For this channel, the fading process $a(t)$ is a complex Gaussian process with a specific Doppler power spectrum (or psd) $S(f)$. A way to simulate a Rayleigh fading channel is given as follows:

1. Generate a complex Gaussian process with variance 1 (the real and imaginary part each have variance 1/2).
2. Filter the process with a Doppler filter (e.g., FIR filter) with frequency response $H(f) = \sqrt{S(f)}$ and impulse response $h(t) = \mathbb{F}^{-1}\{H(f)\}$, where $\mathbb{F}^{-1}\{.\}$ denotes inverse Fourier transform. The impulse response is sampled at a rate f_s, to obtain a discrete-time impulse response $h(n)$.
3. Scale the filtered Gaussian noise sequence to obtain the desired average power.

The process is illustrated in Figure 1.

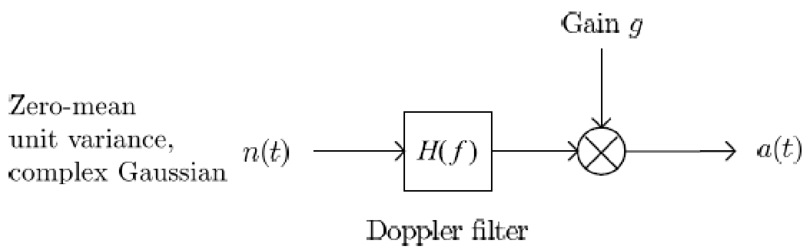

Figure 1: Generation of channel gain processes.

One of the commonly used Doppler power spectrum models is the Jakes Doppler spectrum which is given by:

$$S(f) = \frac{1}{\pi f_d \sqrt{1-(f/f_d)^2}}, \quad |f| \le f_d \tag{1}$$

where f_d is the maximum Doppler shift. The corresponding autocorrelation is:

$$R(\tau) = J_0(2\pi f_d \tau) \tag{2}$$

where $J_0(x)$ is the Bessel function of the first kind of order 0. The impulse response of the Doppler filter can be derived as

$$h(t) = \Gamma(3/4)\left(\frac{f_d}{\pi|t|}\right)^{1/4} J_{1/4}(2\pi f_d|t|) \tag{3}$$

where $\Gamma(.)$ is the gamma function. The value of $h(t)$ at $t = 0$ is calculated as $\lim_{t\to 0} h(t) = \Gamma(3/4)/\Gamma(5/4) f_d^{1/2}$.

The discrete-time impulse response used for simulation is a sampled, truncated (to M points), causal (delayed by $M/2$ points) version of $h(t)$, given by

$$\begin{aligned} h(n) &= h((n - M/2)t_s) \\ &= \Gamma(3/4)\left(\frac{f_d}{\pi|(n - M/2)t_s|}\right)^{1/4} J_{1/4}(2\pi f_d|(n - M/2)t_s|) \end{aligned} \tag{4}$$

for $n = 0, 1, ..., M - 1$. To reduce the effect of the Gibbs phenomenon due to truncation, the sampled impulse response $h(n)$ is multiplied by a window, e.g., a Hamming window, to obtain the windowed impulse response of the shaping filter:

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$$h_w(n) = h(n) w_H(n), \quad n = 0, 1, ..., M - 1 \tag{5}$$

The windowed impulse response is then normalized such that its total power is 1:

$$\bar{h}(n) = \frac{h_w(n)}{\sqrt{\sum_{m=0}^{M-1} |h_w(m)|^2}} \tag{6}$$