" **Detection probability**"

Integrate[(z b)^((a - 1) / 2) BesselK[a - 1, 2 (z / b)^0.5], {z, g, Infinity}]

$$\text{ConditionalExpression}\left[\frac{1}{\left(\frac{1}{b}\right)^{0.5}} b^{\frac{1}{2}(-1+a)} g^{0.5a} \left(0.5\,\text{BesselI}\left[-a, 2\left(\frac{g}{b}\right)^{0.5}\right] \text{Gamma}[1-a]\,\text{Gamma}[a] + 0.5\,\text{BesselI}\left[a, 2\left(\frac{g}{b}\right)^{0.5}\right] \text{Gamma}[-a]\,\text{Gamma}[1+a]\right), \text{Re}[g] > 0 \,\&\&\, \text{Im}[g] == 0 \,\&\&\, \left(\frac{1}{b}\right)^{0.5} > 0\right]$$

"Moment generating function"

Integrate[Exp[-s z] (z b)^((a - 1) / 2) BesselK[a - 1, 2 $\sqrt{z/b}$], {z, 0, Infinity}]

$$\text{ConditionalExpression}\left[\frac{1}{2s} b^{-1+a} e^{\frac{1}{bs}} \text{ExpIntegralE}\left[a, \frac{1}{bs}\right] \text{Gamma}[a], \text{Re}[a] > 0 \,\&\&\, \text{Re}[s] > 0 \,\&\&\, \text{Re}[b] > 0 \,\&\&\, \text{Im}[b] == 0\right]$$

"First Moment"

f[x_] := D[2 / (Gamma[a] b^a) $\frac{1}{2x} b^{-1+a} e^{\frac{1}{bx}}$ ExpIntegralE[a, $\frac{1}{bx}$] Gamma[a], x]

f[x]

First Moment

$$\frac{1}{b^2 x^3} e^{\frac{1}{bx}} \text{ExpIntegralE}\left[-1+a, \frac{1}{bx}\right] - \frac{1}{b^2 x^3} e^{\frac{1}{bx}} \text{ExpIntegralE}\left[a, \frac{1}{bx}\right] - \frac{1}{b x^2} e^{\frac{1}{bx}} \text{ExpIntegralE}\left[a, \frac{1}{bx}\right]$$

Limit[f[x], x → 0]

$-a\,b$

"Second Moment"

g[x_] := D[2 / (Gamma[a] b^a) $\frac{1}{2x} b^{-1+a} e^{\frac{1}{bx}}$ ExpIntegralE[a, $\frac{1}{bx}$] Gamma[a] , {x, 2}]

Second Moment

Limit[g[x], x → 0]

$2\,a\,(1+a)\,b^2$

"Analysis with non central chi-square distibution"
"pdf "

```
Integrate[Exp[ - (x + l) / 2] (x / l) ^ (1 / 4 - 1 / 2)
  BesselI[1 / 2 - 1, (l x) ^ (1 / 2)] 1 / x Exp[-z / x], {x, 0, Infinity}]
```

$$\int_0^\infty \left(\left(e^{\frac{1}{2}(-l-x)-\frac{z}{x}}\sqrt{\frac{2}{\pi}}\,\mathrm{Cosh}\left[\sqrt{l\,x}\right]\right)\Big/\left(x\left(\frac{x}{l}\right)^{1/4}(l\,x)^{1/4}\right)\right)dx$$

$$\int_0^\infty \frac{1}{x}\,e^{\frac{1}{2}(-l-x)-\frac{z}{x}}\left(\frac{x}{l}\right)^{-\frac{1}{2}+\frac{k}{4}}\mathrm{BesselI}\left[-1+\frac{k}{2},\sqrt{l\,x}\right]dx$$

"Solving the problem ny considering the moment generating function of the non central chi-2 distribution. Using, MGF the first two moments are computed. The parameters mean and variance are function of exponential distribution. The first two meoments can be used to approximate the density with well known distribution e.g. gamma distribtuion. This simplify the coputation of the density of the power recieved at SR"

```
Integrate[Exp[K x t / (1 - 2 t)] / (1 - 2 t) ^ (K / 2) Exp[- x / b] , {x, 0, Infinity} ]
```

$$\mathrm{ConditionalExpression}\left[\left(b\,(1-2\,t)^{-K/2}\,(-1+2\,t)\right)\Big/(-1+(2+b\,K)\,t),\ \mathrm{Re}\left[\frac{K\,t}{1-2\,t}\right]<\mathrm{Re}\left[\frac{1}{b}\right]\ \&\&\ \mathrm{Re}\left[\frac{1-(2+b\,K)\,t}{b-2\,b\,t}\right]\geq 0\right]$$

"First Central Moment"

$$\mathrm{Simplify}\left[D\left[\mathrm{Log}\left[\left(b\,(1-2\,t)^{-K/2}\,(-1+2\,t)\right)\Big/(-1+(2+b\,K)\,t)\right],\ \{t,1\}\right]\ /.\ t\to 0\right]$$

$$(1+b)\,K$$

"Second Central Moment"

$$\mathrm{Simplify}\left[D\left[\mathrm{Log}\left[\left(b\,(1-2\,t)^{-K/2}\,(-1+2\,t)\right)\Big/(-1+(2+b\,K)\,t)\right],\ \{t,2\}\right]\ /.\ t\to 0\right]$$

$$K\left(2+4\,b+b^2\,K\right)$$

"Third Central Moment"

$$\mathrm{Simplify}\left[D\left[\mathrm{Log}\left[\left(b\,(1-2\,t)^{-K/2}\,(-1+2\,t)\right)\Big/(-1+(2+b\,K)\,t)\right],\ \{t,3\}\right]\ /.\ t\to 0\right]$$

$$2\,K\left(4+12\,b+6\,b^2\,K+b^3\,K^2\right)$$

"Finding the central moments of a non central chi squared Random variable where the channel is Gamma distributed."

