DIY Astronomy

Human Bodies - They Radiate…

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JOHNSON SPACE CENTER ASTRONOMICAL SOCIETY

STAR PARTY NEWS

With David Haviland

Oct 2025

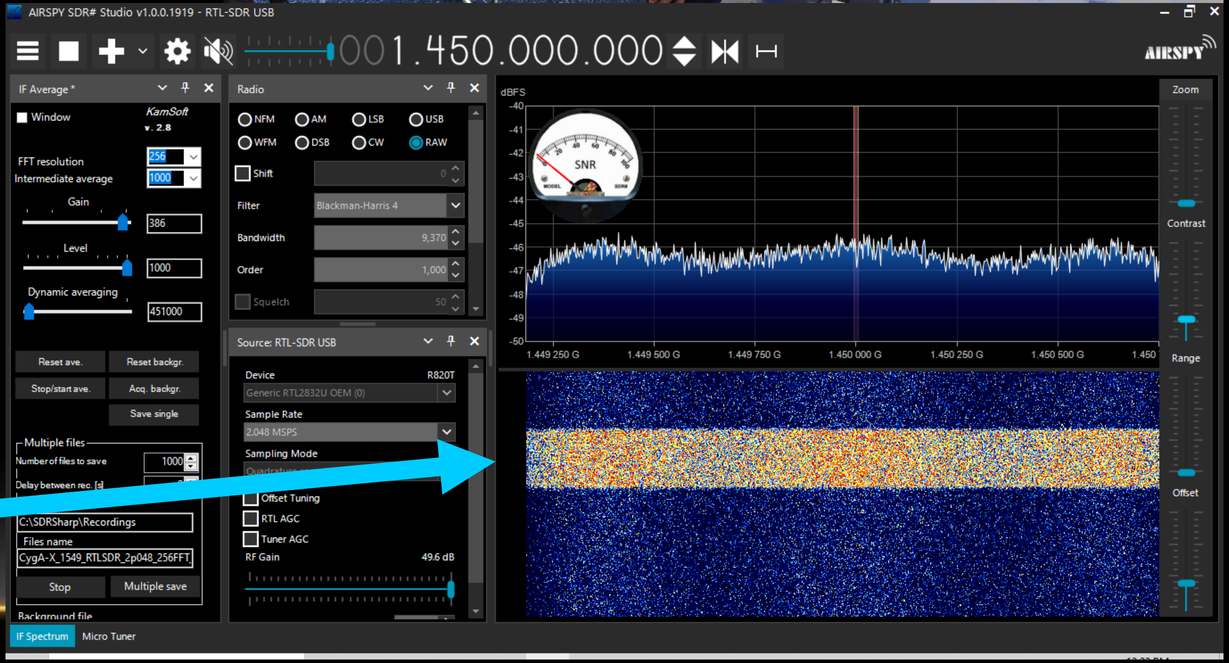
At last month's meeting, during Star Party News…

Pictures were shown of Astronomy Day 2025 =>

Included in those pictures was our Radio Astronomy display!

Ric

not Ric



Detection of radiation from human bodies

Part of that display was a live demonstration of a Radio Telescope

Later at =>

MOD

What exactly were we measuring?...?

Assume a combination of:

