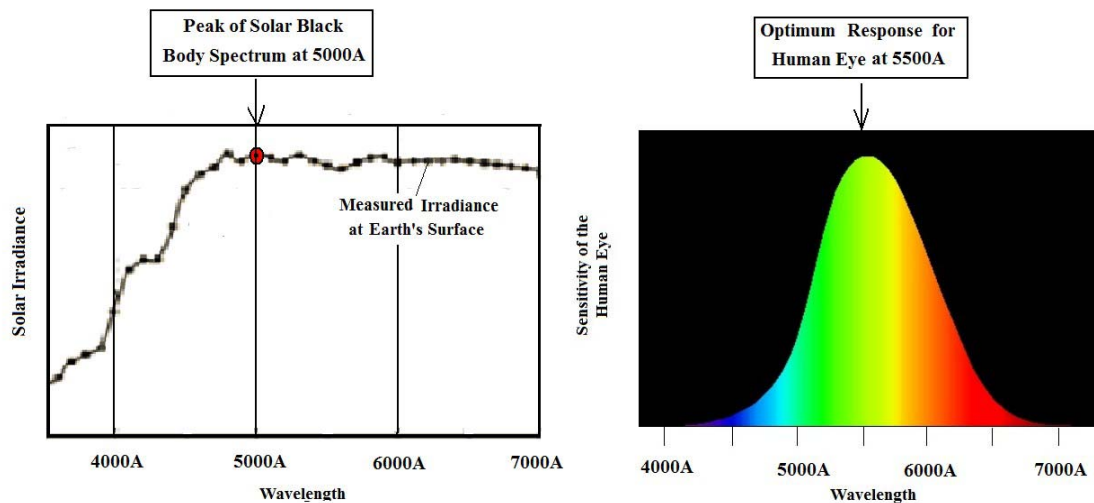


ON HUMAN VISION AND HEARING

Of the five human senses of vision, hearing, taste, smell, and touch it is the first two which are perhaps the most important for survival. Our homo-sapiens ancestors and those species preceding clearly required acute seeing and hearing capabilities to function in the environment in which they were existed. The question that arises is how were these senses developed in the process of evolution. **Clearly human eyes must have become tuned through evolution to the wavelength range for which the sun has a maximum in its electromagnetic spectrum.** Since the sun acts essentially as a black body radiating at a temperature $T=5800\text{K}$, one has a maximum in its radiation spectrum at a wavelength of $5000\text{\AA}=0.5$ microns. At the surface of the earth this black body irradiance is partially filtered to give a rather flat optimized range between 4500\AA and 7000\AA and a rapid drop off on either side of this range. Human eyes must have adjusted themselves to this range as I show you in the following a comparison of sun's irradiance versus the sensitivity of the human eye -

THE HUMAN EYE AND SOLAR IRRADIANCE

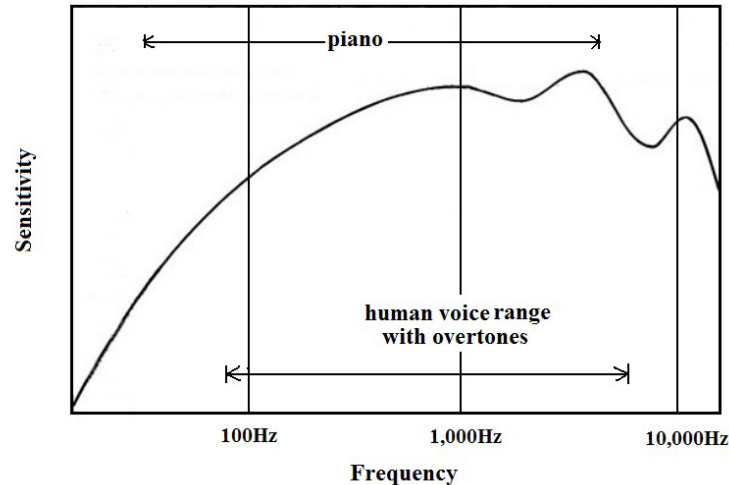


Notice optimum response of the human eye occurs for yellow-green light at 5500\AA . This number is just slightly above the value of 5000\AA for the solar irradiance maximum. It is interesting to also note that chlorophyll in plants absorbs sunlight best at the same wavelength range as the human eye. The fact that most plants are green is not coincidence. In view of the above it also stands to reason that, if life exists on other planets in the universe, that their vision sensors will be tuned to a wavelength which is inversely proportional to the surface temperature of their sun. This observation follows directly from the Planck radiation law for black bodies.

Next we look at the sense of hearing. One has the basic formula that sound of wavelength λ equals the speed of sound $c=1080\text{ft/sec}$ divided by its frequency f measured in Herz. Sound is generated by vibrating surfaces or by vortex shedding, or a combination of the

two as is thought to occur for the human vocal system. One knows from measurements that the human vocal cord system is capable of producing sound in the frequency range of 90Hz to 7000Hz when overtones are included. If one looks at the measured hearing sensitivity of the human ear one finds the following pattern indicating humans hear in the range of 20Hz to 20,000Hz with the optimum response occurring precisely for the range of frequencies produced by our vocal system.

SENSITIVITY OF THE HUMAN EAR



This is no coincidence but rather indicates that through evolution human hearing has evolved to best detect sounds created by other human beings. Not only does the ear pick up sounds created by babies crying and others talking, singing and shouting but also it easily detects sounds such as rain, thunder, and moving predators which produce sounds in the same frequency range. Human ears do not respond to infra-sounds($f < 20\text{Hz}$) or ultrasounds($f > 20,000\text{Hz}$.) although other animals such as elephants and bats have their hearing range overlap into one or the other of these regions. Humans in their evolution have had no need to detect acoustic signals outside of the $20\text{Hz} < f < 20,000\text{Hz}$ range.