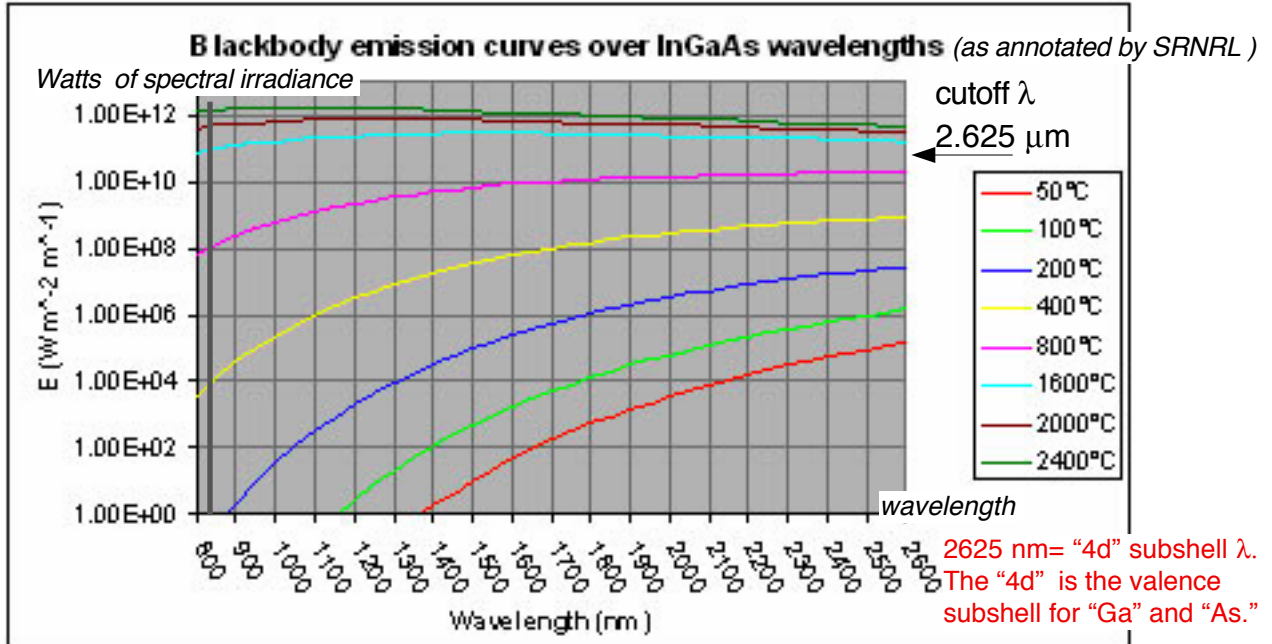


# The Energy Gains of Short Wavelength infrared Semiconductors shown to be supplied by Nuclear Magnetic-Current Power Gains

The following is a set of energy curves for thermal radiation temperatures as absorbed by the InGaAs semiconductor.

## High Temperature SWIR Thermography<sup>1</sup>

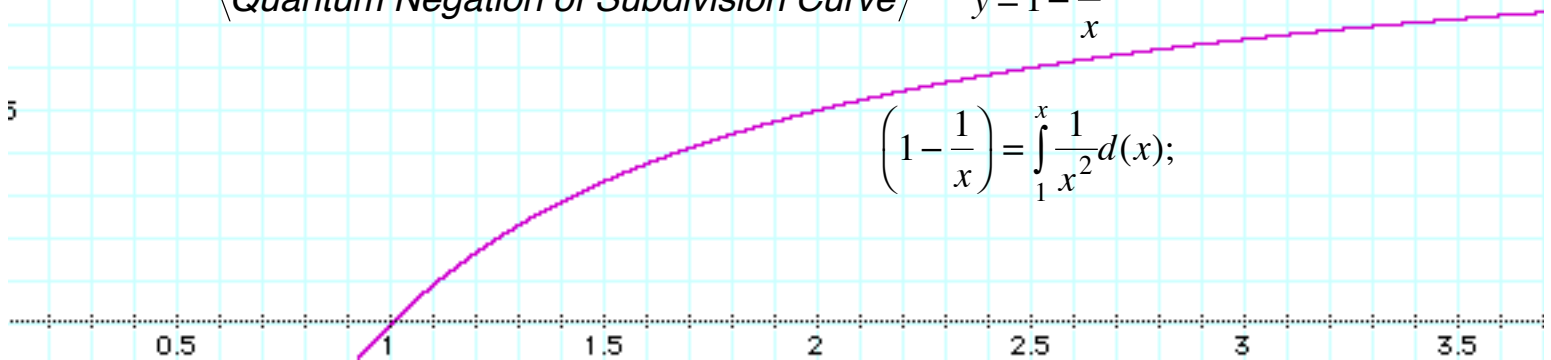
Indium Gallium Arsenide (InGaAs) short wave infrared (SWIR) cameras are useful tools for high temperature thermography applications, where object temperatures are above 100 degrees Celsius.