"Finding the expression of the expected MGF, where the MGF where lambda is Gamma distributed"

"Considering a case where the energy measurements consists of K samples, where K samples witness N different realization of the channel, 1 < N <K"

```
Integrate[1 / Gamma[a] × 1 / b^a Exp[K x t / (1 - 2 t)] / (1 - 2 t)^(K / 2)
  x^(a - 1) Exp[- x / b] , {x, 0, Infinity} ]
```

$$\text{ConditionalExpression}\left[b^{-a}\,(1-2\,t)^{-K/2}\left(\frac{1}{b}+\frac{K\,t}{-1+2\,t}\right)^{-a},\ \text{Re}\left[\frac{1-(2+b\,K)\,t}{b-2\,b\,t}\right]>0\,\&\&\,\text{Re}\left[\frac{K\,t}{1-2\,t}\right]<\text{Re}\left[\frac{1}{b}\right]\&\&\,\text{Re}[a]>0\right]$$

"First Central Moment"

$$\text{Simplify}\left[D\left[\text{Log}\left[b^{-a}\,(1-2\,t)^{-K/2}\left(\frac{1}{b}+\frac{K\,t}{-1+2\,t}\right)^{-a}\right],\ \{t,1\}\right]\ /.\ t\to 0\right]$$

$$K+a\,b\,K$$

"Second Central Moment"

$$\text{Simplify}\left[D\left[\text{Log}\left[b^{-a}\,(1-2\,t)^{-K/2}\left(\frac{1}{b}+\frac{K\,t}{-1+2\,t}\right)^{-a}\right],\ \{t,2\}\right]\ /.\ t\to 0\right]$$

$$K\,(2+a\,b\,(4+b\,K))$$

"Third Central Moment"

$$\text{Simplify}\left[D\left[\text{Log}\left[b^{-a}\,(1-2\,t)^{-K/2}\left(\frac{1}{b}+\frac{K\,t}{-1+2\,t}\right)^{-a}\right],\ \{t,3\}\right]\ /.\ t\to 0\right]$$

$$2\,K\,\left(4+a\,b\,\left(12+6\,b\,K+b^2\,K^2\right)\right)$$

"Fourth Central Moment"

$$\text{Simplify}\left[D\left[\text{Log}\left[b^{-a}\,(1-2\,t)^{-K/2}\left(\frac{1}{b}+\frac{K\,t}{-1+2\,t}\right)^{-a}\right],\ \{t,4\}\right]\ /.\ t\to 0\right]$$

$$6\,K\,\left(8+a\,b\,\left(32+24\,b\,K+8\,b^2\,K^2+b^3\,K^3\right)\right)$$

"Considering a case where the energy measurements consists of K samples, where each sample witness a different realization of the channel"

"MGF defined for K = 1"

```
Simplify[Integrate[1 / Gamma[a] × 1 / b^a Exp[ x t / (1 - 2 t)] / (1 - 2 t)^(1 / 2)
   x^(a - 1) Exp[- x / b] , {x, 0, Infinity} ]]
```

$$\text{ConditionalExpression}\left[\frac{b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}}{\sqrt{1-2\,t}},\ \text{Re}\left[\frac{1-(2+b)\,t}{b-2\,b\,t}\right]>0\,\&\&\,\text{Re}\left[\frac{t}{1-2\,t}\right]<\text{Re}\left[\frac{1}{b}\right]\&\&\,\text{Re}[a]>0\right]$$

"MGF for K"

$$\left(\frac{b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}}{\sqrt{1-2\,t}}\right)\text{^}K$$

$$\left(\frac{b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}}{\sqrt{1-2\,t}}\right)^K$$

"First Central Moment"

$$\text{Simplify}\left[\text{D}\left[\text{Log}\left[\left(\left(b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}\right)\Big/\left(\sqrt{1-2\,t}\right)\right)^{K}\right],\ \{t,1\}\right]\ /.\ t\to 0\right]$$

$$K + a\,b\,K$$

"Second Central Moment"

$$\text{Simplify}\left[\text{D}\left[\text{Log}\left[\left(\left(b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}\right)\Big/\left(\sqrt{1-2\,t}\right)\right)^{K}\right],\ \{t,2\}\right]\ /.\ t\to 0\right]$$

$$(2+a\,b\,(4+b))\,K$$

"Third Central Moment"

$$\text{Simplify}\left[\text{D}\left[\text{Log}\left[\left(\left(b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}\right)\Big/\left(\sqrt{1-2\,t}\right)\right)^{K}\right],\ \{t,3\}\right]\ /.\ t\to 0\right]$$

$$2\,\left(4+a\,b\,\left(12+6\,b+b^{2}\right)\right)\,K$$

"Fourth Central Moment"

$$\text{Simplify}\left[\text{D}\left[\text{Log}\left[\left(\left(b^{-a}\left(\frac{1}{b}+\frac{t}{-1+2\,t}\right)^{-a}\right)\Big/\left(\sqrt{1-2\,t}\right)\right)^{K}\right],\ \{t,4\}\right]\ /.\ t\to 0\right]$$

$$6\,\left(8+a\,b\,\left(32+24\,b+8\,b^{2}+b^{3}\right)\right)\,K$$

"Determine the density of a random variable Z = XY that involves the product of two random variables , where X Inverse-Gamma distributed Regulated power and Z Gamma-distributed channel"

"First determine the density z"

```
Integrate[ 1 / (Gamma[a1] b1^a1 Gamma[a2] b2^(a2)) x^(a1 + a2 - 1)
  Exp[- (x / b1) - (x / (z b2))] / z^(a2 + 1) , {x, 0, Infinity}]
```

$$\text{ConditionalExpression}\left[\left(b1^{-a1}\,b2^{-a2}\left(\frac{1}{b1}+\frac{1}{b2\,z}\right)^{-a1-a2} z^{-1-a2}\,\text{Gamma}[a1+a2]\right)\Big/\left(\text{Gamma}[a1]\,\text{Gamma}[a2]\right),\ \text{Re}\left[\frac{1}{b1}+\frac{1}{b2\,z}\right]>0\ \&\&\ \text{Re}[a1+a2]>0\right]$$