1. Electrical activity in body

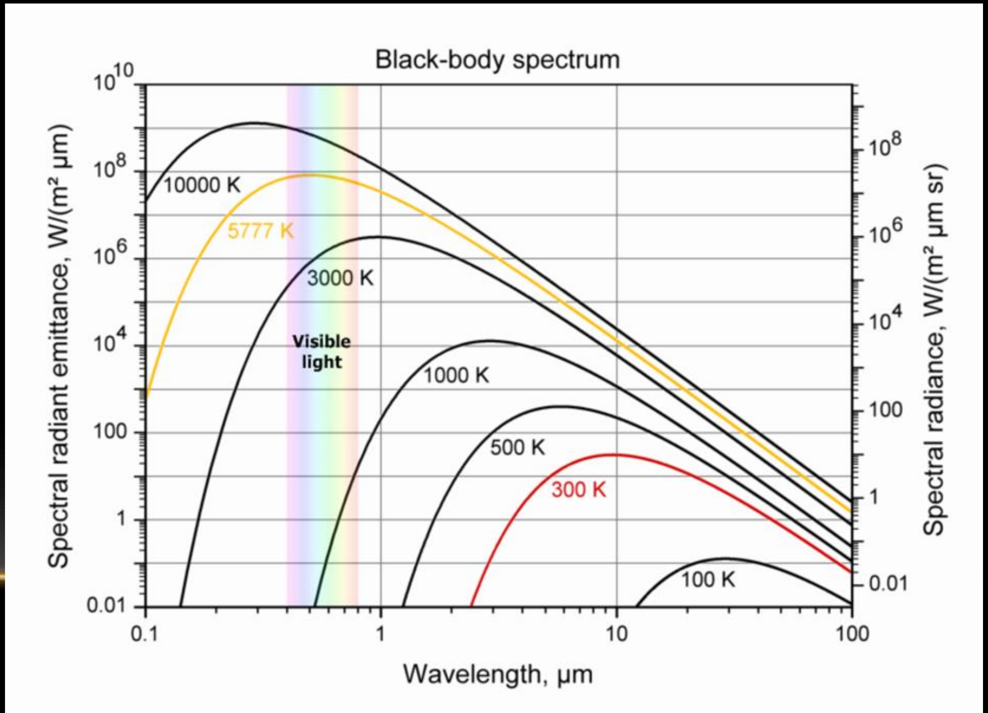
2. Body's quasi black body radiation / heat

Knowledgeable JSCAS member said:

1. Body’s electrical activity probably too low to detect

- and -

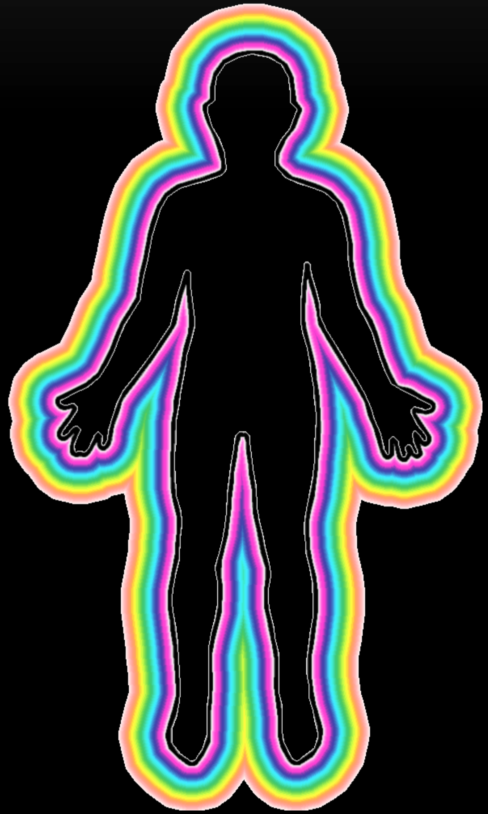
2. 12.7GHz far down on black body curve (2.36cm => 23,600um)