These empirically- measured curves model the quantum negation of subdivision

$$y_{limit} \equiv 1$$

*<Quantum Negation of Subdivision Curve>*  $y = 1 - \frac{1}{x}$



$$x = \frac{\text{wavelength}}{(\text{minimum wavelength for temperature}) = (\lambda @ "y = 1.00E + 00")};$$

$$x_{max} = \frac{(\text{InGaAs cut - off wavelength}) = 2625 \text{ nm}}{(\text{minimum wavelength for temperature})}$$

$$\{\text{Total Power Gain for Temperature}\} = \left(1 - \frac{1}{x_{max}}\right) y_{limit} = \int_1^{x_{max}} \frac{y_{lim}}{x^2} d(x); \quad y_{lim} = \{\text{maximum power}\}$$

<sup>1</sup> "Application: High Temperature SWIR Thermography," UTC Aerospace Systems: Sensors Unlimited.

## Quantum-Dimensional Mathematics as applied to the InGaAs Blackbody Emission Curves

(minimum wavelength for temperature) =  $\lambda @ 1.00E + 00''$ )

Quantum = (minimum wavelength for temp.) ;  $x = \lambda / \text{Quantum}$  ;  $x_{\text{max}} = (2.625 \mu\text{m}) / \text{Quant.}$

$(1 - 1/x) = (1 - \text{Quantum} / \lambda)$

$$\{\text{Diode Power - Gain Factor for any Temperature}\} = \left(1 - \frac{1}{x_{\text{max}}}\right) = \left(1 - \frac{\text{Quantum}}{\lambda_{\text{cut-off}}}\right) = \int_1^{x_{\text{max}}} \frac{1}{x^2} d(x)$$

Natural Blackbody Thermal Energy =  $\frac{c}{\text{peak } \lambda} h = (4.7959) k_b T$  (see graph below)

$$\text{peak } \lambda = \frac{c(h)}{(4.7959) k_b T} = \frac{0.00300}{T}; \quad T = \{\text{Temperature in Kelvin}\}; \quad k_b = \{\text{Boltzmann's Constant}\}$$

$$\{\text{SWIR Thermal Energy Boost}\} = \frac{\lambda_{\text{nat.peak}}}{\lambda_{\text{cut-off}}} (4.7959) k_b T = \frac{c}{\lambda_{\text{cut-off}}} h = 7.5674e - 20$$

$$y = \left(1 - \frac{1}{x}\right) y_{\text{lim}}; \quad y_{\text{lim}} = \frac{y}{1 - 1/x}$$

$$y_{\text{lim}} = \frac{y_{\text{cut-off}}}{1 - 1/x_{\text{max}}}$$

$$\frac{x_{\text{peak}}}{x_{\text{max}}} = \frac{\lambda_{\text{peak}}}{2.625 \mu\text{m}}; \quad x_{\text{peak}} = \frac{\lambda_{\text{peak}}}{Q}; \quad Q = \{\text{Minimum InGaAs } \lambda \text{ for the temperature}\}$$

Temperature	InGaAs minimum wavelength (by graph)	Natural Blackbody Peak wavelength	$Y_{\text{cut-off}} / X_{\text{max}}$ (calculating by graph values)	$(X_{\text{peak}}) / (X_{\text{max}}) = \lambda_{\text{peak}} / \lambda_{\text{cut-off}}$	Estimated "y <sub>lim.</sub> " (using data)	Total Power C i h d i h
50° 323 K	1.375 μm	9.288 μm	5.1/1.91	3.5383	E+10.71	<b>E+5.1</b>
100° 373 K	1.16 μm	8.043 μm	6.2/2.26	3.064	E+11.12	<b>E+6.2</b>
200° 473 K	0.88 μm	6.3425 μm	7.5/2.98	2.416	E+11.29	<b>E+7.5</b>
400° 673 K	0.59 (est.)	4.4576 μm	8.9/4.42 (est.)	1.698	E+11.5	<b>E+8.9</b>
800° 1073K	0.35 (est.)	2.7959 μm	10.2/7.58 (est.)	1.065	E+11.75	<b>E+10.2</b>