"Distribution function"

$$\text{Simplify}\left[\text{Integrate}\left[\left(\text{b1}^{-\text{a1}}\,\text{b2}^{-\text{a2}}\left(\frac{1}{\text{b1}}+\frac{1}{\text{b2 z}}\right)^{-\text{a1}-\text{a2}}\text{z}^{-1-\text{a2}}\,\text{Gamma}[\text{a1}+\text{a2}]\right)\Big/\right.\right.$$
$$\left.\left.(\text{Gamma}[\text{a1}]\,\text{Gamma}[\text{a2}]),\ \{\text{z},0,\text{z1}\}\right]\right]$$

$$\text{ConditionalExpression}\left[\left(\left(\frac{1}{\text{b1}}\right)^{-\text{a1}-\text{a2}}\text{b1}^{-\text{a1}}\,\text{b2}^{-\text{a2}}\,\text{z1}^{-\text{a2}}\left(\frac{\text{b2 z1}}{\text{b1}}\right)^{\text{a1}+\text{a2}}\text{Gamma}[\text{a1}+\text{a2}]\right.\right.$$
$$\left.\text{Hypergeometric2F1}\left[\text{a1},\ \text{a1}+\text{a2},\ 1+\text{a1},\ -\frac{\text{b2 z1}}{\text{b1}}\right]\right)\Big/(\text{a1 Gamma}[\text{a1}]\,\text{Gamma}[\text{a2}]),$$
$$\left.\left(\text{Re}\left[\frac{\text{b1}}{\text{b2 z1}}\right]\geq 0\ ||\ \text{Re}\left[\frac{\text{b1}}{\text{b2 z1}}\right]\leq -1\ ||\ \frac{\text{b1}}{\text{b2 z1}}\notin\text{Reals}\right)\ \&\&\ \text{Re}[\text{a1}]>0\ \&\&\ \text{Re}\left[\frac{1}{\text{b1}}\right]>0\right]$$

"Determine the Expected value"

$$\text{Simplify}\left[\text{Integrate}\left[\right.\right.$$
$$\text{z}\left(\text{b1}^{-\text{a1}}\,\text{b2}^{-\text{a2}}\left(\frac{1}{\text{b1}}+\frac{1}{\text{b2 z}}\right)^{-\text{a1}-\text{a2}}\text{z}^{-1-\text{a2}}\,\text{Gamma}[\text{a1}+\text{a2}]\right)\Big/(\text{Gamma}[\text{a1}]\,\text{Gamma}[\text{a2}]),$$
$$\left.\left.\{\text{z},0,\text{Infinity}\}\right]\right]$$

$$\text{ConditionalExpression}\left[\left(\text{b1}^{-\text{a1}}\left(\frac{1}{\text{b2}}\right)^{-\text{a1}-\text{a2}}\text{b2}^{-\text{a2}}\left(\frac{\text{b2}}{\text{b1}}\right)^{-1-\text{a1}}\text{Gamma}[1+\text{a1}]\,\text{Gamma}[-1+\text{a2}]\right)\Big/\right.$$
$$(\text{Gamma}[\text{a1}]\,\text{Gamma}[\text{a2}]),\ \left(\text{Re}\left[\frac{\text{b1}}{\text{b2}}\right]\geq 0\ ||\ \frac{\text{b1}}{\text{b2}}\notin\text{Reals}\right)\ \&\&$$
$$\left.(1+\text{a1})\ \text{Arg}\left[\frac{\text{b2}}{\text{b1}}\right]\leq\pi\ \&\&\ \text{Re}[\text{a1}]>-1\ \&\&\ \text{Re}[\text{a2}]>1\ \&\&\ \text{Re}\left[\frac{1}{\text{b2}}\right]>0\right]$$

"Density of non central chi-squared distribution with parameter lambda is exp distributed"

```
Simplify[Integrate[1 / (2) Exp[-(x + K l) / 2 ] (x / (K l)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K l x)] Exp[-l], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\right.$$
$$\left(e^{-\frac{x}{2+p}}\left(\frac{x}{p}\right)^{\frac{1}{4}(-2+p)}(p\,x)^{\frac{2+p}{4}}\left(\frac{p\,x}{2+p}\right)^{-p/2}\left(\text{Gamma}\left[-1+\frac{p}{2}\right]-\text{Gamma}\left[-1+\frac{p}{2},\ \frac{p\,x}{4+2\,p}\right]\right)\right)\Big/$$
$$\left.\left((2+p)^2\,\text{Gamma}\left[-1+\frac{p}{2}\right]\right),\ \text{Re}[p]<6\ \&\&\ 2+\text{Re}[p]>0\ \&\&\ \left(\text{Im}\left[\sqrt{p\,x}\right]>0\ ||\ \text{Re}\left[\sqrt{p\,x}\right]>0\right)\right]$$

"Distribution function"

```
Integrate[
 (E^(-x/(2+p)) (x/p)^(1/4 (-2+p)) (p x)^((2+p)/4) ((p x)/(2+p))^(-p/2) (Gamma[-1 + p/2] - Gamma[-1 + p/2, (p x)/(4 + 2 p)]))/
  ((2 + p)^2 Gamma[-1 + p/2]), {x, 0, x1}]
```

$$\frac{1}{x1^2} e^{-\frac{x1}{2+p}} \left(-1+e^{\frac{x1}{2+p}}\right) \left(\frac{x1}{p}\right)^{\frac{2+p}{4}} (p\,x1)^{\frac{2+p}{4}} \left(\frac{p\,x1}{2+p}\right)^{1-\frac{p}{2}} -$$
$$\left(-\left(\frac{1}{p}\right)^{\frac{2+p}{4}} p^{\frac{2+p}{4}} \left(\frac{p}{2+p}\right)^{-p/2} (2+p)^{1-\frac{p}{2}} \left(p^{1+\frac{p}{2}}+2\,p^{p/2}-p\,(2+p)^{p/2}\right) \text{Gamma}\left[\frac{1}{2}(-2+p), 0\right] + \right.$$
$$e^{-\frac{x1}{2+p}} x1^{1-\frac{p}{2}} \left(\frac{x1}{p}\right)^{\frac{1}{4}(-2+p)} (p\,x1)^{\frac{2+p}{4}} \left(\frac{p\,x1}{2+p}\right)^{-1-\frac{p}{2}} \left(-p\,x1^{p/2}\,\text{Gamma}\left[-1+\frac{p}{2}, \frac{p\,x1}{4+2\,p}\right] + \right.$$
$$\left.\left. e^{\frac{x1}{2+p}} (2+p) \left(\frac{p\,x1}{2+p}\right)^{p/2} \text{Gamma}\left[\frac{1}{2}(-2+p), \frac{x1}{2}\right]\right)\right) \Big/ \left((2+p)^2\,\text{Gamma}\left[-1+\frac{p}{2}\right]\right)$$

"Density of a Inverse non central chi-squared distribution, where lambda is gamma distributed: Bessel function: Density of the regulated power at ST:Here the snr is exponetially distributed: Working: Version 1"