https://www.sun.org/uploads/images/mainimage_BlackbodySpectrum_2.png

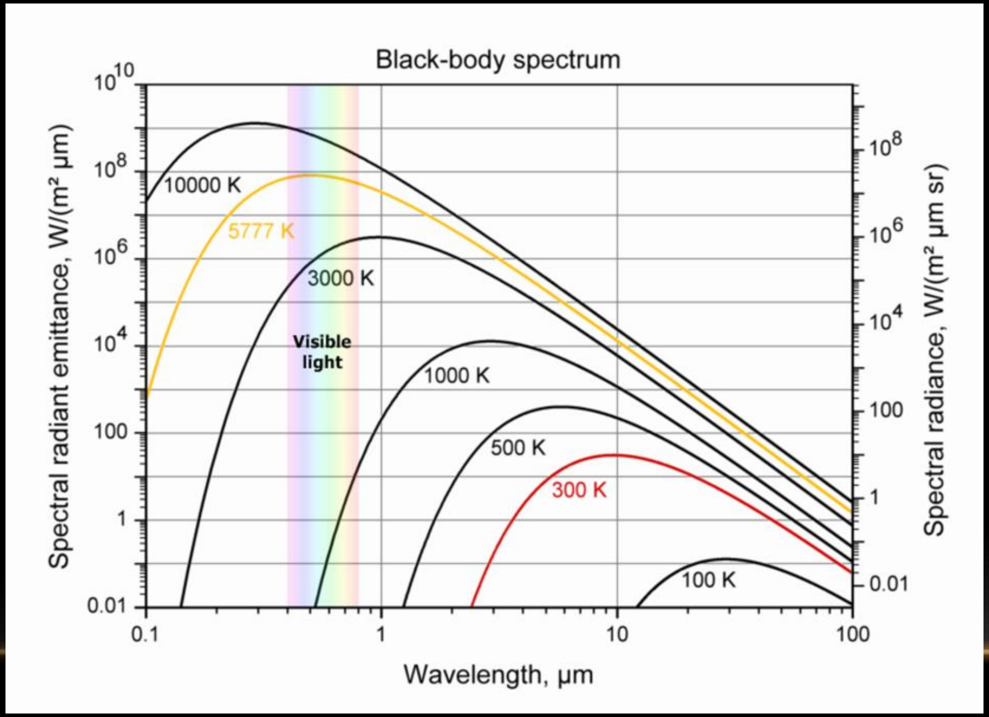
Since knowledgeable JSCAS members are “super doctors” ===>

Accept their view that signal is probably not body’s electrical activity…



But ...

I wonder if there could still be enough signal from quasi Black Body radiation to detect .?.



https://www.sun.org/uploads/images/mainimage_BlackbodySpectrum_2.png

We will explore the question of whether there is enough thermal radiation (black body) to detect it with our radio telescope

Analyze signal level from human body and compare with expected sensitivity of radio telescope

Math is Fun !!

Question #1 – What is the temperature of the human body?

