

A Day in the Life of a Physics Major

I wake up at 6:00 a.m. to the repetitive roar of my alarm clock. I fumble underneath the soft cotton cushion and finally locate my cell phone; the source of the draconian noise. I pick it up and press the button – “Dismiss”. *Millions of transistors behind the shell of the plastic phone and LCD screen command the digital to analog signals to cease, while simultaneously changing the display on the screen back to the familiar picture of my background. Millions of transistors “chiseled” intricately into a chip, following Boolean logic, command the electrons’ flow.*

I snap out of it. I have to make it to Jiu-Jitsu by 7:00 a.m. I stumble out of bed and make my way to the kitchen and pour myself a glass of billions of trillions of water molecules, muddled with impurities (fluoride to name one) that the Brita filter ‘s technology has failed to catch. *There are more water molecules in this cup than cups of water in the world.* I gulp down the cold water which wakes me up. I head over to one of the cabinets and swing it open with ease; *torque*. I fill a small bowl full of oatmeal to the brim. I watch as gravity takes over the individual motions of each oat. Potential is converted to kinetic energy by the command of my hand. I fill the water in the bowl and pop it in the microwave. I press in the time for one minute and thirty seconds. There seem to be transistors everywhere.

2.45 gigahertz is the standard frequency of the waves this convenient modern day commodity produces. The speed of light is equal to frequency times the wavelength of any electromagnetic radiation, which makes the waves bouncing inside roughly 12 cm. Huh. A magnetron consisting of a cathode in the middle, an anode ring around it, and resonant cavities carved to precision within the anode all reside in a neat compartment near the top right of the microwave. A voltage, applied between the cathode and anode, originates from the power source of the wall. The electrons ejected by the cathode are caught in a swirl before reaching the anode, due to a magnetic field strategically placed, where the resonant cavities are carved along the

perimeter of the ring. The Lorentz Force is to blame for the capture of the swirling electrons. The electrons exhibit the properties of a wave and a particle where the momentum and position cannot be simultaneously determined. The whizzing electrons induce microwave frequency electromagnetic waves within the cavities (thanks Faraday); much like a resonant sound is produced when blowing into a didgeridoo. The microwaves are guided by the waveguide, designed with particular dimensions only allowing certain minimum wavelengths through. You only have to solve a few partial differential equations with boundary conditions to figure out what this cutoff wavelength is. Trivial (in the sense all physicists use the word). Finally the waves reach my food where they act like standing waves on a string. The cold spots on my food originating from the nodes of the standing wave are conquered by means of a rotating table. The microwaves hardly penetrate the metals within the microwaves, interacting with the free electrons of the metals, reemitting the waves hardly undisturbed (reflected if you will).

BEEP...BEEP... BEEP. My train of thought screeches to a halt.

I take out the steaming hot oatmeal and cut a fresh peeled banana on top. Let's be honest, I sprinkle a little sugar on top too. I chow it down. I rely on the fact that the oatmeal, sugar, and banana will be relatively easily digested, providing me with adequate energy to get through my workout. I brush my teeth, and then I gear up. I put my knee pads on, ankle brace, and shoulder brace. I put my gi pants on and shove my water bottle and blue belt and kimono in my book bag. I put on my jacket, then another, my beanie, and my gloves. I turn on my iPod to a familiar song by Modest Mouse. *I can't seem to get away from these transistors.* Out the back door I go.

I step on my bike and it's unusually cold with snow still on the ground from the night before. The sky is dark, but the sun's red face is peaking over the horizon from the east at me; *Rayleigh scattering. The sun is a tangent to the horizon, passing through most of the atmosphere*

during this time of day through the line of sight to my eyes. The electric twisters of the sun vibrate the air's molecules, causing them to scatter most strongly wavelengths of blue. The path directly hit by the sun gets it the worst, and all that is left is the color red. The tiny electric dipoles of the air molecules reradiate the energy of the sunlight with a power proportional to the fourth power of frequency. No wonder the short wavelengths of blue are emitted so readily. Other than the pinhole of red created by the electromagnetic bullets of the sun, the blue light dominates most of the sky.

I continue to ride my bike. The faster I go, the colder I feel, but I go faster anyways. The air molecules rushing past my face, mostly nitrogen, send a shiver down my spine. *I'm losing heat through convection at a faster rate.* I ignore my racing thoughts and listen to the music. I get to Jiu-Jitsu and lock my bike on a post outside.

We warm-up, and do a little bit of rolling (how we practice the art of Jiu-Jitsu; grappling on mats, slightly similar to wrestling but more elegant and refined). Focal points are taken advantage of and I easily lift opponents who are fifty pounds greater than me with simple mechanics. I lock in an arm-bar, overextending the joint at the elbow, forcing my opponent to tap. We drill, we train, and at eight o'clock I leave.