```
Simplify[
 Integrate[1 / (2) 1 / a × 1 / x^2 Exp[- (1 / x + K l) / 2 ] (1 / (x K l)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K l / x)] Exp[-l / a], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\left(a\,e^{-\frac{1}{2x+aKx}} (-2+K) \left(\frac{2}{a}+K\right)^{K/2} \left(\frac{1}{K\,x}\right)^{\frac{1}{4}(-2+K)} \left(\frac{K}{x}\right)^{\frac{1}{2}-\frac{K}{4}} \right.\right.$$
$$\left.\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2}, \frac{a\,K}{4\,x+2\,a\,K\,x}\right]\right)\right) \Big/ \left(2\,(2+a\,K)^2\,x^2\,\text{Gamma}\left[\frac{K}{2}\right]\right),$$
$$\left.(\text{Re}[a]\neq 0 \,||\, a\notin \text{Reals}) \,\&\&\, \text{Re}[K]<6 \,\&\&\, \left(\text{Im}\left[\sqrt{\frac{K}{x}}\right]>0 \,||\, \text{Re}\left[\sqrt{\frac{K}{x}}\right]>0\right)\right]$$

"Density of a Inverse non central chi-squared distribution, where lambda is gamma distributed: Bessel function: Density of the regulated power at ST:Here the energy (that isncludes path loss) is exponetially distributed: Working: version 2"

```
Simplify[
 Integrate[1 / (2) 1 / x^2 Exp[- (1 / x + K p l) / 2 ] (1 / (x p K l)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K p l / x)] Exp[-l], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\left(e^{-\frac{1}{2x+Kpx}} (-2+K)\,(2+K\,p)^{-2+\frac{K}{2}} \left(\frac{1}{K\,p}\right)^{\frac{1}{2}(-2+K)} \right.\right.$$
$$\left.\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2}, \frac{K\,p}{4\,x+2\,K\,p\,x}\right]\right)\right) \Big/ \left(2\,x^2\,\text{Gamma}\left[\frac{K}{2}\right]\right),$$
$$\left.\text{Re}[K]<6 \,\&\&\, \left(\text{Im}\left[\sqrt{\frac{K\,p}{x}}\right]>0 \,||\, \text{Re}\left[\sqrt{\frac{K\,p}{x}}\right]>0\right) \,\&\&\, \text{Re}[K\,p]>-2\right]$$

"Density of a Inverse non central chi-squared distribution, where lambda is gamma distributed: Bessel function: Density of the regulated power at ST:Here the energy (that includes path loss and noise power) is exponetially distributed: Working: version 3"

```
Simplify[Integrate[1 / (2)  1 / x^2 × 1 / np
   Exp[- (1 / (x np) + K pl l / np) / 2 ] (1 / (x pl K l)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √ (K pl l / (x np^2)) ] Exp[-l], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\left(e^{-\frac{1}{2\,np\,x+K\,pl\,x}}\,(-2+K)\,np\left(2+\frac{K\,pl}{np}\right)^{K/2}\left(\frac{1}{K\,pl\,x}\right)^{\frac{1}{4}(-2+K)}\left(\frac{K\,pl}{np^2\,x}\right)^{\frac{1}{2}-\frac{K}{4}}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\,(K\,pl)\Big/\left(4\,np^2\,x+2\,K\,np\,pl\,x\right)\right]\right)\right)\Big/\left(2\,(2\,np+K\,pl)^2\,x^2\,\text{Gamma}\left[\frac{K}{2}\right]\right),\ np\neq 0\,\&\&\,\text{Re}[K]<6\,\&\&\left(\text{Im}\left[\sqrt{\frac{K\,pl}{np^2\,x}}\right]>0\,||\,\text{Re}\left[\sqrt{\frac{K\,pl}{np^2\,x}}\right]>0\right)\right]$$

"Density of a Inverse non central chi-squared distribution, where lambda is gamma distributed: Bessel function: Density of the regulated power at ST:Here the energy (that includes path loss, noise power, interference temp, normalization constant) is exponetially distributed: Working: Final version"

```
Simplify[Integrate[K * it * nc / (2 np x^2)
   Exp[- K / (2 np) (nc it / x  +  pl g tp) ] (nc it / (x pl tp g)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √ (K^2 pl nc it tp g / (x np^2)) ] Exp[-g], {g, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\left(e^{-\frac{it\,K\,nc}{2\,np\,x+K\,pl\,tp\,x}}\,(-2+K)\,K\,np\,pl\,tp\left(2+\frac{K\,pl\,tp}{np}\right)^{K/2}\left(\frac{it\,nc}{pl\,tp\,x}\right)^{\frac{2+K}{4}}\left(\frac{it\,K^2\,nc\,pl\,tp}{np^2\,x}\right)^{\frac{1}{2}-\frac{K}{4}}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\,\left(it\,K^2\,nc\,pl\,tp\right)\Big/\left(4\,np^2\,x+2\,K\,np\,pl\,tp\,x\right)\right]\right)\right)\Big/\left(2\,(2\,np+K\,pl\,tp)^2\,x\,\text{Gamma}\left[\frac{K}{2}\right]\right),\ \text{Re}[K]<6\,\&\&\left(\text{Im}\left[\sqrt{\left(\left(it\,K^2\,nc\,pl\,tp\right)/\left(np^2\,x\right)\right)}\right]>0\,||\,\text{Re}\left[\sqrt{\left(\left(it\,K^2\,nc\,pl\,tp\right)/\left(np^2\,x\right)\right)}\right]>0\right)\&\&\ \text{Re}\left[\frac{K\,pl\,tp}{np}\right]>-2\right]$$

"Extension: Hypergeometric function: Working"