### Shortening Thermal Radiation Wavelengths by a Diode-Supplied Energy Boost

: cf 'bUh i fU' V'UW\_VcXm'dYU\_ kUj'Y'Yb[h\g'k\]W\ 'UfY'' cb[Yf'h\Ub'h\Y'X]cXYfig' Wi h!cZZ''  
 kUj'Y'Yb[h\.'che diode must supply energy to raise all thermal radiation wavelengths to be shorter than the "cut-off." The mathematical formula shows that all thermal radiation signals can be raised to the "cut-off" by supplying an equivalent amount of energy (7.567e-20 joules or 0.4723 eV). Ø [ ;Á ] ^æ VÁ c@^/ { æ/Á , æç^/ ^ } \*c@ •Á , @ã&@Áæ;^Á \* / ^æc^!Ác@æ } Ác@^Á& ^cÉ [ ~Ác@ ^ } Ác@^Áãã [ ã^c •Á ] [ , ^!Á [ ^c ] ^cÁÁ , ã|ÁÁã^Á@ã \*@ / ^Á ãã~^/ ^ } cãæ/c^ãÁ^c , ^^ } Ác^ { ] ^!æc ^!^ •Á ] ; [ çããã } \*ÁæÁ& / ^æ; Ác@^/ { æ/Áá { æ \* ^ÉQ-ÉÁ@ [ , ^ç^!ÉÁÁ

### Discussion of the InGaAs Semiconductor's Photoelectric Qualities

InGaAs is a crystalline semiconductor composed as an amalgamation of the elements Indium (atomic # 49), Gallium (atomic # 31) and Arsenic (atomic # 33). As a crystalline semiconductor, InGaAs has

photoelectric qualities. The lower limit on the light frequencies (cutoff wavelength) with which the semiconductor can interact is determined by the mixture of elements during the crystal growing process. The lowest light frequency limit for the amalgam has been determined to be around 2.6 micrometers (2600 nanometers) which is near the “2.625  $\mu\text{m}$ ” wavelength emitted by the “4d” valence subshell for the “Ga” and “As” components of the amalgam as determined by the Quantum-Dimensional Periodic Table of Elements<sup>2</sup>.

*“[i]t is possible to extend the cut-off wavelength [of InGaAs] up to about 2.6  $\mu\text{m}$ .”<sup>3</sup>*

This maximum cutoff wavelength is illustrated by the above blackbody emission curves graph which shows the maximum wavelength as nearly 2625 nanometers (the 2.625  $\mu\text{m}$  of the “4d” valence subshell). That graph shows blackbody curves for various temperatures as defined by light wavelengths along the “x” axis as arrayed against watts of spectral irradiance along the “y” axis which are “...incident on a [semiconductor’s] surface.... called spectral irradiance and has SI units  $\text{W}\cdot\text{m}^{-2}$  or commonly  $\text{W}\cdot\text{m}^{-2}\cdot\text{nm}^{-1}$ .”

### **Thermal Radiation and Thermal Magnetic-Current Induction in the Nucleus**

The thermal radiation signatures from blackbodies are absorbed by an InGaAs crystalline semiconductor as watts per meter cubed of spectral irradiance which have been modified by gains in the peak frequencies which the semiconductor has imposed upon the thermal signatures.

The “peak wavelength” of any blackbody thermal radiation signature is identified as the wavelength which emits the greatest amount of spectral radiance. These peak wavelengths are directly related to the temperature of the thermal radiation signature (as measured in Kelvin). The doubling of the temperature of the thermal signature doubles the peak frequency (halves the peak wavelength). Since these peak frequencies provide a Planck energy value which is directly proportional to the temperature of the thermal signature, that peak frequency Planck value identifies the energy in the temperature induced thermal signature<sup>5</sup>.

The “spectral radiance” emitted by the black body is the opposite of the “spectral irradiance” absorbed by the semiconductor. Instead of watts of light *falling upon* a surface (spectral irradiance), spectral radiance is watts of light *emitted* to a surface through a three dimensional angle called a “steradian.”

