27 August 2025

Dear Tyler:

I hope the beginning of the semester is treating you well. My name is Lucas Geraldi-Smith, and I am a 4th year biomedical engineering student here at the University of Florida. I want to bring to your attention something that is very important to me, that being medical imaging. Imaging entails many different mediums, like writing. CT scans, x-rays, mammography, and ultrasound are just some of the ways physicians can get a peek at what is going on inside the human body. Each of these mediums leverages different aspects of physics to develop an image and each comes with a list of pros and cons that are vital for physicians and engineers to understand.

Dosimetry is one of the main reasons the physics behind medical imaging is so important. Do you ever wonder why you have to wear the heavy bib at the dentist's office, and the tech walks out of the room? It because of dosimetry. X- electrons come out of a heated tungsten wire, bouncing off the anode and producing x-rays or photons. These photons have varying amounts of energy and depending on the energy, penetrate the skin deeper as well as coming with more severe radioactive consequences. Knowing the math on exactly how much exposure someone is receiving through a simple dental x-ray is vital to ensuring the safety of the patient. The vest, however, is made of lead. Lead is a very heavy atom in the grand scheme of things, and this heaviness translates to an effective shield. This shield will block out a lot of the low energy photons that don't have enough energy to pass fully through the body and thus get absorbed, damaging it in the process. The lead shield leaves only the photons strong enough to pass through, allowing the machine to create an image using the bare minimum amount of exposure. Personally, I'm glad this technology is so well understood. I recently had to undergo a dental procedure and the number of x-rays taken of me were astronomical. It is comforting to know the math behind them is understood and I was not exposed to too much radiation.

On top of X-rays, computed tomography (CT) scans are a sort of 3-dimensional version of an x-ray. The machine takes images at different angles and compiles them together for full 3D image of the organ or system. This allows physicians to catch certain abnormalities that might otherwise not be visible in traditional x-rays. However, as you might imagine, taking multiple x-rays also increases the dose of radiation the patient receives. Luckily, there is a standard mathematical way to ensure the dose received by any type of radiation imaging is within acceptable ranges. The math considers the time of exposure and multiplies it with the number of x-rays the machine produces, or kerma. Agencies like the FDA set limits on how high this ratio can be before being dangerous.

I appreciate you taking the time to read my letter on the medical imaging and the math that keeps us safe. I would love to hear your thoughts about the subject and hope to hear from you soon! Feel free to contact me at my email lgeraldismith@ufl.edu.

Sincerely,

Lucas Geraldi-Smith