Fundamentals of Photographic Optics

Excerpt

Introduction

In this monograph we will explore some of the fundamental characteristics of the lens used in photography. It matters not whether or not the lens is on an analog (film) or a digital camera. The following discussion applies equally to all manner of photographic lenses. The concepts are universal.

To sharpen your comprehension of the concepts in this paper, you'll be tasked to solve relevant problems. The answers to these problems are on page 19.

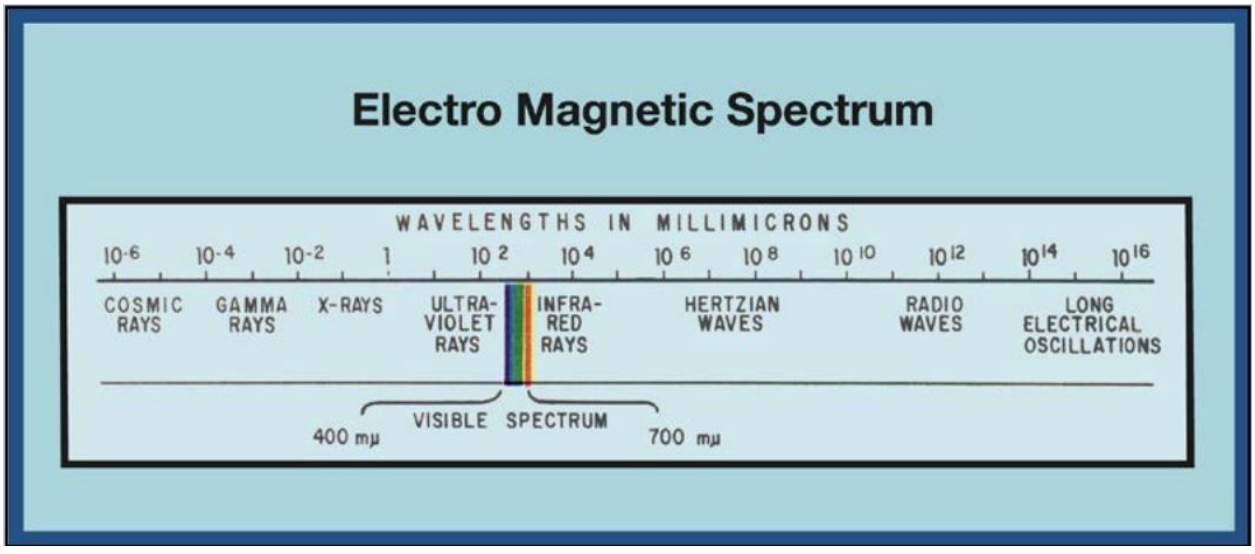
Discussion

Light is a form of energy. It has two simultaneous natures.
1. It is an expression of energy as a continuous wave.
2. It is a small packet of individual particles of energy, dubbed photons.

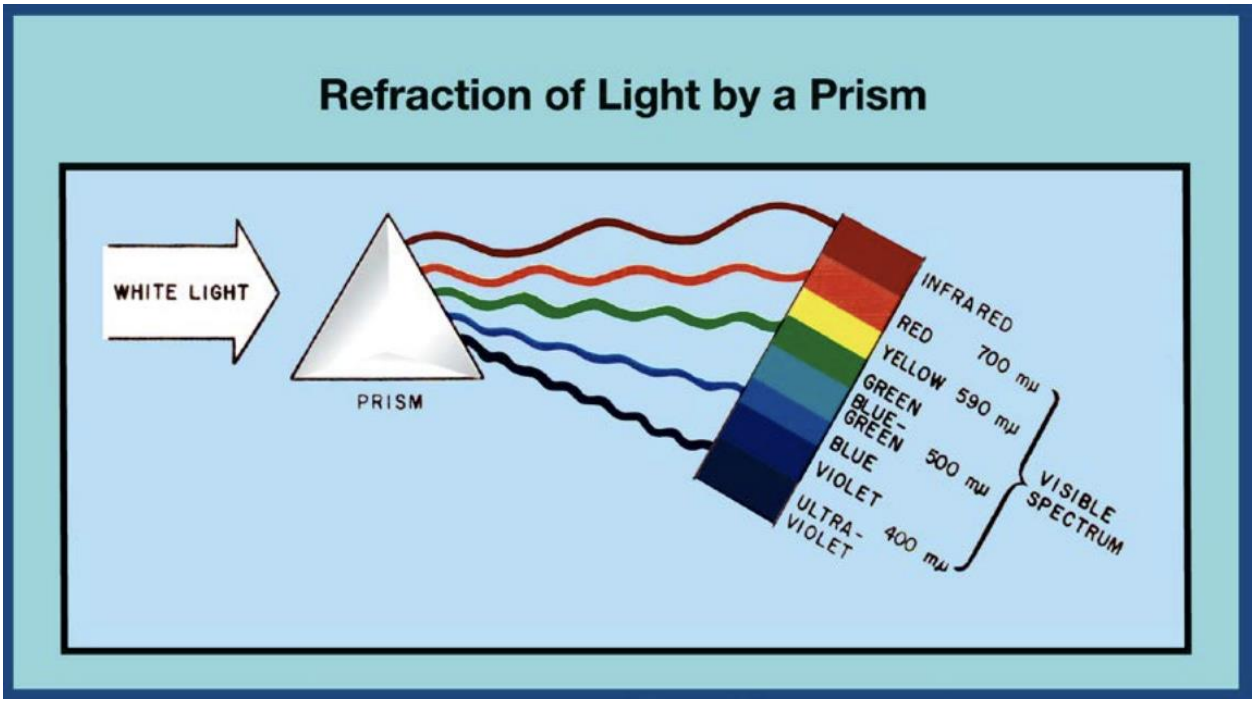
In this monograph I focus on the wave theory of light. I ignore its second and simultaneous nature—the particle theory of light. Should the reader want more information on this dual nature of light, I suggest that you read *In Search of Schrödinger's Cat*, Bantam Books, New York, 1984. This book is quantum physics for the lay person. It's an outstanding read.