*“Spectral radiance measures of the quantity of radiation that passes through or is emitted from a surface and falls within a given solid angle [steradian] in a specified direction. ... The SI unit of spectral radiance [for wavelength] is..  $\text{W} \cdot \text{s}^{-1} \cdot \text{m}^{-3} [\text{sr}=\text{steradian}]$ .”<sup>6</sup>*

Spectral irradiance is the reception of watts of light by a surface. Spectral radiance is the emission of light to such a surface from a blackbody.

A thermal temperature graph of a “short wave infrared camera,<sup>7</sup>” using an InGaAs semiconductor receptor, plots spectral irradiance (“y” axis) against thermal signature wavelengths. The graph provides a lower limit cutoff frequency established by the 2.625  $\mu\text{m}$  wavelength of the valence subshell shared by Gallium and Arsenic. It provides an upper limit frequency by the 0.820  $\mu\text{m}$  boundary of the highest infrared shell for the electron orbital structure which is the “3” Paschen shell<sup>8</sup>.

### **The Graph Identifies a Spectral Radiance Power Increase for a Range of Thermal Signatures**

The InGaAs Short Wavelength Infrared graph is shown to accurately models the negation of subdivision or the graph of “1-1/x.” For the InGaAs graph, “x” is an “ $x \geq 1$ ” multiple of the shortest wavelength of any graphable thermal signature. The shortest wavelength is the highest energy wavelength for the

<sup>2</sup> *Four Dimensional Atomic Structure*. Tab 10, “*The Quantum Geometric Periodic Table of Elements.*” Dawson, L. Paradigm Publishing 2013.

<sup>3</sup> <http://en.wikipedia.org/wiki/InGaAs>

<sup>4</sup> *Irradiance*. Wikipedia. [http://en.wikipedia.org/wiki/Radiant\\_exitance](http://en.wikipedia.org/wiki/Radiant_exitance)

<sup>5</sup> See graph titled “*Radiation Characteristics of a Blackbody in relation to its Temperature*” below.

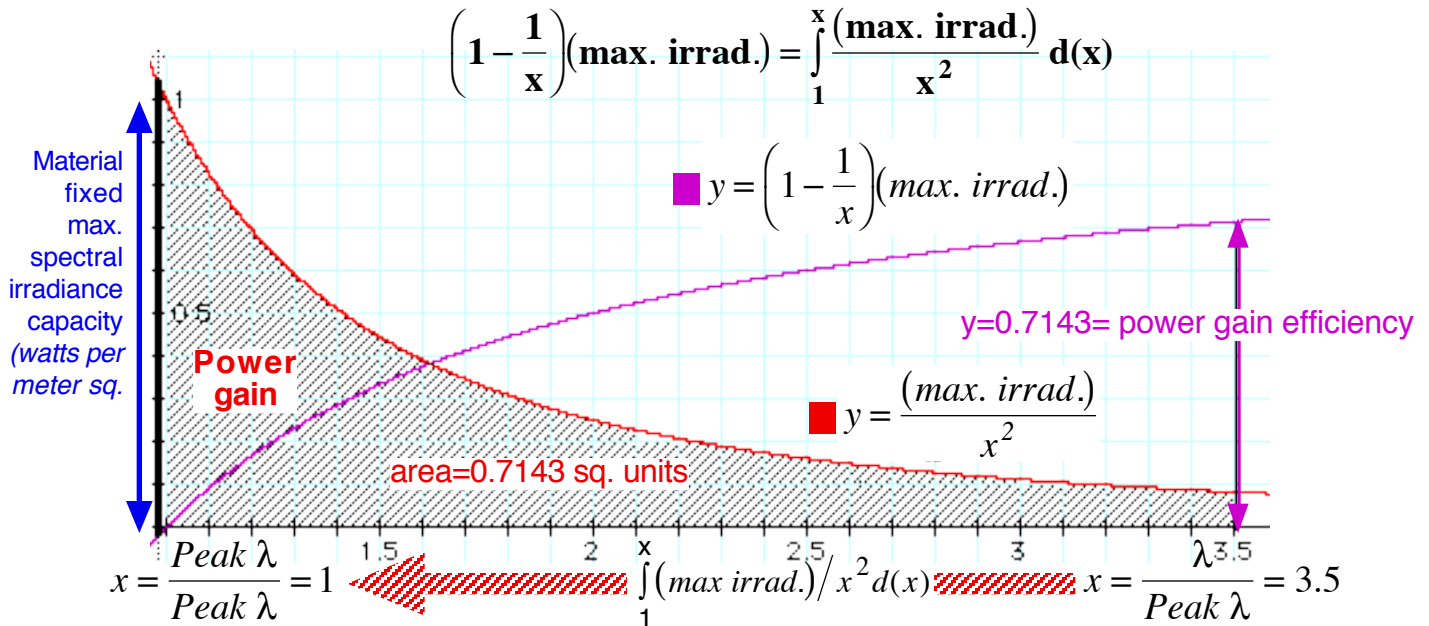
<sup>6</sup> *Radiance*. Wikipedia. <http://en.wikipedia.org/wiki/Radiance>