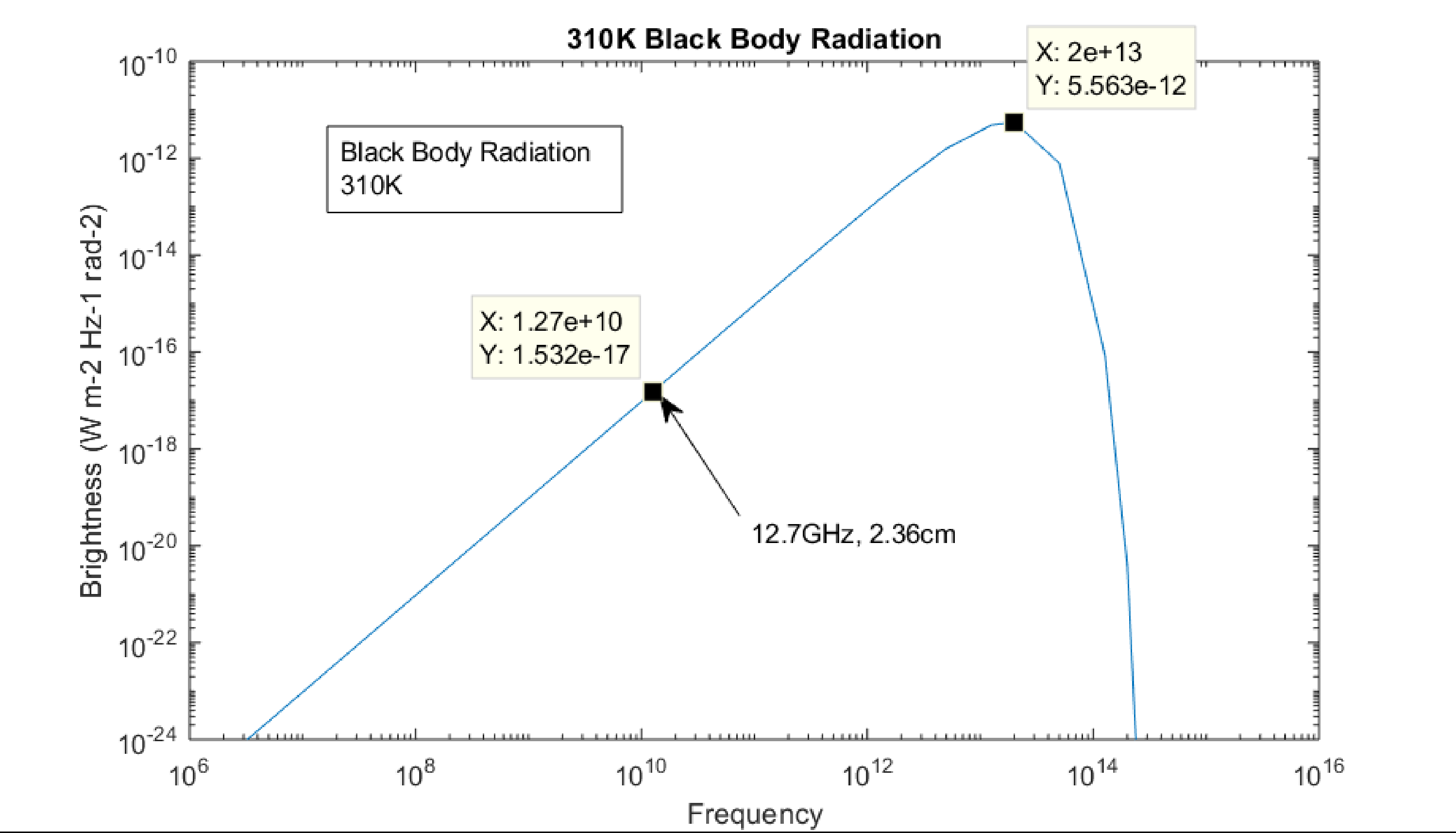
98.6°F

$$K = \left(\left(98.6^{0}F - 32^{o}F\right)\frac{5}{9}\right) + 273.15K$$

$$K \approx 310K$$

Kelvin scale is the absolute temperature starting at absolute 0 (0ºK) the point where particles are nearly motionless (small amount of energy remains due to quantum effects)

Question #2 – How much signal can we expect from 310K human?



Planck's Radiation Law

$$B = \frac{2hv^3}{c^2}\frac{1}{e^{hv/kT} - 1}$$

$B = brightness, Wm^{-2}Hz^{-1}rad^{-2}$

$h = Planck's\ contant\ 6.63x10^{-34}$JS

$v = frequency, Hz$

$c = speed\ of\ light, 3x10^8$m/s

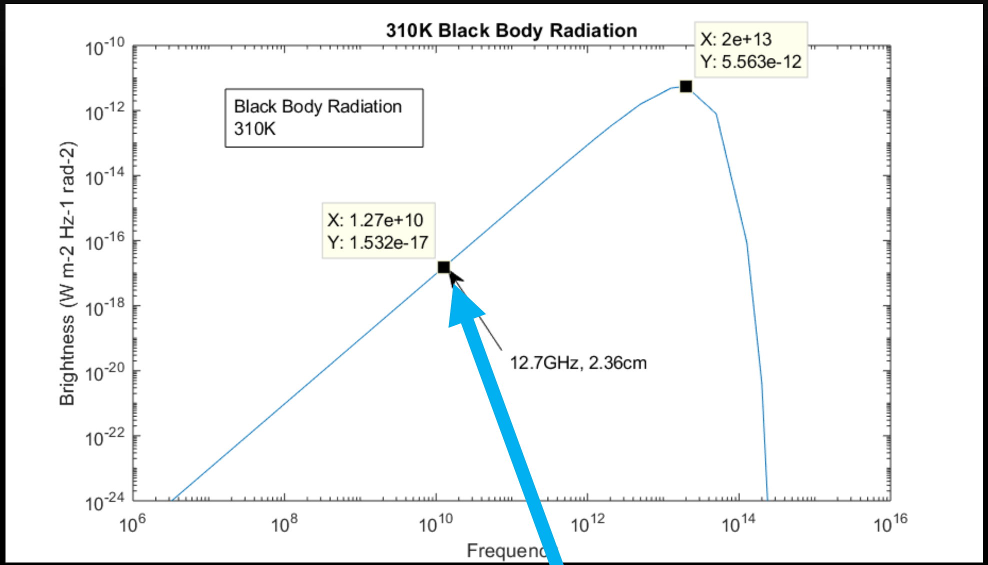
$k = Boltzmann's\ constant,$
1.3810^{-23}J/K

