THE QUARK

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Applying Poiseuille's Law to the Human Body

By Akash Maheshwari

Poiseuille's Law is a fascinating tool that can be used to determine the volume flow rate of a fluid in laminar flow. Poiseuille's equation takes into account the fluid's viscosity, the radius of the pipe, the length of the pipe and the pressure difference between two different points in the pipe (see equation below).

Q	Flow rate
P	Pressure
r	Radius
η	Fluid viscosity
l	Length of tubing

$$Q = \frac{\pi \mathrm{P} r^4}{8\eta l}$$

While this equation may be used to describe a variety of interesting phenomena, I believe it is most interesting to apply this law to the human body. The human body is composed of a complex network of billions of blood vessels that constantly have fluid flowing through them. By applying this profound equation, we can gain greater insight into a physiological process that is continually occurring inside each and every one of us.

One key aspect of this formula is the fact that the radius term is raised to the fourth power. To understand the immense difference a slight change in the radius can make,

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About The Quark

The Quark is a monthly newsletter produced by the Public Relations Committee of the Texas Tech chapter of the Society of Physics Students (SPS). Our goal is to help new students become more familiar with the Physics Department and provide returning students more insight on aspects of the department they might not have been aware about.

If you have any questions about The Quark or SPS, you can email our Public Relations Officer Rob Chambers at Robert.Chambers@ttu.edu .

consider the following example. An artery carries blood to an arteriole (a vessel that is smaller than an artery) that has a radius that is 1/3 the length of the radius of the artery. If we assume that the flow rate, fluid viscosity and length of tubing remains constant, we can see that this decrease in radius size will lead to an increase in pressure of 81 times for the fluid flowing through the arteriole! Even if the radius of the arteriole is 1/2 of the radius of the main artery, the pressure difference of the fluid flowing through the same length of vessel will be 16 times greater!

As we can see, even slight changes in the radius of an artery can lead to drastic changes in blood pressure. If there is excess cholesterol in the blood, there is a higher likelihood of a fatty deposit forming on the side walls of an artery, thereby effectively decreasing the radius of the artery. This condition, known as atherosclerosis, is quite dangerous because it can lead to a massive increase in blood pressure that can potentially be fatal. If a fatty deposit decreases the radius of an artery by only 30%, blood pressure can increase by a factor of about 4.2. This is very dangerous and can lead to a stroke or heart disease, two extremely fatal conditions. Therefore, Poiseuille's law is a very valuable tool that can be used to illustrate fascinating medical phenomena.

Professor Spotlight: Dr. Igor Volobouev

By Robert Chambers

What is your background? Where did you grow up, and what led to your interest in physics?

I grew up in Russia. My native town was Voronezh, a city about three hundred miles south of Moscow. I guess what got me into physics is that I loved science fiction. I especially enjoyed reading books by Robert A Heinlein. His book Friday was the first big novel I read entirely in English. My love for science fiction eventually grew into a fascination with popular science literature and culminated in my choosing physics as my undergraduate major. I received my diploma from the Moscow Institute of Physics and Technology, then traveled to the US and attended Southern Methodist University in Dallas, Texas. I chose SMU because at the time in 1992, there was a big project called the SSC: The Superconducting Super Collider, which was planned to be built near Waxahachie, Texas, and SMU was one of the closest places to that. Unfortunately, that project was killed in 1993.

After you got your PhD, did you go directly into teaching or did you spend time solely as a researcher first?

After I got my PhD, I was hired at the Lawrence Berkeley laboratory as a postdoc, where I continued working on high-energy physics. At that time, I was working on the CDF experiment. That took some time, and we did some quite interesting science. One of the main things we did was measure various properties of the top quark. In fact, I was one of the main authors of a paper that had at the time the world's best measurement of the top quark's mass. After working at the Lawrence Berkeley lab, I spent about a year at the Stanford Linear Acceleration Center as a research software developer for what is now known as the Fermi Mission, which is a space telescope used to study gamma ray bursts. After that I came to Texas Tech in 2006, when I was offered a job in the Department of Physics. I had kind of gotten tired with my software development job, because in my life software development was more of a hobby, and at some point I made the mistake of making it my profession. I didn't like it.

What research are you presently working on?

Right now, I am working at the Large Hadron Collider on the Compact Muon Solenoid experiment. The stuff I'm particularly interested in are the so-called "jets" of high-energy particles. "Jets" are a feature of high-energy physical processes, where whenever you release a particle with strong charge, like a gluon or quark, it doesn't fly alone. It develops a spray of particles that propagate together, and these sprays produce interesting patterns in the detector. There is still science to be done to identify these jets, do some pattern recognition, perform various measurements, so on and so forth.

What do you enjoy doing when not researching or teaching?

As I said before, I enjoy doing software development, though that does often connect to my research. For example, I develop software for the LHC, as well as work on statistical software. I really like statistics as a field, especially certain topics related to physics, like the solution to the so-called "statistical inverse problems", the so-called "look elsewhere effect", and other stuff like that. Basically, the stuff that allows us to make certain conclusions about our data in a predictable and repeatable way.

Do you have any advice for incoming or current physics students?

I would say to stay hungry, stay foolish, stay curious, and have fun. I hope you know what that means. If you don't, listen to Steve Jobs' commencement speech from 2005. Also, don't neglect other subjects besides physics, like I did with my English studies.

Student Spotlight: Victor Ethan Bradley

By Samuel Cano

Taking a closer look at the little things is something Victory Ethan Bradley credits for introducing him to the world of physics. For Victor, there was one experience he recalls that really put him on track to be where he is today. When he was six or seven years old, he visited a thrift store with his uncle where they spotted two broken electrical wheelchairs. The two ended up spending an entire summer learning how to

fix and modify. There were no equations or measurements, each time they took apart and rebuilt the motors, they learned something. Pretty soon he was asking how and why other things around him worked. As he entered high school, he was especially determined to excel in physics and math classes. At the same time, he was a dedicated musician and was still interested in studying music in college. Unfortunately, during his sophomore year of high school, he was diagnosed with carpal tunnel. He decided the best option would be to turn his love of science and math into a career.

Today, Victor is attending studying both Astrophysics and Math and has even worked in a minor in Arabic. In fact, as a rising sophomore he took part in an immersive experience in Jordan where he built on his foundation in Arabic. He has also done his best to stay active in research; with the High Energy Physics Research Group he has been a part of several projects centered around Muon Tomography under Dr. Kunori and Dr. Akchurin at the Advanced Particle Detector Laboratory. Recently he has been learning more about condensed matter theory with Dr. Wade DeGottardi, after taking his Electricity and Magnetism course last semester. Victor is currently doing background research on one dimensional interactions of light with Luttinger systems to prepare for future projects. His other hobbies include playing guitar, skateboarding, and still to this day, motors. He loves to watch Formula One and has even spent time on the racetrack himself.

Victor plans on pursuing graduate school in Physics and eventually live the dream as a professional researcher in condensed matter theory. A year away from graduating, Victor is focused on his classes and research but is looking forward to what's next.

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Acknowledgements

The Public Relations Committee of the Society of Physics Students would like to thank the following people for contributing to the success of this month's edition of the *Quark*:

- Dr. Igor Volobouev
- Victor Ethan Bradley

Writers

- Akash Maheshwari
- Samuel Cano
- Robert Chambers

Editors

- Robert Chambers (Editor in Chief)
- Akash Maheshwari

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