<sup>7</sup> “*Application: High Temperature SWIR Thermography,*” UTC Aerospace Systems: Sensors Unlimited. <http://www.sensorsinc.com/swirthermography.html>

<sup>8</sup> *Four Dimensional Atomic Structure*: Appendix: “1. *Four-Dimensional Orbital Structure*” p.p. 13-14. Op. cit.

thermal signature. It is the wavelength with the highest spectral radiance output. This fact is established by the quantum-dimensional mathematics governing the negation of subdivision.

### The Quantum Dimensional Mathematics Governing the InGaAs Power Increase



$$\{Energy\ Gain\} = \frac{InGaAs\ Peak\ Energy}{Blackbody\ peak\ Energy} = \frac{c}{Peak\ blackbody\ temperature\ \lambda} h = (4.7959)k_b T$$

$h = \{Planck's\ constant\}$ ;  $k_b = \{Boltzmann\ \&\ constant\}$ ;  $T = \{Temperature\ in\ Kelvin\}$

$$\{Peak\ blackbody\ temperature\ \lambda\} = \frac{c(h)}{(4.7959)k_b T} = \frac{0.0029999972}{T}$$

$$Energy\ Gain = \frac{c(h)/(Peak\ InGaAs\ \lambda)}{c(h)/(Peak\ Blackbody\ \lambda)} = \frac{(Peak\ Blackbody\ \lambda)}{(Peak\ InGaAs\ \lambda)} = \lg(Quantum\ Power\ Gain)$$

$$Quantum\ Power\ Gain = \{integral\ of\ magnetic\ current\ induction\} = \int_1^x \frac{max.\ InGaAs\ irradian.}{x^2} d(x)^9$$

$$x = \frac{\lambda}{Peak\ \lambda}; \quad \sigma = \{frequency\ of\ proton\ spin\} = \left\{ \begin{array}{l} number\ proton\ charges\ inducted\ into \\ a\ magnetic\ current\ in\ one\ second. \end{array} \right\}^{10}$$

$$\lambda = \frac{c}{light\ frequency}; \quad \{light\ frequency\} = 8(\sigma); \quad \lambda = \frac{c}{8(\sigma)}^{11} \text{ wavelength} = f(\text{magnetic induction})$$

$$x = \frac{\lambda}{Peak\ \lambda} = \frac{c/8(\sigma)}{c/8(\sigma_{Peak})} = \frac{\sigma_{Peak}}{\sigma} \quad x = (\text{gain in the induction of proton charges into a magnetic current})$$

$$\frac{1}{x^2} = \frac{\sigma^2}{\sigma_{Peak}^2}; \quad \frac{Wm^{-3}}{x^2} = \frac{Wm^{-3}\sigma^2}{\sigma_{Peak}^2} = \{power\ difficiency\ at\ \lambda\}; \quad \{Quant.\ power\ gain\} = \int_1^x \frac{Wm^{-3}}{x^2} d(x)$$

<sup>9</sup> See *Four Dimensional Atomic Structure*; Tab 14, "THE QUANTUM MECHANICS OF A GRAVITATIONAL OPEN ENERGY SYSTEM" for a discussion of the quantum open energy integral and its description of field created energy.

<sup>10</sup> Ibid. Tab 3 "Thermal-Radiation Frequencies are "1 & 2 shell" Fourier-Series Harmonics of Proton Spin Frequencies" p. 18 and forward.