$T = temperature, K$

At 12.7GHz => 1.532×10^{-17} Watts meter^{-2} Hertz^{-1} radian^{-2}

Note – Peak is 363,120x brighter than our signal

Question #3 – Is our black body curve even close to being correct?



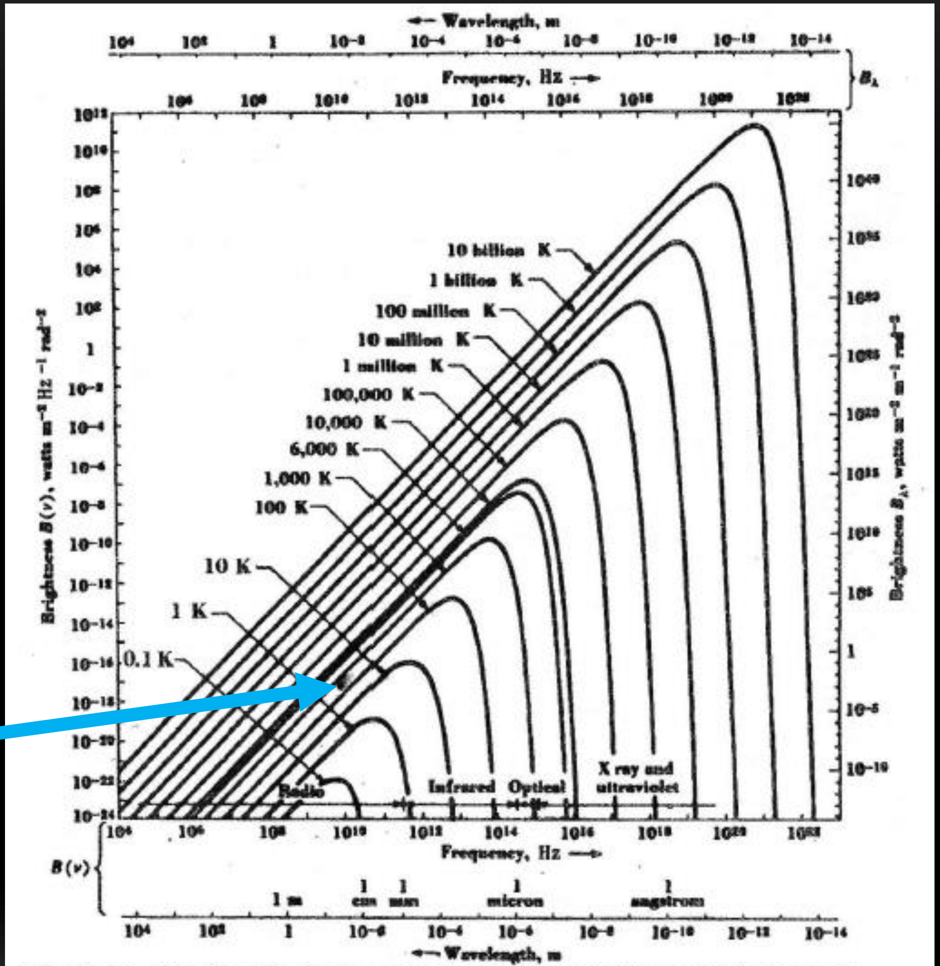


Fig. 3-14. Planck-radiation-law curves with frequency increasing to the right.

* The usual statement gives the integrated value of B' over one hemisphere as obtained by multiplying (3-57) by π. See (3-10).

