

Let there be 2 systems with statistical #s Ω_1, Ω_2 , they will correspond to entropy $S_1 = f(\Omega_1), S_2 = f(\Omega_2)$.

The statistical # must be multiplicative, yet the entropy must add, thus

$$S_1 + S_2 = f(\Omega_1) + f(\Omega_2) = f(\Omega_1 \times \Omega_2)$$

$$\Rightarrow f = k \ln \Omega$$