

# Laser Physics 101

by Randy Brenner

**H**ave you ever walked out onto your driveway on a sunny summer day on your bare feet? How about a sandy beach on an afternoon in August? Last but not least, have those leather seats in a car come into contact with the backside of your thighs? A good, mild burn is the sensation I'm trying to evoke here.

What does all of this have to do with laser physics? Well, sit back, relax for a few minutes, and let your mind get used to the heated topic of lasers....

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When most people think about lasers, many different thoughts come to mind... from Star Wars light sabers and missile defense systems, to hair removal methods and those annoying pointers used during lectures. The funny thing about this is that all of these are really the same thing. Let us keep our thoughts focused on how lasers are applicable in the aesthetic field.

LASER is an acronym – It stands for Light Amplification by the Stimulated Emission of Radiation. This really means that we take some light, make it really strong, and focus it. In our world, energy is a constant. All of the energy that is on this planet is the same amount that was here yesterday, is here today, and will be here tomorrow. It may be in a different form than it has been before, but it will always somehow be here. Energy is really never consumed; it is merely converted from one form to another. Light is a form of radiation and therefore a form of energy. We can measure that radiation in a wavelength and that wavelength can be measured in nanometers (nm). A nanometer is one billionth of a meter and a meter is approximately 39 inches long.

Since light is expressed in wavelengths, we can measure it. Different wavelengths have different “colors” and also different characteristics. The human visible spectrum is about 400nm (violet colors) to 700nm (red colors). Remember “Roy G Biv” from your high school days (red, orange, yellow, green, blue, indigo and violet)? These represent the colors of our visible spectrum, or what we can see if we use a prism to refract (or separate) normal white light. White light is simply all of those wavelengths and colors mixed all together at the same time, so it appears as a white light. A laser is the most consistent source of monochromatic (one color or single wavelength) light that we can achieve.



Lasers are also collimated and coherent. This means that this single wavelength of light can be focused and made to travel in a single direction with little or no divergence (spreading). If we take light of a single wavelength and concentrate it into a small area and focus it, we have a laser.

Johann Stark and Albert Einstein did research on all of this and came up with what we now refer to as the Stark/Einstein Law. This law of physics tells us that the energy from a photon (a unit of light energy) is not only measurable, but is repeatable. If we know how specific wavelengths will react, and we know that reaction can be repeated with consistent results, we can use that form of photonic energy for specific needs.

Light energy can either be reflected or absorbed; does that sound familiar for sunscreens? Dark colors (or pigments) absorb light energy better than light colors. Think of an asphalt driveway versus a concrete sidewalk. You would pick the sidewalk to stroll on without sandals over the driveway anytime. It is not as hot. That is because the concrete sidewalk is lighter in color and reflects light but does not absorb as much light energy as the dark asphalt driveway.

In the world of laser hair removal or Intense Pulsed Light (IPL) photo-facials, the same applies. Our darker hair clients can typically have better results for laser hair removal than their blond counterparts. IPL photo therapies work by absorption of the light energy into the melanin in the skin. The difference between IPL and laser is that where laser is only one wavelength or color of light, IPL is multiple wavelengths or colors. Basically, an IPL is a really intense bulb, which produces a variety of wavelengths all at the same time. Typically, these wavelengths run from around 400nm (short) to about 1200nm (long). All of these light therapies work by



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the same principle, the absorption and conversion of light energy into heat energy. Something that converts light energy into heat energy is called a chromophore. The chromophore would be melanin in the case of skin or hair as the target, or if we want to target a vascular concern, the chromophore would be hemoglobin (de- or oxygenated blood). For some collagen stimulating procedures, water is the chromophore. Again, a chromophore is considered anything that converts light energy into heat. We are simply taking light energy and converting it to heat energy to affect a change. It is the pigment in our hair that is the chromophore for laser hair removal and it is the blood in a vessel if we are closing a vein or small capillary. For collagen stimulation, we look for water as the chromophore and heat that up. The effective heating of the water in the epidermis stimulates the fibroblast in the reticular dermis, increasing the production of collagen.

For hair removal, light therapies simply target the melanin in the hair bulb as the chromophore, the melanin absorbs the light energy from the laser or IPL, and heats up to the point of destruction. The trick with all of these therapies is first to choose the best method for your client's needs, and then to be able to safely and effectively administer those treatments.

With many more factors to consider before being able to fully understand all of the intricacies of laser physics and light therapies, I strongly urge all interested parties to take a registered and certified course in the field of your choosing. To give you some idea of the other factors you will need to fully understand, think about skin typing, heredity, and the role that pigment in the skin plays as a competing chromophore (this is how people get burned). Other things to consider include spot size, pulse duration, joules, frequency, photothermolysis, target size, depth of penetration, epidermal cooling, and short and long wavelengths. The list goes on and on and on.



*Randy Brenner is a certified laser technician and educator. He has a biology and chemistry background, as well as over 15 years experience as a business owner. Brenner owns and operates Dimensions in Aesthetic Advancement, the Northeast distributorship for Circadia skin care products and advanced aesthetic equipment. He is also a contributing author for industry trade magazines and expert guest speaker.*

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