```
Simplify[Integrate[ 1 / x^2 × 1 / snr Exp[- (K l) / 2 ]
   Hypergeometric0F1[K / 2, K l / (4 x) ] 1 / 2^(K / 2) × 1 / Gamma[K / 2]
   Exp [-1 / (2 x)] (1 / x )^(K / 2 - 1) Exp[- l / snr], {l, 0, Infinity}]]
```

ConditionalExpression$\left[\left(e^{-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\,\left(\frac{1}{x}\right)^{2+\frac{K}{2}}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\ \frac{K\,snr}{4x+2K\,snr\,x}\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right),\ \frac{K}{x}\in\text{Reals}\ \&\&\ (\text{Re}[snr]\neq 0\ ||\ snr\notin\text{Reals})\ \&\&\ ((\text{Re}[K]\geq 0\ \&\&\ \text{Im}[K]==0)\ ||\ (\text{Re}[x]\geq 0\ \&\&\ \text{Im}[x]==0))\ \&\&\ ((\text{Re}[K]\leq 0\ \&\&\ \text{Im}[K]==0)\ ||\ (\text{Re}[x]\leq 0\ \&\&\ \text{Im}[x]==0))\right]$

"Find the Moment Generating method for the density of the regulated power ST: No closed form expression"

Integrate$\left[\left(e^{-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\,\left(\frac{1}{x}\right)^{2+\frac{K}{2}}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\ (K\,snr)\,/\,(4x+2K\,snr\,x)\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)\text{Exp}[-t\,x],\ \{x,\ 0,\ \text{Infinity}\}\right]$

$$\int_0^\infty\left(\left(e^{-t\,x-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\,\left(\frac{1}{x}\right)^{2+\frac{K}{2}}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\ (K\,snr)\,/\,(4x+2K\,snr\,x)\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)\right)dx$$

"Expected value for the density of the regulated power ST"

$$\text{Integrate}\left[\left(e^{-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\left(\frac{1}{x}\right)^{2+\frac{K}{2}}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\,(K\,snr)/(4x+2K\,snr\,x)\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)x,\ \{x,0,\text{Infinity}\}\right]$$

$$\text{ConditionalExpression}\Big[-\Big(\Big((-2+K)\left(\frac{K\,snr}{2+K\,snr}\right)^{-K/2}\text{Gamma}\left[-1+\frac{K}{2}\right]\Big(-(-2+K)\,\text{HypergeometricPFQ}\left[\left\{1,1,\frac{K}{2}\right\},\{2,2\},-\frac{2}{K\,snr}\right]+K\,snr\left(\text{EulerGamma}+\text{Log}\left[\frac{2}{K\,snr}\right]+\text{PolyGamma}\left[0,-1+\frac{K}{2}\right]\right)\Big)\Big)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)\Big),\ \text{Re}[K]>2\ \&\&\ \Big(\Big(\text{Im}[snr]+(\text{Im}[K]\,\text{Re}[snr])/\text{Re}[K]==0\ \&\&\ \text{Re}[snr]>-\left((2\,\text{Re}[K])\big/\left(\text{Im}[K]^2+\text{Re}[K]^2\right)\right)\Big)\ ||\ \left(\text{Re}[K\,snr]>-2\ \&\&\ \text{Re}\left[\frac{1}{-2-K\,snr}\right]\le 0\right)\Big)\Big]$$

"Second moment for the density of the regulated power ST: no closed form expression"

$$\text{Integrate}\left[\left(e^{-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\left(\frac{1}{x}\right)^{2+\frac{K}{2}}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\,(K\,snr)/(4x+2K\,snr\,x)\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)x\text{^}2,\ \{x,0,\text{Infinity}\}\right]$$

$$\int_0^\infty\left(\left(e^{-\frac{1}{2x+K\,snr\,x}}(-2+K)\,K\,snr\left(\frac{1}{x}\right)^{K/2}\left(\frac{K\,snr}{2x+K\,snr\,x}\right)^{-K/2}\left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2},\,(K\,snr)/(4x+2K\,snr\,x)\right]\right)\right)\Big/\left(2\,(2+K\,snr)^2\,\text{Gamma}\left[\frac{K}{2}\right]\right)\right)dx$$

"Extensions: non central distribution is apporoximated by the gamma distribution. In this case the parameters (a, b) are functions of lambda which is exponentially distributed: No closed form expression"

```
Integrate[x^((K (1 + l)^2 / (2 + 4 l)) - 1) / Gamma[K (1 + l)^2 / (2 + 4 l)]
  1/ ((2 + 4 l) / (1 + l))^(K (1 + l)^2 / (2+ 4 l))
  Exp[-x / ((2 + 4 l) / (1 + l))] Exp[-l], {l, 0, Infinity}]
```

```
Extensions: non central distribution is apporoximated
  by the gamma distribution. In this case the parameters (a,
  b) are functions of lambda which is exponentially distributed
```

$$\int_0^\infty \frac{e^{-l-\frac{x}{(1+l)\,(2+4\,l)}}\,\left(\frac{2+4\,l}{1+l}\right)^{-\frac{K\,(1+l)^2}{2+4\,l}}\,x^{-1+\frac{K\,(1+l)^2}{2+4\,l}}}{\text{Gamma}\left[\frac{K\,(1+l)^2}{2+4\,l}\right]}\,dl$$

"Density of a Inverse non central chi-squared distribution which is scaled with parameter lambda, where lambda (K snr) is gamma distributed: Density of the power received at PR: Working version 1"

