i.e.

$$\frac{u^{2N} S_u^2 \det(\Lambda)^{\cancel{\;}}}{2^N \omega_N} \sim X^N \qquad 2$$

~~$\sim$~~ exp

So $N=1 \Rightarrow$

$$\frac{u^2 S_u^2 \det(\Lambda)}{2\omega_N^2} \sim \exp(1)$$

$$1-e^{-\lambda x} \qquad \Rightarrow S_u^2 \sim \exp\left(\frac{u^2 \det(\Lambda)}{2\omega_N}\right)$$

$X, Y \sim \exp(\lambda)$

$\Rightarrow aY \sim \exp\left(\frac{\lambda}{a}\right)$

$S_u = 2\sqrt{2(u-v)/\lambda}$

$\mathbb{P}(aY > x) = e^{-\lambda x/a}$

$$\Rightarrow \frac{S_u^2}{8} \sim \frac{u-v}{\lambda}$$

$\boxed{u-v \sim \exp(1)}$