The sun has faded to a pale yellow due to it no longer being at a tangent to the horizon. It is less fierce now than before. I get home and take a shower and make another breakfast. *Chemical reactions are carefully manipulated with the use of heat, denaturing and transforming the proteins of the clear egg to a pearly white.* Two eggs with a slice of cheese melted on top and a couple slices of bacon will be sufficient to remedy my hunger. I use the bacon grease to cook the eggs. *Mmmmm.* The sheer expectation of the taste causes my mouth to salivate.

I bake chicken in the oven, quinoa in the rice cooker, and bread in the toaster to prepare my meals for the upcoming day on campus. I pack my bag and leave out the backdoor. Again I get onto my bike in the cold Wednesday morning. I get an Americano at Bollos. Caffeine, the drug of productivity and health that allows me to become a proficient workhouse for academics, is readily available to me for a hefty price of \$2.07.

I pour two packets of raw sugar into my steaming hot drink. *The individual sugar granules are each made of inconceivable amounts of glucose molecules, held together by weak intermolecular forces. Three events must occur for the sugar to dissolve in the coffee. The glucose molecules separate from each other, then the water molecules, and then the two mix. These events essentially occur simultaneously. When the intermolecular bonds of the sugar and water separate, energy is absorbed in the process. When they mix back together, energy is released. Overall my coffee cools down. It spontaneously occurs because the entropy of the system is greater than the individual coffee and sugar, so the sugar dissolves into my steaming hot Americano. Ultimately the hydrogen bonds of the water form a snug bond with the hydroxyl groups of the sugar molecules.* At last I sip my coffee and appreciate the chaos occurring at a molecular level.

I step outside and see a blade of grass sticking out of the snow. I look down into my coffee and realize the grass cell wall is largely composed of cellulose (among other things such as proteins, hemicelluloses, and other complexes). *Isn't cellulose also made up of glucose molecules? The intermolecular forces though are much stronger, and while table sugar has alpha linkages that render it soluble, the cellulose has beta linkages which make it impervious to the universal solvent (water).* Thankfully the snow doesn't dissolve the grass or the trees around me.

I leave my bike at Bollos and carefully sip my steaming hot Americano as I walk towards campus. I find a comfortable spot on the first floor of the library and pull my lap top out of my book bag. *There are more transistors in my lap top than the total number of humans to have existed on earth.*

I open the screen and plug in my charger. The screen light flickers on and off as I try to adjust the angle of my screen. Finally the flickering stops as I achieve the perfect angle. I check my email and my scholar website. I realize I need to catch up on some assignments. I drink the coffee and crank out the assignments. At 1:25 I head to Physics 4717, otherwise known as Biophysics. I sit in class as I watch the mathematics of the position of random thermal motions of water molecules and the dynamics of a sphere at low Reynolds's numbers to derive the diffusion constant (for a sphere). An integral over a delta function here and there, some averaging over the thermal noise, and voila. The class provokes my curiosity and provides me with another snippet of information that allows me to analyze the world in a mathematical and physical context; it reminds me why I had become a Physics major in the first place. I leave class promptly at 2:15 and ride my bike back home.

I have work at 5:00, so I take the time to give myself some well-deserved rest. I sit in my room and think about the statistical mechanics that provides me with the ubiquitous uniform distribution of molecules that make up air. *For the same reason that my sugar spontaneously dissolved into my Americano, the air in the room doesn't bunch up in one corner.* I'm grateful for this, for it would create a sudden vacuum where I lay, which would be detrimental to my existence. *While this is possible, it is extremely unlikely and would take much longer than the age of the universe for it to occur. Consider the many elements of air to be non-interacting molecules. All the air molecules of the closed system are equally likely to be in any of the states*

accessible to it, with a probability of one over the number of states (a fundamental assumption of statistical mechanics). I consider my room, one closed system, to be brought into contact with another closed system, the room in the apartment next to mine, creating a larger closed system. The wall acts as the Thermal conductor and allows for the exchange of energy between the air molecules of the closed systems. I use my knowledge of thermal physics to save money on the electric bill and don't turn on my heat. As long as the neighbors in the apartment next to mine aren't quite as thrifty as I am, the flow of energy will be from high to low. The maximum number of states accessible to the system occurs when the temperature of the two systems are equal. Thus my room heats up and the apartment next to mine cools down, causing the entropy of the closed system to increase overall. I smile to myself as I relax in my bed, and fall asleep for an hour.