```
Simplify[
 Integrate[1 / 2 × 1 / snr l / x^2 Exp[-(l / x + K l) / 2] (1 / (x K))^(K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K l^2 / x)] Exp[-l / snr], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\Bigg[\Bigg(2^{-1+\frac{K}{2}}\,K\,\text{snr}^2\left(\frac{1}{K\,x}\right)^{\frac{1}{4}\,(-2+K)}\left(\frac{K}{x}\right)^{\frac{1}{4}\,(-2+K)}$$

$$\left(\frac{1}{\text{snr}\,x}\left(\text{snr}+2\,x+K\,\text{snr}\,x+\text{snr}\,x\,\sqrt{\frac{-4\,K\,x+\frac{(\text{snr}+2\,x+K\,\text{snr}\,x)^2}{\text{snr}^2}}{x^2}}\right)\right)^{-K/2}\Bigg(8-4\,K+$$

$$\frac{(\text{snr}+2\,x+K\,\text{snr}\,x)^2}{\text{snr}^2\,x}+\frac{1}{\text{snr}}\,(\text{snr}+2\,x+K\,\text{snr}\,x)\,\sqrt{\frac{-4\,K\,x+\frac{(\text{snr}+2\,x+K\,\text{snr}\,x)^2}{\text{snr}^2}}{x^2}}\Bigg)\Bigg)\Big/$$

$$\left((\text{snr}+2\,x+K\,\text{snr}\,x)\,\sqrt{1-\frac{4\,K\,\text{snr}^2\,x}{(\text{snr}+2\,x+K\,\text{snr}\,x)^2}}\,\left(-4\,K\,\text{snr}^2\,x+(\text{snr}+2\,x+K\,\text{snr}\,x)^2\right)\right),$$

$$\text{Re}\left[-\frac{K}{2}-\frac{1}{\text{snr}}+\sqrt{\frac{K}{x}}\,-\frac{1}{2\,x}\right]<0\;\&\&\;\left(\text{Im}\left[\sqrt{\frac{K}{x}}\,\right]>0\;||\;\text{Re}\left[\sqrt{\frac{K}{x}}\,\right]>0\right)\;\&\&\;\text{Re}[K]>-2\Bigg]$$

"Density of a Inverse non central chi-squared distribution which is scaled with parameter lambda, where lambda (K path loss) is gamma distributed: Density of the power received at PR: version 2"

```
Simplify[Integrate[1 / 2 l p / x^2 Exp[- (l p / x + K p l) / 2] (1 / (x K)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K p^2 l^2 / x)] Exp[- l], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\frac{1}{p\,x}\left(\frac{1}{K\,x}\right)^{\frac{1}{4}(-2+K)}\left(\left(K\,p^2\,x\right)/\left(p+2\,x+K\,p\,x\right)^2\right)^{\frac{2+K}{4}}\right.$$
$$\text{Hypergeometric2F1}\left[\frac{2+K}{4},\frac{4+K}{4},\frac{K}{2},\frac{4\,K\,p^2\,x}{(p+2\,x+K\,p\,x)^2}\right],$$
$$\left.\left(\text{Im}\left[\sqrt{\frac{K\,p^2}{x}}\right]>0\,||\,\text{Re}\left[\sqrt{\frac{K\,p^2}{x}}\right]>0\right)\&\&\,\text{Re}[K]>-2\,\&\&\,\text{Re}\left[K\,p-2\sqrt{\frac{K\,p^2}{x}}+\frac{p}{x}\right]>-2\right]$$

"Density of a Inverse non central chi-squared distribution which is scaled with parameter lambda, where lambda (K path loss) is gamma distributed: Density of the power received at PR: version 3: noise power included"

```
Simplify[Integrate[
  1 / 2 l pl / x^2 1 / np Exp[- (l pl / (x np) + K pl l / np) / 2] (1 / (x K)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, √(K pl^2 l^2 / (x np^2))] Exp[- l], {l, 0, Infinity}]]
```

$$\text{ConditionalExpression}\left[\frac{1}{pl\,x}\,np\left(\frac{1}{K\,x}\right)^{\frac{1}{4}(-2+K)}\left(\left(K\,pl^2\,x\right)/\left(pl+2\,np\,x+K\,pl\,x\right)^2\right)^{\frac{2+K}{4}}\right.$$
$$\text{Hypergeometric2F1}\left[\frac{2+K}{4},\frac{4+K}{4},\frac{K}{2},\left(4\,K\,pl^2\,x\right)/\left(pl+2\,np\,x+K\,pl\,x\right)^2\right],$$
$$\left(\text{Im}\left[\sqrt{\frac{K\,pl^2}{np^2\,x}}\right]>0\,||\,\text{Re}\left[\sqrt{\frac{K\,pl^2}{np^2\,x}}\right]>0\right)\&\&\,\text{Re}[K]>-2\,\&\&$$
$$\left.\text{Re}\left[\frac{1}{np\,x}\left(pl+K\,pl\,x-2\,np\sqrt{\frac{K\,pl^2}{np^2\,x}}\,x\right)\right]>-2\right]$$

"Density of a Inverse non central chi-squared distribution which is scaled with parameter lambda, where lambda (K path loss) is gamma distributed: Density of the power received at PR: version 4: noise power, path loss, interference temperature, transmission power and normalization constant included"

