$$h = a e^{j\phi}$$

$$f_{A,\phi}(a,\phi) = \frac{a}{\pi} e^{-a^2}$$

$$F_A(a) = 2a e^{-a^2} \leftarrow \text{Rayleigh Density.}$$

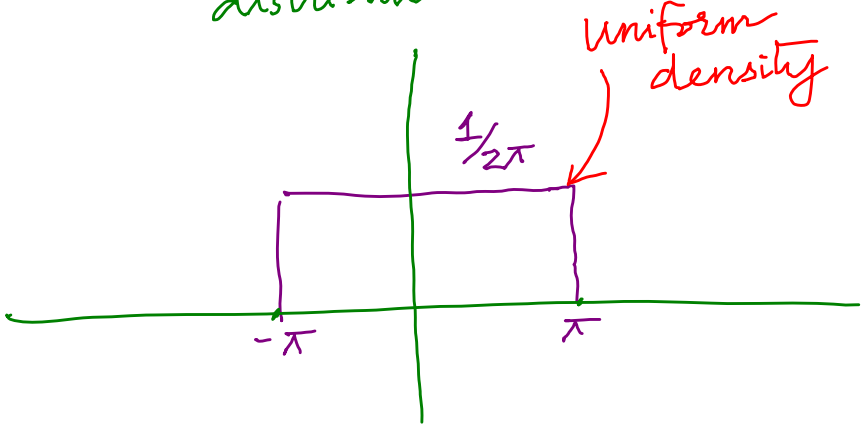
$$F_\phi(\phi) = \int_0^\infty f_{A,\phi}(a,\phi)\, da$$

$$= \int_0^\infty \frac{a}{\pi} e^{-a^2} da = \frac{1}{2\pi} \int_0^\infty 2a e^{-a^2} da$$

$$= \frac{1}{2\pi} \cdot \left(-e^{-a^2}\right)\Big|_0^\infty = \frac{1}{2\pi}$$

$$f_\phi(\phi) = \frac{1}{2\pi} \qquad -\pi < \phi \leq \pi$$

uniform distribution



$$f_A(a) = 2ae^{-a^2} \qquad 0 \le a \le \infty$$

$$f_\phi(\phi) = \frac{1}{2\pi} \qquad -\pi < \phi \le \pi$$

densities of amplitude (a) & phase (ϕ)

$$f_{A,\phi}(a,\phi) = \frac{a}{\pi} e^{-a^2}$$

$$= \frac{1}{2\pi} \cdot 2ae^{-a^2}$$

$$f_{A,\phi}(a,\phi) = f_\phi(\phi) \cdot f_A(a)$$

Joint density = Product of Marginal densities

A, ϕ are independent random variables.

Example: What is the probability that the attenuation of the channel is worse than 20 dB?

Gain of channel $= a^2$

$$10 \log_{10} a^2 < -20 \text{ dB}$$

$$\log_{10} a^2 < -2$$

$$a^2 < 10^{-2} = 0.01$$

$$\Rightarrow \quad a < 0.1$$

$$f_A(a) = 2ae^{-a^2}$$

$$Pr(a < 0.1) = \int_0^{0.1} 2ae^{-a^2}\,da$$

$$= -e^{-a^2}\Big|_0^{0.1}$$

$$= 1 - e^{-0.01}$$

$$\approx 0.01$$

Probability that attenuation is worse than 20dB.