I wake up and get ready for work at The Blacksburg Taphouse. Soon I'll be washing dishes and running food from the basement of the kitchen to the heat table in the room above. Sometimes I dread it and sometimes I don't. There is something nice about washing dishes hours on end. You can let the stress and worries of everyday life melt away; the only goal is to spray the grease stain off the plates or the onions out of the pan. I get to work and put the rubber apron on and reside in the dish pit for nearly the entirety of my shift. I listen to the noises of the kitchen. Heard! Sharp! Behind! Swingin'! Corner! *The sound waves from the chefs' shouts travel in all directions from their mouths. I think of the compressions and rarefactions of the longitudinal waves in air. At the points of the greatest compression and rarefaction of the wave, the displacement of the air molecules is zero. The molecules are pulled apart and compressed while traveling in a sphere from the source. The power output of a shout is on the order of 10^{-2} Watts, and the intensity decreases as a function of one over the square of the radius of the sphere from the source (Power equals intensity times $4\pi r^2$). This relationship doesn't necessarily work*

in the confined spaces of the kitchen where the sound waves are reflected from various walls and the ceiling. In this case the drop off would fall off as less than one over the square of the radius, due to the fact that the energy of the shouts is essentially trapped within the boundaries of the room.

The pressure waves of the shouts travel through my ear canal to my eardrum. The other side of the ear canal is kept at the atmospheric pressure of the room by means of the Eustachian tube. The differences in the pressure set the eardrum into vibration. The vibrations of the eardrum are picked up by the three smallest bones in the human body, the hammer, anvil, and stirrup. These three bones are connected together and are set into an oscillation, with the stirrup finally transmitting these oscillations to the inner ear filled with fluid. Since the surface area of the stirrup is smaller than that of the eardrum, the amplitude of the pressure wave is magnified by an order of ten times. The waves in the fluid reach the Cochlea of the inner ear, covered by thousands of tiny hair cells that each react to a corresponding resonant frequency. The hair cells finally release an electric impulse to the brain where it is received and interpreted as sound. I continue to spray the caked on mash potatoes at the bottom of the pot as the thoughts whizz through my head.

The end of my shift finally is nearing towards 12 O'clock. I am tired, and I am ready to go home. Luckily nobody decides to stay until the very end of the restaurant closing. I get off right at 12 and ride my bike back home. The sun is absent from the sky now and the stars act as tiny lights on a black blanket. I peer up beyond the treetops. I fixate my eyes to the brightest stars, some on the order of ten, a hundred, or a thousand light years away. *Is this star dead? I peer into history and travel in time simply by glancing upward. Although it looks as though the light has travelled a direct path to my eyes, general relativity tells me otherwise. Space isn't flat,*

but curved and distorted by the masses of the planets. Like a trampoline with a bowling ball in the middle of it, space is warped by the various objects that it holds. The light that has reached my eyes didn't travel in a straight line; it followed the geodesic of this curved topography where it finally reached my cornea and was transformed into a visual by the electrical signals to my brain. Just like the intensity of a sound wave falls off as one over the square of the radius from its source, so does the luminosity of the stars I gaze upon.

I continue to ride my bike along the hilly Blacksburg streets, imagining myself as a beam of light faithfully taking the geodesic home. The clear night sky focuses my thoughts to the secondary cosmic rays that have been showering down on me all day long. *Highly energetic primary cosmic rays interact with air molecules high in the atmosphere creating a plethora of secondary rays. Some charged pions are produced as a result, and among the particles' decay products are the infamous charged muons. The pions decay is mediated by either a W^+ or W^- boson, which act as carriers of the weak force. The mass of these force carrying elementary particles is the reason for the extremely short range this force acts over, analogous to the massless photon (also a boson) mediating the infinitely ranged electromagnetic force. The short lived (on the order of micro seconds) charged muons wouldn't make it to the surface of the earth if it wasn't for the high speeds they travelled. The laws of special relativity tell us that as these high speeds time dilation and length contraction can't be ignored. In the muons frame, time slows down or the length it travels contracts, whichever way you want to look at it. This allows the muon to survive the trip sometimes even beyond the surface of the earth.*

I finally make it home and unlock my door to find my roommate is already fast asleep. I eat a little snack, brush and floss my teeth, set my alarm for the next day and rest my head on my pillow once again. *My displacement is zero since six O'clock this morning.* My thoughts still race

about. I think of tomorrow, the next day, and even five years ahead. Soon I will be teaching high school kids the knowledge and wealth of information I have acquired as a physics major. Not only will I empower them with this knowledge, but I'll give them the tools to become lifelong learners, to inquire about the world around them, and to "see" the scientific and mathematical beauty that lays invisible to our sight. Maybe tomorrow I'll ponder the evolution of our existence from the Big Bang to the first organisms on the planet. Are we possibly martians that landed on earth by means of an asteroid harboring life that landed on this rocky planet? Did we evolve from native bacteria? If bosons don't obey the Pauli Exclusion Principle can infinite amounts exist in one state? What's the difference from friction and adhesion at a molecular level? Are quantum fluctuations responsible for the beginning glitches in the vacuum of space? How many universes are there really? I have to go to sleep now. I lay my mind to rest. My dreams propel me into the next day for the cycle of thoughts to begin once again.