```
Simplify[Integrate[K nc it g pl / (2 np x^2)
  Exp[-K g pl / (2 np) (nc it / x + tp ) ] (nc it / (x tp)) ^ (K / 4 - 1 / 2)
  BesselI[K / 2 - 1, K pl g / np √(nc it tp / x)] Exp[-g], {g, 0, Infinity}]]
```

ConditionalExpression$\Big[$

$$\frac{1}{\text{it nc pl}}\,\text{np}\left(\frac{\text{it nc}}{\text{tp x}}\right)^{\frac{2+K}{4}}\left(\left(\text{it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\right)^{\frac{2+K}{4}}$$
$$\text{Hypergeometric2F1}\Big[\frac{2+K}{4},\ \frac{4+K}{4},\ \frac{K}{2},$$
$$\left(4\text{ it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\Big],\ \text{Re}\left[\frac{\text{K pl}\sqrt{\frac{\text{it nc tp}}{x}}}{\text{np}}\right]\geq 0\ \&\&$$
$$\left(\text{Im}\left[\frac{\text{K pl}\sqrt{\frac{\text{it nc tp}}{x}}}{\text{np}}\right]>0\ ||\ \text{Re}\left[\frac{\text{K pl}\sqrt{\frac{\text{it nc tp}}{x}}}{\text{np}}\right]>0\right)\ \&\&\ \text{Re}[K]>-2\Big]$$

"Expected value"

$$\textbf{Integrate}\Big[x\,\frac{1}{\text{it nc pl}}\,\text{np}\left(\frac{\text{it nc}}{\text{tp x}}\right)^{\frac{2+K}{4}}$$
$$\left(\left(\text{it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\right)^{\frac{2+K}{4}}\text{Hypergeometric2F1}\Big[\frac{2+K}{4},$$
$$\frac{4+K}{4},\ \frac{K}{2},\ \left(4\text{ it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\Big],\ \{x,\ 0,\ \text{Infinity}\}\Big]$$

$$\int_0^\infty \frac{1}{\text{it nc pl}}\,\text{np}\left(\frac{\text{it nc}}{\text{tp x}}\right)^{\frac{2+K}{4}} x$$
$$\left(\left(\text{it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\right)^{\frac{2+K}{4}}\text{Hypergeometric2F1}\Big[$$
$$\frac{2+K}{4},\ \frac{4+K}{4},\ \frac{K}{2},\ \left(4\text{ it }K^2\text{ nc pl}^2\text{ tp x}\right)/\left(\text{it K nc pl}+2\text{ np x}+\text{K pl tp x}\right)^2\Big]\,dx$$

Integrate$\left[\left(2^{-1+\frac{K}{2}} K\, snr^2 \left(\frac{1}{K x}\right)^{\frac{1}{4}(-2+K)} \left(\frac{K}{x}\right)^{\frac{1}{4}(-2+K)} \left(\frac{1}{snr\, x}\left(snr + 2 x + K\, snr\, x + snr\, x \sqrt{\left(\frac{1}{x^2}\left(-4 K x + (snr + 2 x + K\, snr\, x)^2 / snr^2\right)\right)}\right)\right)^{-K/2} \left(8 - 4 K + (snr + 2 x + K\, snr\, x)^2 / \left(snr^2 x\right) + \frac{1}{snr}(snr + 2 x + K\, snr\, x) \sqrt{\left(\frac{1}{x^2}\left(-4 K x + (snr + 2 x + K\, snr\, x)^2 / snr^2\right)\right)}\right)\right) / \left((snr + 2 x + K\, snr\, x) \sqrt{\left(1 - \left(4 K\, snr^2 x\right) / (snr + 2 x + K\, snr\, x)^2\right)} \left(-4 K\, snr^2 x + (snr + 2 x + K\, snr\, x)^2\right)\right), \{x, 0, x1\}\right]$

$$\int_0^\infty \left(\left(2^{-1+\frac{K}{2}} K\, snr^2 \left(\frac{1}{K x}\right)^{\frac{1}{4}(-2+K)} \left(\frac{K}{x}\right)^{\frac{1}{4}(-2+K)} \left(\frac{1}{snr\, x}\left(snr + 2 x + K\, snr\, x + snr\, x \sqrt{\left(\frac{1}{x^2}\left(-4 K x + (snr + 2 x + K\, snr\, x)^2 / snr^2\right)\right)}\right)\right)^{-K/2} \left(8 - 4 K + (snr + 2 x + K\, snr\, x)^2 / \left(snr^2 x\right) + \frac{1}{snr}(snr + 2 x + K\, snr\, x) \sqrt{\left(\frac{1}{x^2}\left(-4 K x + (snr + 2 x + K\, snr\, x)^2 / snr^2\right)\right)}\right)\right) / \left((snr + 2 x + K\, snr\, x) \sqrt{\left(1 - \left(4 K\, snr^2 x\right) / (snr + 2 x + K\, snr\, x)^2\right)} \left(-4 K\, snr^2 x + (snr + 2 x + K\, snr\, x)^2\right)\right)\right) dx$$

"Other way round, first compute the distribution function and then average over different channel realizations"

```
Simplify[Integrate[1 / 2 × 1 / snr l / x^2 Exp[- (l / x + K l) / 2 ]
   (1 / (x K)) ^ (K / 4 - 1 / 2) BesselI[K / 2 - 1, √(K l^2 / x)] , {x, 0, x1}]]
```

$$\int_0^{x1} \frac{1}{2\, snr\, x^2} e^{-\frac{l + K l x}{2 x}}\, l \left(\frac{1}{K x}\right)^{\frac{1}{4}(-2+K)} \text{BesselI}\left[-1 + \frac{K}{2}, \sqrt{\frac{K l^2}{x}}\right] dx$$

"Inverse exponential random variable"

"Expected value"

```
Integrate[ Exp[-t y] np / y^2 Exp[-np / y], {y, 0, Infinity}]
```

ConditionalExpression$\left[2 \sqrt{np} \sqrt{t}\ \text{BesselK}\left[1, 2 \sqrt{np} \sqrt{t}\right], \text{Re}[t] > 0\ \&\&\ \text{Re}[np] > 0\right]$

"First Moment"

Limit$\left[D\left[2 \sqrt{np} \sqrt{t}\ \text{BesselK}\left[1, 2 \sqrt{np} \sqrt{t}\right], t\right], t \to 0\right]$

$np\,(-\infty)$

