Performance of Macrodiversity System with Two SC Microdiversity Receivers in the Presence of Rician Fading

Dragana S. Krstic, Mihajlo C. Stefanovic, Danijela A. Aleksic, Ivica Marjanovic, and Goran Petkovic

***Abstract*—**In this work, macrodiversity system consisting of macrodiversity selection combining (SC) receiver and two microdiversity SC receivers in the presence of shadowing and multipath fading is considered. Communication channel is subjected to Gamma long term fading and Rician short term fading. Probability density function (PDF), cumulative distribution function (CDF) and average level crossing rate (LCR) of macrodiversity SC receiver output signal envelope are calculated. The obtained expressions for PDF, CDF and LCR converge for any values of Gamma long term fading parameters and Rician short term fading parameters. Also, the influence of Gamma shadowing parameters and Rician multipath fading parameters on PDF, CDF and LCR are analyzed and discussed.

***Keywords*—**Gamma shadowing; level crossing rate, macrodiversity and microdiversity, Rician fading.

I. Introduction

Long term fading and short term fading are present in communication channel simultaneously, resulting in system performance degradation [1]. Reflections and refractions cause multipath propagation resulting in signal envelope variation and large obstacles cause shadowing resulting in signal envelope average power variation. Macrodiversity system enables simultaneously reduction of long term fading effects and short term fading effects on system performance in wireless communication channels. Macrodiversity system has macrodiversity receiver and two or more microdiversity receivers. Macrodiversity receiver mitigates shadowing effects fading effects and microdiversity receivers mitigate multipath fading effects. There are more distributions that can be used model signal envelope variation and signal envelope average power variation in communication channels in the presence of short term fading and long term fading. Mathematical model for describing short term fading channel depend on existence the line-of-site components, the number of clusters in propagation environment, non-homogenous of environment and inequality of quadrature components powers [2].

Rician distribution can describe multipath fading channel in the presence of one strong dominant component and more scattering components in propagation environment with one cluster. This distribution has parameter k. Parameter k is Rician factor. Rician factor is defined as ratio of dominant component power to scattering component power. When Rician factor goes to infinity, Rician fading channel becomes no fades channel and when Rician factor goes to zero, Rician fading channel becomes Rayleigh fading channel. Rician fading model has application in cellular mobile radio channel and land mobile satellite environment.

Long term fading channel can be modeled by using long-normal distribution or Gamma distribution. When large scale fading is described with Gamma distribution, expressions for PDF and CDF of receiver output signal can be derived in closed form. In this case, performance analysis of wireless communication systems is simpler.

There are more works considering outage probability and bit error probability of wireless communication systems with macrodiversity reception in the presence of long term fading and short term fading. In [3], average level crossing rate (LCR) and average fade duration (AFD) of wireless communication system with macrodiversity selection combining (SC) receiver and two microdiversity maximal ratio combining (MRC) receivers operating over Gamma shadowed Nakagami-m multipath fading channel are evaluated.

The paper [4] also considers second-order statistics of wireless communication system with micro- and macrodiversity reception in correlated gamma shadowed Nakagami-m fading channels. Here, macrolevel is of selection combining (SC) type and consists of two base stations (dual diversity), while N-branch receiver employing maximal ratio combining (MRC) is implemented on microlevel. Rapidly converging infinite-series expressions for LCR and AFD are derived.

Macrodiversity system including macrodiversity SC

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receiver and two microdiversity SC receivers is considered in [5]. Received signal experiences long term Rayleigh fading and short term Gamma shadowing. Closed form expressions for level crossing rate of microdiversity SC receivers output signals envelopes are calculated. This expression is used for evaluation of level crossing rate of macrodiversity SC receiver output signal envelope.

Effect of microdiversity and macrodiversity on average bit error probability in Gamma-shadowed Rician fading channels are investigated in [6]. The second order statistics of macrodiversity system working over Gamma shadowing and Rician multipath fading channel are calculated in [7]. The probability density function, cumulative distribution function and moments of macrodiversity output signal are computed.

