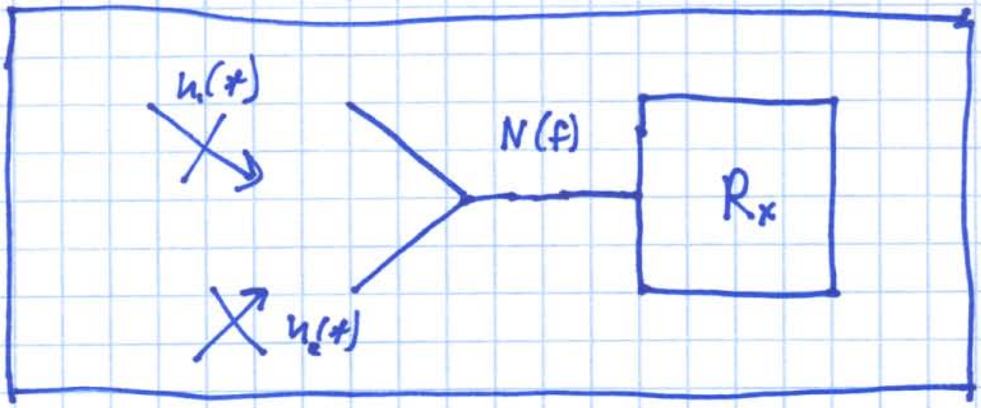
Antenna Noise Temperature

A R_x will receive noise from both terrestrial and extra-terrestrial sources:

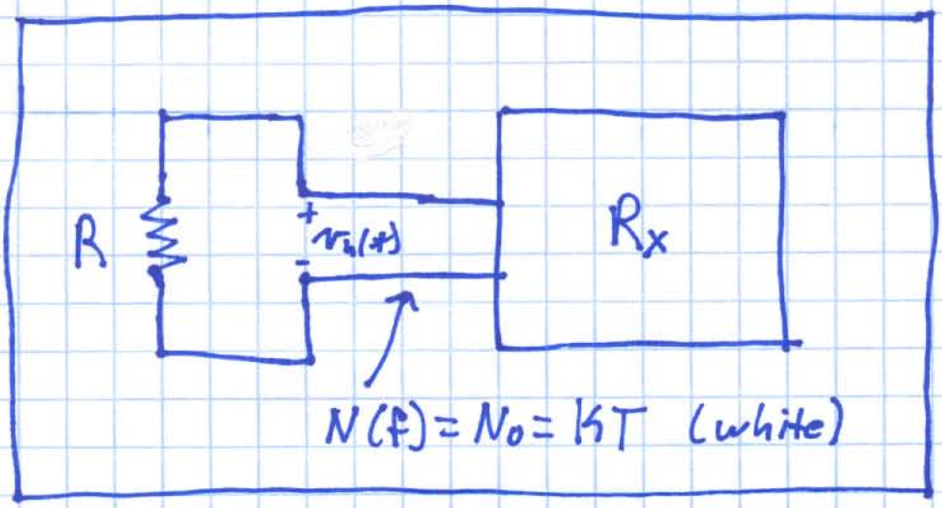


Q: What is the average spectral power density $N(f)$ of this received noise ??

A: Generally speaking, it is <u>white noise</u>!!

$\Rightarrow$ i.e., the spectral power density of the noise is $\approx$ constant wrt frequency (or, at least, <u>within</u> the <u>antenna bandwidth</u>).

Therefore, as far as <u>noise</u> is concerned, the receiver appears to have a resistor attached to it!!



If the antenna couples external noise into the receiver with average spectral power density N_0, then we define antenna temperature T_A as:

$$\boxed{T_A = \frac{N_0}{K}}$$

Or, in other words, we decribe the spectral power density of the input noise as:

$$\boxed{N_0 = K\,T_A}$$

So we could describe the noise with N_0, in Watts/Hz, or with T_A, in degrees Kelvin.

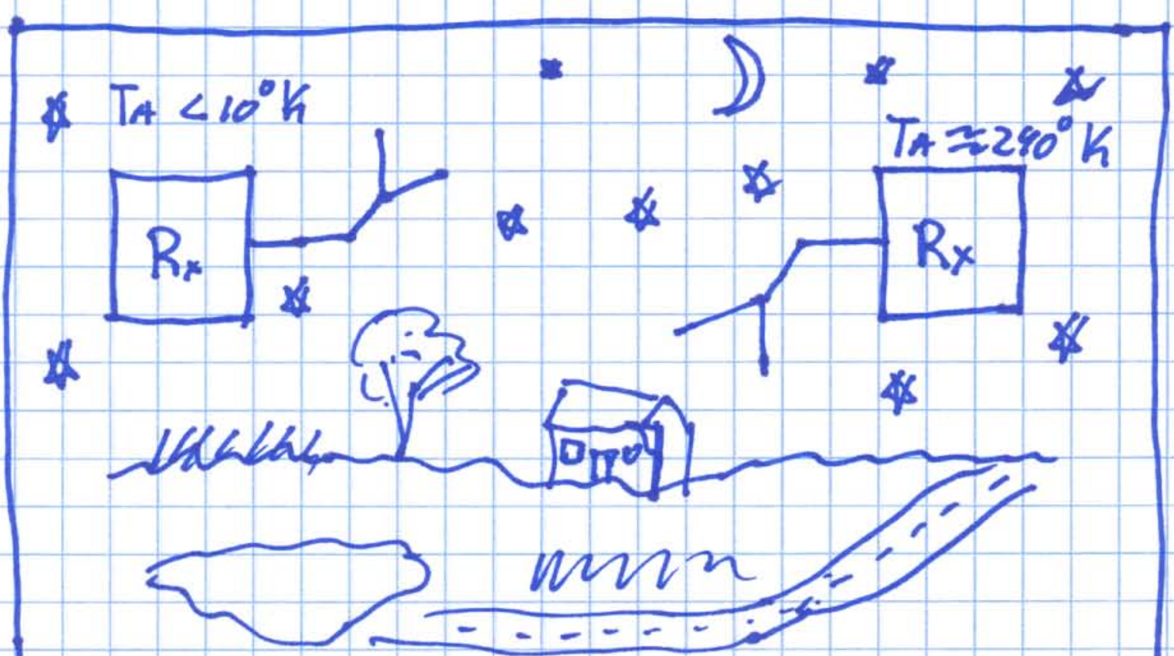
Note: The higher the antenna temperature T_A, the larger the average spectral power density.

Q: What typically is the value of T_A ??

A: It depends on which direction the antenna is pointed!!

- If the antenna is pointed toward the sky (e.g. satellite communication), the antenna noise temperature could be $< 10°K$.

- If the antenna is not pointed at the sky, the antenna temp. is typically the physical temperature of the Earth! (There are physical reasons for this.).



- We often assume that $\underline{\underline{T_A \approx 290^\circ K}}$ for $\underline{\text{terrestrial}}$ applications:

$$\boxed{\begin{aligned} N_0 &= k\,T_A \\ &= (1.38\times10^{-23})\,(290) \\ &= 4\times10^{-21}\ \text{W/Hz} \\ &= -174\ \text{dBm/Hz} \end{aligned}}$$