First, let's set the perspective for this discussion of light. Visible light is a part of the electromagnetic spectrum. The electromagnetic spectrum encompasses a wide scale of energy forms that range from the extremely short wave length X-rays and gamma rays to very long radio waves and beyond.

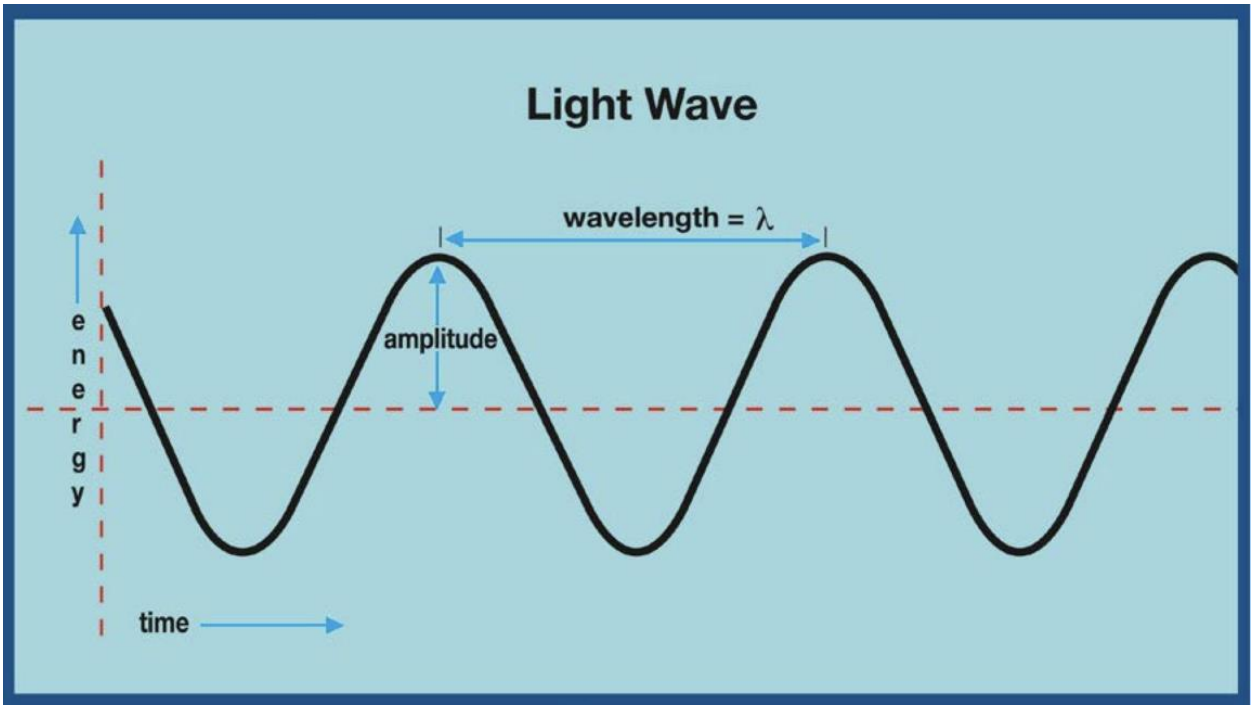
In the graphic below, we see that visible light-waves are located in an exceptionally narrow section on the vast electromagnetic spectrum. The electromagnetic spectrum is plotted on a base-10 logarithmic scale.



The **visual spectrum** ranges from the short wavelength at ultraviolet at 400 mu to the longer wave length at dark red at 700 mu. (mu = Millimicron; or one-millionth of a meter). A higher frequency wave has more energy than a lower frequency wave.



Wave is a vibrating disturbance by which energy is transmitted as a wave through a medium (glass, air, water, etc.). Let's explore a representation of a typical light wave in Graphic # 4. It is a sine wave (pronounced "sign").



What is significant about the light wave to us as photographers are:

- **Wavelength** (λ) is the distance between two consecutive peaks (up or down). Wavelength determines the color of light. See "Degrees Kelvin" in the Definitions Section.
- **Amplitude** is the measure of height of the peak from the norm (dashed red line). Amplitude determines the intensity of the light.
- **Frequency** is the measure of the number of waves that pass by a given point in one second. Frequency is measured in Hertz (Hz). That is, Hz = waves/second.