Derivation of the Wave-Particle Duality Principle of Quantum Mechanics a la Count de Broglie

Max Planck derived the following equation in his research of blackbody radiation in 1900:

$$E = h\nu$$

Albert Einstein discovered the energy to matter conversion formula in his “Miracle Year” of 1905:

$$E = mc^2$$

Now equate the previous energy equations:

$$h\nu = mc^2$$

There exists a well-known equation relating the wavelength and frequency of light:

$$c = \lambda\nu$$

Solving the previous equation for the frequency of light we have:

$$\nu = \frac{c}{\lambda}$$

Substitution of the previous relationship into the third equation above:

$$h\frac{c}{\lambda} = mc^2$$

$$h = \lambda mc$$

Using another equation of Einstein’s from the Theory of Special Relativity:

$$p = mc$$

Finally, de Broglie’s famous equation relating particles and waves:

$$\lambda = \frac{h}{mc} = \frac{h}{p} \approx \frac{h}{mv}$$

Exercise: What is the wavelength of 3695-pound 2023 Hyundai Tucson SUV going 100 miles per hour?

Solution: 3695 pounds = 1676.0238 kilograms, 100 miles per hour = 44.704 meters per second, h = 6.626069934 x 10^{-34} kg·m^2/s, mv = 1,676.0238 kg x 44.704 m/s = 74,924.9679552 kg m/s

$$\lambda = \frac{6.626069934 \times 10^{-34}\ \mathrm{kg \cdot m^2/s}}{74{,}924.9679552\ \mathrm{kg\ m/s}} = 8.843607 \times 10^{-39} m = 2.901411 \times 10^{-38} feet$$