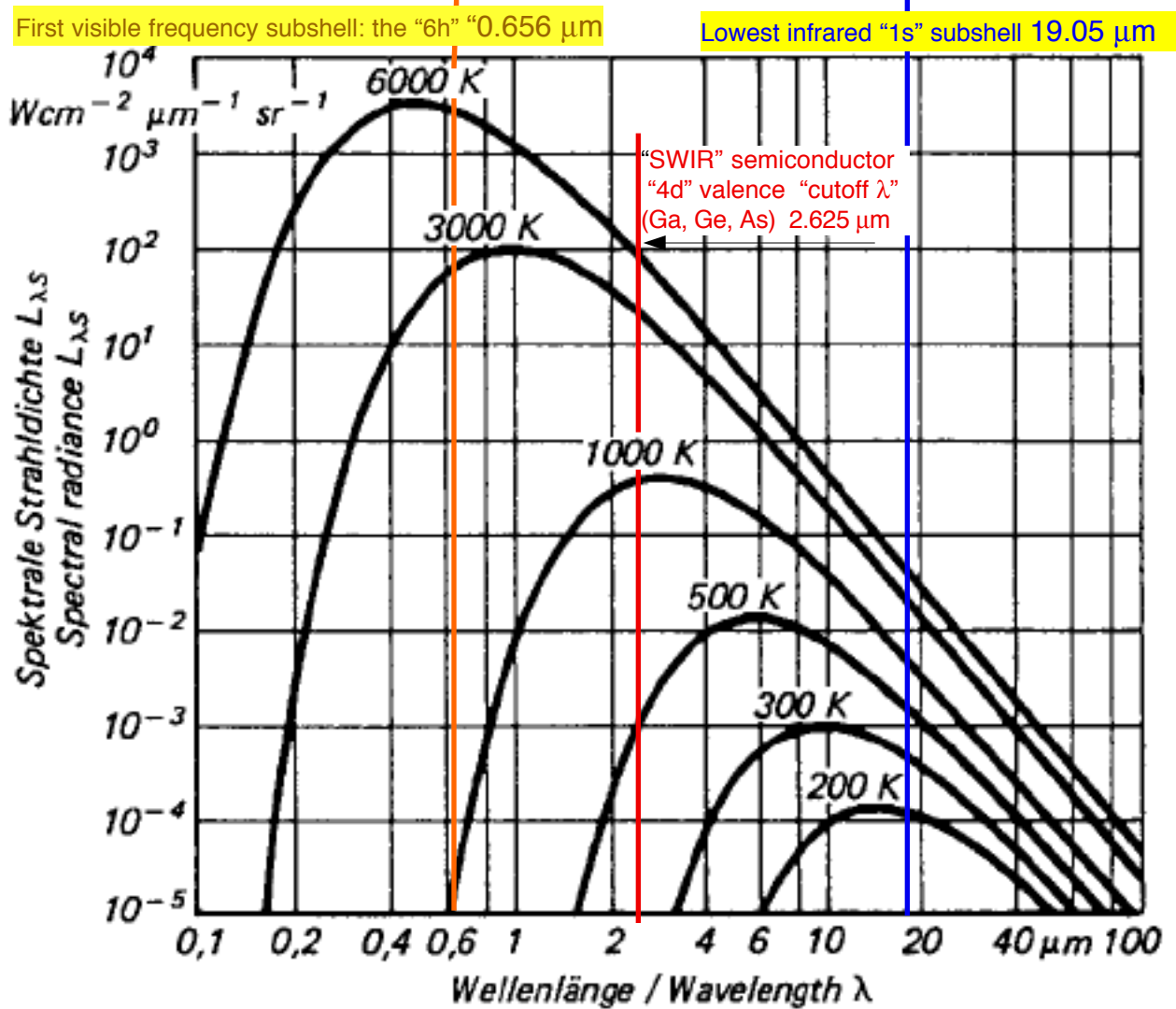
<sup>11</sup> Ibid.

# The Blackbody Spectral Radiance Curves for Several Thermal Signatures

“Wien's displacement law states that the wavelength distribution of thermal radiation from a black body at any temperature has essentially the same shape as the distribution at any other temperature, except that each wavelength is displaced on the graph<sup>12</sup>.”

Perfect blackbody thermal radiation emissions are graphed as an asymmetrical bell-shaped curve with radiant intensity measured along the “y” axis and radiation frequency or wavelength measured along the “x” axis. The Wien displacement law states that these bell-shaped curves of “equivalent variance proportionality” are displaced upward in intensity as blackbody temperatures increase. The curves never intersect and are, therefore, unique to the temperature.