In [8], a wireless communication system with a wireless communication system with two *L*-branch MRC receivers at the micro level and a dual-branch SC receiver at the macro level in gamma-shadowed Rician fading channels is considered. Exact and rapidly converging infinite-series expressions for the average level crossing rate and average fade duration at the output of the system are provided.

In this paper, macrodiversity system with macrodiversity SC receiver and two microdiversity SC receivers in the presence of shadowing and multipath fading is considered. The received signal experiences Rician short term fading resulting in signal envelope variation and Gamma long term fading resulting in signal envelope average power variation. Closed form expressions for probability density function, cumulative distribution function and average level crossing rate of macrodiversity SC receiver output signal are evaluated.

Probability density function can be used for calculation the important performance measures of wireless system such as outage probability and bit error probability. The obtained results are analyzed to calculate the influence of shadowing parameters and multipath fading parameters on system performance. To the best authors' knowledge, the performance of macrodiversity system with two microdiversity SC receivers operating over correlated Gamma shadowed Rician multipath fading is not reported in the available technical literature.

II. Rician Random Variable Level Crossing Rate

Rician random variable follows distribution:

$$p_x(x)=\frac{2x}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot I_0\left(\frac{2Ax}{\Omega}\right)=$$

$$=\frac{2x}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}I_0\left(\frac{Ax}{\Omega}\right)^{2i_1}\cdot\frac{1}{(i_1!)^2}=$$

$$=\frac{2}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot x^{2i_1+1} \qquad (1)$$

where Ω is average square value of *x*, A is dominant component and $I_0(x)$ is modified Bessel function of the first kind, zero order and argument *x*. The cumulative distribution function of Rician random variable is:

$$F_x(x)=\int_0^x p_x(t)dt=$$

$$=\frac{2}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot x^{2i_1+1}\int_0^x dt\; e^{-\frac{t^2}{\Omega}}t^{2i_1+1}=$$

$$=\frac{2}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot\frac{1}{2}\Omega^{i_1}\gamma\left(i_1,\frac{x^2}{\Omega}\right) \qquad (2)$$

The joint probability density function of Rician random variable and its first derivative is

$$p_{x\dot{x}}(x\dot{x})=p_x(x)\cdot p_{\dot{x}}(\dot{x})=$$

$$=\frac{2}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot x^{2i_1+1}\frac{1}{\sqrt{2\pi}\,\beta}e^{-\frac{\dot{x}^2}{2\beta^2}} \qquad (3)$$

where variance of $\dot{x}$ is:

$$\beta^2=\pi^2 f_m^2\Omega,$$

with f_m being maximal Dopler frequency.

Average level crossing rate of Rician random process can be calculated as average value of the first derivation of Rician random process:

$$N_x=\int_0^{\infty}d\dot{x}\;\dot{x}\,p_{x\dot{x}}(x\dot{x})=$$

$$=\frac{2}{\Omega}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot x^{2i_1+1}\frac{1}{\sqrt{2\pi}}\pi f_m\Omega^{1/2}=$$

$$=\frac{f_m\sqrt{2\pi}}{\Omega^{1/2}}e^{-\frac{x^2}{\Omega}}\cdot\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{\Omega^{2i_1}}\cdot\frac{1}{(i_1!)^2}\cdot x^{2i_1+1} \qquad (4)$$

Probability density function of dual SC receiver output signal operating over identical, independent Rician multipath fading channel is:

$$p_y(y)=2p_{y_1}(y)\cdot F_{y_2}(y)$$

where y_1 and y_2 are signal envelope at input of SC receiver and *y* is SC receiver output signal envelope, as it is shown in Fig.1. $p_{y_1}(y)$ is given by (1) and $F_{y_1}(y)$ is given by (2) .