At 12.7GHz =>1.532 x 10^{-17} Watts meter^{-2} Hertz^{-1} radian^{-2}

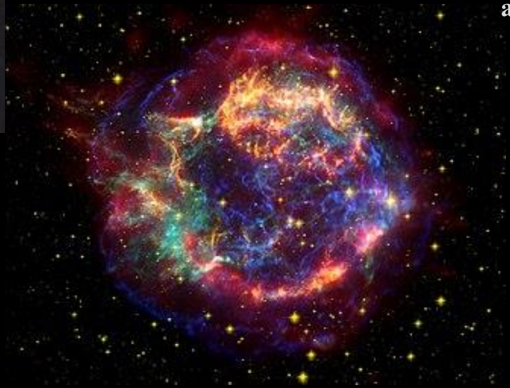
=> Looks about right <=

Radio Astronomy by John D. Kraus

Question #4 – What signals have we been able to detect previously?

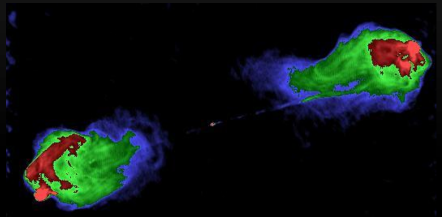
(2.1m Radio Telescope sensitivity)

M1 – Crab Nebula
1000Jy (1GHz)



https://en.wikipedia.org/wiki/Cassiopeia_A

Cassiopeia A
2400Jy (1.4GHz)



https://en.wikipedia.org/wiki/Cygnus_A#/media/File:3c405.jpg

Cygnus A
1500Jy (1.4GHz)

https://en.wikipedia.org/wiki/Cygnus_X_(star_complex)

Cygnus X
5000Jy (1.4GHz)

Jy (Jansky) [Unit of Flux Density] = $10^{-26} W\, m^{-2} Hz^{-1}$

Question #5 – How does our human body signal compare to previous?

If human body fills our antenna beam =>

Flux Density = Brightness x Antenna Beam $Sv = B * \Omega$

514.6×10^{-21} W m^{-2} Hz^{-1} = 1.532×10^{-17} Watts $meter^{-2}$ $Hertz^{-1}$ $radian^{-2}$ * 0.0335 sr

51,460,000Jy = 514.6×10^{-21} W m^{-2} Hz^{-1} * $\frac{1\ Jy}{10^{-26} W\ m^{-2} Hz^{-1}}$

A lot larger than previously detected signals

≈ 1000Jy

One more thing ==>

Previous presentation

‘Measuring the Temperature of the Moon’

with a satellite TV dish antenna (aka Radio Telescope)

=> Used measurements of warm garage wall vs. cold sky to derive Tsys (System Temperature)

$$Teff = Ttotal - Tsys$$

$$Tsys = system\ noise\ level$$

$$Tsys = \frac{Th - yTc}{y - 1}$$

$$Th = temperature\ of\ hot\ area, garage\ wall\ (82^0F)$$

$$Tc = temperature\ of\ cold\ area, sky\ (10K)$$

Need Th in Kelvin, K

$$(((82^oF - 32^0F)\frac{5}{9}) + 273.15K) = 300.9K$$

$$Tsys = \frac{300.9K - 2.0893(10K)}{2.0893 - 1}$$

$$Tsys = 257K$$

$$PwrhotdB - PwrcolddB = 10\log(y)$$

$$PwrhotdB = Hot\ power\ measured\ in\ dB$$

$$PwrcolddB = Cold\ power\ measured\ in\ dB$$

$$-47.5\text{dB} - (-50.7\text{dB}) = 3.2\text{dB} = 10\log(\text{y})$$

$$\text{y} = 2.0893$$

So… seems reasonable to get good signal at 98.6°F

Conclusion –

- It appears that the signal level from a 310K human body is more than sufficient to detect with a Satellite TV Dish Antenna Radio Telescope at 12.7GHz

Also – This is a fun Radio Telescope demo for public star parties www.holland-observatory.net