**Fig. 3: Radiation Characteristics of a Blackbody in relation to its Temperature.<sup>13</sup>**  
(As annotated by the SRNRL)



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The electromagnetic spectrum, with range from around 0.7 to 14 μm are useful for measuring purposes<sup>15</sup>

<sup>12</sup> “Wien's displacement law.” [http://en.wikipedia.org/wiki/Wien%27s\\_displacement\\_law](http://en.wikipedia.org/wiki/Wien%27s_displacement_law)

<sup>13</sup> *Principles of Non-Contact Temperature Measurement*; P. 8. KGruner@Raytek.de; RAYTEC. [http://support.fluke.com/raytek-sales/Download/Asset/IR\\_THEORY\\_55514\\_ENG\\_REVB\\_LR.PDF](http://support.fluke.com/raytek-sales/Download/Asset/IR_THEORY_55514_ENG_REVB_LR.PDF)

<sup>14</sup> “Radiance and spectral radiance are measures of the quantity of radiation that passes through or is emitted from a surface and falls within a given solid angle in a specified direction. They are used in radiometry to characterize diffuse emission and reflection of electromagnetic radiation. In astrophysics, radiance is also used to quantify emission of neutrinos and other particles. The SI unit of radiance is watts per steradian per square meter ( $W \cdot s \cdot r^{-1} \cdot m^{-2}$ ), while that of spectral radiance is  $W \cdot s \cdot r^{-1} \cdot m^{-2} \cdot H \cdot z^{-1}$  or  $W \cdot s \cdot r^{-1} \cdot m^{-3}$  depending on whether the spectrum is a function of frequency or of wavelength.” Wikipedia: <http://en.wikipedia.org/wiki/Radiance>

<sup>15</sup> *Principles of Non-Contact Temperature Measurement*. P. 7. Op. cit.



**Natural Blackbody Thermal Radiation Peak Wavelengths are longer than the InGaAs Cutoff  $\lambda$**

The above graph indicates that the “Short Wavelength Infrared” InGaAs semiconductor must shift peak wavelengths to higher energy states which are shorter than the cutoff wavelength of “2.625  $\mu\text{m}$ .” The natural peak blackbody wavelength for “1000 K (727° C)” is below the InGaAs cutoff wavelength. The natural peak blackbody wavelengths of “500 K (227° C) and “300 K (27° C) are also well below the InGaAs cutoff wavelength.

In order to be sensitive to the irradiance from thermal signatures between “50° C (373 K)” and “800° C (1073 K)” the SWIR InGaAs semiconductor must shift the peak wavelength downward (increasing frequency and energy) so they become operational in the “Short Wavelength Infrared” range. This shifting is accomplished as a quantum function of the cutoff wavelength which takes advantage of the power gain possibility for semiconductor nuclear magnetic currents using the quantum open energy integral. The energy gain of this peak wavelength shift is the log of the quantum power gain for the magnetic current.

**Thermal Signature Energy and the Peak Wavelength**

$$\lambda_{\text{peak}} = \{ \text{wavelength at maximum wattage} \}; \quad E_{\text{peak}} = \frac{c}{\lambda_{\text{peak}}} h$$

$$W_{\text{peak}} = \{ \text{maximum wattage} \} = x \frac{E_{\text{peak}}}{\text{sec.}}; \quad x = \frac{W_{\text{peak}}(\text{sec.})}{E_{\text{peak}}}$$

$$\{ \text{Assumed Boltzmann Temp. Related Energy} \} = \text{Assumed } E_B = k_b(T)$$

**Energy Calculated from Blackbody Thermal Radiation Curves**

Temp	Peak Wavelength	Planck Energy calculated for peak wavelength $E=f(h)$	Assumed Boltzmann Energy	Spectral Wattage peak (from table)	x	variance limit: 19.05 $\mu\text{m}$ / max. minus 1
200 k	15 $\mu\text{m}$	1.3242983e-20	2.761316e-21	10e-3.9	9.50635823e15	1.27-1=.27
300 k	10 $\mu\text{m}$	1.9864475e-20	4.141974e-21	10e-3	5.0341125e16	1.905-1=.905
500 k	6 $\mu\text{m}$	3.3107458e-20	6.90329e-21	10e-1.9	3.80254326e17	3.175-1=2.175
1000 k	3 $\mu\text{m}$	6.6214915e-20	1.380658e-20	10e-0.3	7.5690988e18	6.35-1=5.35
3000 k	1 $\mu\text{m}$	1.9864475e-19	4.141974e-20	10e2	5.0341125e20	19.05-1=18.05
6000 k	0.5 $\mu\text{m}$	3.9728949e-19	8.283948e-20	10e3.5	7.95963075e21	38.1=37.05

