curiosity and drive for a career in theoretical physics research.

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 particles shaped like figure-8s and 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 number of holes (its abstract mathematical shape) rather than by its apparent physical shape. A particle suspended in liquid crystal deforms the material in the way that an animal running through tall grass distorts the uniform alignment of the blades. The deformation of the alignment of liquid crystal molecules is characteristically different for a particle with two holes, like a figure-8, than for a spherical particle or a knot. The further I have explored research in physics the more I have become aware of these types of fundamental relationships. I believe that they reveal that the foundations of pure mathematics, which are not obviously rooted in the physical world and are not derived from any experimental findings, are at heart deeply central to the laws of nature. These subtle relationships keep me always excited about my future in physics and mathematics.

I am currently 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 is developing new methods in fluid dynamics that can be used to simulate them on the computer. In my current work, I am exploring a relationship between quark-gluon plasma and a similar fluid, the cold Fermi gas, which may allow us to calculate values for the viscosity of quark-gluon plasma with higher precision than can yet be determined experimentally. The viscosity of quark-gluon plasma is important because it reveals information about the interactions between quarks and gluons, which are believed to be the fundamental constituents of protons, neutrons, and all macroscopic matter. In my future work with this group, I hope to contribute to improving the computability and accuracy of methods in fluid dynamics that will allow us to more effectively simulate the behavior of quark-gluon plasmas.

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.