```
Simplify[Integrate[x K nc it pl / (2 np x^2)
   Exp[-K pl / (2 np) (nc it / x + tp ) ] (nc it / (x tp)) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, K pl / np √(nc it tp / x)] , {x, 0, Infinity}]]
```

$$\int_0^\infty \frac{1}{2\,np}\, e^{-\frac{K\,pl\,\left(tp+\frac{it\,nc}{x}\right)}{2\,np}}\, K\,pl\,tp\,\left(\frac{it\,nc}{tp\,x}\right)^{\frac{2+K}{4}}\, \mathrm{BesselI}\left[-1+\frac{K}{2},\,\frac{K\,pl\,\sqrt{\frac{it\,nc\,tp}{x}}}{np}\right]\, dx$$

$$\int_0^\infty \frac{1}{2\,np\,x}\, e^{-\frac{K\,pl\,\left(tp+\frac{it\,nc}{x}\right)}{2\,np}}\, K\,pl\,tp\,\left(\frac{it\,nc}{tp\,x}\right)^{\frac{2+K}{4}}\, \mathrm{BesselI}\left[-1+\frac{K}{2},\,\frac{K\,pl\,\sqrt{\frac{it\,nc\,tp}{x}}}{np}\right]\, dx$$

$$\int_0^\infty \frac{1}{2\,np\,x}\, e^{-\frac{K\,pl\,\left(tp+\frac{it\,nc}{x}\right)}{2\,np}}\, K\,pl\,tp\,\left(\frac{it\,nc}{tp\,x}\right)^{\frac{2+K}{4}}\, \mathrm{BesselI}\left[-1+\frac{K}{2},\,\frac{K\,pl\,\sqrt{\frac{it\,nc\,tp}{x}}}{np}\right]\, dx$$

" Determining the density for the scaling factor and calulating the expected value "

In[1]:=
```
Simplify[
 Integrate[K g pl / (2 np ) Exp[-K / (2 np) (x g pl + tp pl g) ] (x / tp) ^ (K / 4 - 1 / 2)
   BesselI[K / 2 - 1, K g pl / np √( tp)] Exp[-g], {g, 0, Infinity}]]
```

Out[1]=

$$\mathrm{ConditionalExpression}\Big[\Big(K^2\,np\,pl\,tp^{\frac{1}{4}(-2+K)}\left(\frac{x}{tp}\right)^{\frac{1}{4}(-2+K)} \mathrm{Abs}[K]^{-1+\frac{K}{2}}\, \mathrm{Abs}[np]^{1-\frac{K}{2}}\, \mathrm{Abs}[pl]^{-1+\frac{K}{2}}\, \mathrm{Abs}\left[\frac{2\,np+K\,pl\,(tp+x)}{np}\right]^{1-\frac{K}{2}} \mathrm{Hypergeometric2F1}\left[\frac{2+K}{4},\,\frac{4+K}{4},\,\frac{K}{2},\,\frac{4\,K^2\,pl^2\,tp}{(2\,np+K\,pl\,(tp+x))^2}\right]\Big) \Big/ (2\,np+K\,pl\,(tp+x))^2,\ \mathrm{Re}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]\geq 0\ \&\&\ \left(\mathrm{Im}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]>0\ ||\ \mathrm{Re}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]>0\right)\ \&\&\ \mathrm{Re}[K]>-2\Big]$$

In[2]:=
```
Integrate[% x, {x, 0, Infinity}]
```

Out[2]=

$$\int_0^\infty \mathrm{ConditionalExpression}\Big[\Big(K^2\,np\,pl\,tp^{\frac{1}{4}(-2+K)}\,x\left(\frac{x}{tp}\right)^{\frac{1}{4}(-2+K)} \mathrm{Abs}[K]^{-1+\frac{K}{2}}\, \mathrm{Abs}[np]^{1-\frac{K}{2}}\, \mathrm{Abs}[pl]^{-1+\frac{K}{2}}\, \mathrm{Abs}\left[\frac{2\,np+K\,pl\,(tp+x)}{np}\right]^{1-\frac{K}{2}} \mathrm{Hypergeometric2F1}\left[\frac{2+K}{4},\,\frac{4+K}{4},\,\frac{K}{2},\,\frac{4\,K^2\,pl^2\,tp}{(2\,np+K\,pl\,(tp+x))^2}\right]\Big) \Big/ (2\,np+K\,pl\,(tp+x))^2,\ \mathrm{Re}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]\geq 0\ \&\&\ \left(\mathrm{Im}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]>0\ ||\ \mathrm{Re}\left[\frac{K\,pl\,\sqrt{tp}}{np}\right]>0\right)\ \&\&\ \mathrm{Re}[K]>-2\Big]\, dx$$

"MGF"

In[6]:=
```
Simplify[
 Integrate[K g pl / (2 np ) Exp[-K / (2 np) (x g pl + tp pl g) ] (x / tp)^(K / 4 - 1 / 2)
   BesselI[K / 2 - 1, K g pl / np √( tp x)] Exp[-t x], {x, 0, Infinity}]]
```

Out[6]= ConditionalExpression[$\frac{1}{np} e^{-\frac{g K pl t tp}{g K pl+2 np t}} g K pl \left(\frac{g K pl}{np}+2 t\right)^{-K/2} \left(\frac{1}{tp}\right)^{\frac{1}{4}(-2+K)} \left(\frac{g^2 K^2 pl^2 tp}{np^2}\right)^{\frac{1}{4}(-2+K)}$,

(Re[np] ≠ 0 || np ∉ Reals) && Re[K] > 0]

"First Central moment"

In[7]:= **Simplify[D[Log[** $\frac{1}{np} e^{-\frac{g K pl t tp}{g K pl+2 np t}} g K pl \left(\frac{g K pl}{np}+2 t\right)^{-K/2} \left(\frac{1}{tp}\right)^{\frac{1}{4}(-2+K)} \left(\frac{g^2 K^2 pl^2 tp}{np^2}\right)^{\frac{1}{4}(-2+K)}$ **],**
{t, 1}] /. t → 0]

Out[7]= $-\frac{np + g\,pl\,tp}{g\,pl}$

In[8]:= **Integrate[** $\frac{np + g\,pl\,tp}{g\,pl}$ **, {g, 0, Infinity}]**

Integrate::idiv : Integral of $\frac{np}{g\,pl}+tp$ does not converge on {0, ∞}. ≫

Out[8]= $\int_0^\infty \frac{np + g\,pl\,tp}{g\,pl}\, dg$

" Determining the density for the received power with fading "

In[9]:=
```
Simplify[
 Integrate[K / (2 np ) Exp[-K / (2 np) (x + tp pl g) ] (x / (g pl tp))^(K / 4 - 1 / 2)
   BesselI[K / 2 - 1, K / np √( tp pl g x)] Exp[-g], {g, 0, Infinity}]]
```

Out[9]= ConditionalExpression[
$\left(e^{-\frac{K x}{2 np+K pl tp}} (-2+K) K np \left(2+\frac{K pl tp}{np}\right)^{K/2} \left(\frac{x}{pl tp}\right)^{\frac{1}{4}(-2+K)} \left(\frac{K^2 pl tp x}{np^2}\right)^{\frac{1}{2}-\frac{K}{4}} \left(\text{Gamma}\left[-1+\frac{K}{2}\right]-\text{Gamma}\left[-1+\frac{K}{2}, \frac{K^2 pl tp x}{4 np^2+2 K np pl tp}\right]\right)\right) \Big/ \left(2 (2 np+K pl tp)^2 \text{Gamma}\left[\frac{K}{2}\right]\right)$, np ≠ 0 && Re[K] < 6 && Re[$\frac{K\sqrt{pl tp x}}{np}$] ≥ 0 &&
(Im[$\frac{K\sqrt{pl tp x}}{np}$] > 0 || Re[$\frac{K\sqrt{pl tp x}}{np}$] > 0)]