Temperature energy is determined by the wavelength at the peak of the spectral radiance curve and must be calculated as Planck energy. It cannot be determined directly by the Boltzmann constant. The Boltzmann constant was determined for gases [Boltzmann=(gas constant)/(Avogadro constant)]. Its direct translation to the atomic level is inaccurate, as the blackbody thermal radiation curves prove. Alleged Boltzmann energy calculated for the temperature is only 20.85% of thermal radiation energy for the same temperature as calculated as peak Planck energy (Peak Planck energy is 4.7959 times greater).

**Actual Thermal Temperature Energy as Expressed by the Modified Boltzmann Constant**

$$\{ \text{Assumed Boltzmann Temp. Related Energy} \} = k_b(T)$$

$$\{ \text{Actual Thermal Energy} \} = \frac{c}{\text{peak}\lambda} h = (4.7959)k_bT;$$

⟨ Calculated from the above "Blackbody Thermal Radiation Curves" table ⟩

## Maximum Blackbody Spectral Radiance Wattage is a Function of the Variance between Peak Wavelengths and the Minimum Orbital IR Wavelength

Temperature is directly related to the peak wavelength and its Planck energy. But it is not directly related to wattage output of the light which is controlled by another factor.

$T_1 = \text{lower temp.}; T_2 = \text{higher temp.}; \text{peak}\lambda_1 = \text{lower temp.}; \text{peak}\lambda_2 = \text{higher temp}$   
 $x_1 = \text{lower temp power factor}; x_2 = \text{higher temp power factor};$

"1s" subshell = 19.05  $\mu\text{m}$ ;  $\frac{19.05 \mu\text{m}}{\text{peak}\lambda} - \frac{\text{peak}\lambda}{\text{peak}\lambda} = \lambda_g = \text{maximum wavelength gain}$

$$\left(\frac{T_1}{T_2}\right)\left(\frac{x_2}{x_1}\right) = \left(\frac{\lambda_{g2}}{\lambda_{g1}}\right)(2)^{z?}$$

For $T_1=200 \text{ k}$						
$T_2=$	$\frac{T_1}{T_2}$	$\frac{x_2}{x_1}$	$\frac{\lambda_{g2}}{\lambda_{g1}}=a$	$\left(\frac{T_1}{T_2}\right)\left(\frac{x_2}{x_1}\right)=b$	b/a	$\lg_2(b/a)=z?$
200	1	1	1	1	1	0
300	2/3	5.2955	3.35185	3.53033	1.05325	0.0748
500	2/5	40.00000	8.0555556	15.999999865	1.98621	0.9900
1000	2/10	796.2143459	19.81481481	159.2428692	8.0365560	3.0066
3000	2/30	52955.22	66.851852	3530.34771	52.808525	5.7227
6000	2/60	837295.4771	137.222222	27909.849238	203.39161	7.66812

$$\left(\frac{T_1}{T_2}\right)\left(\frac{x_2}{x_1}\right) = \left(\frac{\lambda_{g2}}{\lambda_{g1}}\right)(2)^{\lg_2(T_1\lambda_{g1}/T_2\lambda_{g2})+\lg_2(x_2\lambda_{g1}/x_1\lambda_{g2})}$$

$$\frac{\{\text{spectral radiance power gain from "T}_1"\}}{2^{\lg_2(x_2\lambda_{g1}/x_1\lambda_{g2})}} = \frac{x_2}{x_1 \left(2^{\lg_2(x_2\lambda_{g1}/x_1\lambda_{g2})}\right)}$$

$$\frac{\{\text{spectral radiance power gain from "T}_1"\}}{2^{\lg_2(x_2\lambda_{g1}/x_1\lambda_{g2})}} = \left(\frac{T_2\lambda_{g2}}{T_1\lambda_{g1}}\right)(2)^{\lg_2(T_1\lambda_{g1}/T_2\lambda_{g2})}$$