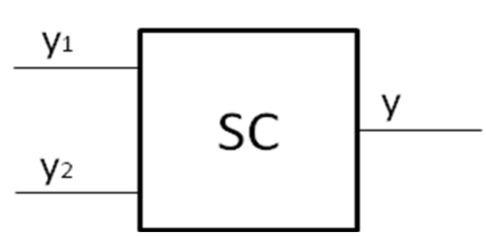

Fig. 1 SC receiver model

Cumulative distribution function of SC receiver output signal is:

$$F_y(y) = F_{y_1}(y) F_{y_2}(y) = \left(F_{y_1}(y)\right)^2 . \qquad (5)$$

Average level crossing rate of SC receiver output signal is:

$$N_y = 2F_{y_1}(y) \cdot N_{y_1} \qquad (6)$$

where N_{y_1} is given by (4).

III. Performance of Macrodiversity System

Macrodiversity system with macrodiversity SC receiver and two microdiversity SC receivers operating over Gamma shadowed Rician multipath fading channel is considered. Model of macrodiversity system is shown in Fig. 2.

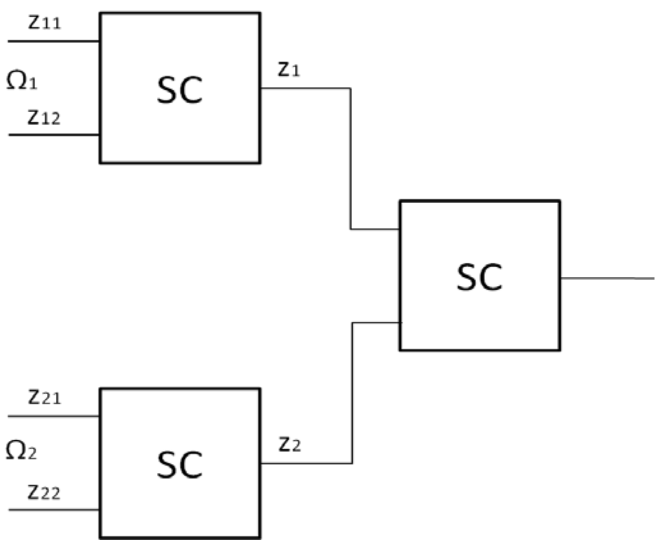

Fig. 2 System model

Signal envelopes at inputs of the first SC receiver are denoted with z_{11} and z_{12}, and z_{11} and at the second with z_{21} and z_{22}. Signal envelopes at outputs of microdiversity receivers are z_1 and z_2, and macrodiversity SC receiver output signal is z.

Signal envelope average power of inputs of microdiversity receivers, Ω_1 and Ω_2, follows joint Gamma distribution [9]:

$$p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) = \frac{1}{\Gamma(c)\left(1-\rho^2\right)\rho^{\frac{c-1}{2}}\Omega_0^{c+1}} \cdot$$

$$\cdot e^{-\frac{\Omega_1+\Omega_2}{\Omega_0\left(1-\rho^2\right)}} I_{c-1}\left(\frac{2\rho}{\Omega_0\left(1-\rho^2\right)}\Omega_1^{1/2}\Omega_2^{1/2}\right) =$$

$$= \frac{1}{\Gamma(c)\left(1-\rho^2\right)\rho^{\frac{c-1}{2}}\Omega_0^{c+1}} \cdot \sum_{i_2=0}^{\infty}\left(\frac{\rho}{\Omega_0\left(1-\rho^2\right)}\right)^{2i_2+c}\frac{1}{i_2!\,\Gamma(i_2+c)} \cdot$$

$$\cdot \Omega_1^{2i_2+c-1}\Omega_2^{2i_2+c-1} \cdot e^{-\frac{\Omega_1+\Omega_2}{\Omega_0\left(1-\rho^2\right)}} \qquad (7)$$

Macrodiversity SC receiver selects microdiversity SC receiver with the highest signal envelope average power at inputs to provide service to user. Therefore, probability density function of macrodiversity SC receiver output signal is:

$$p_z(z) = \int_0^{\infty} d\Omega_1 \int_0^{\Omega_1} d\Omega_2\, p_{z_1}(z/\Omega_1)\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) +$$

$$= \int_0^{\infty} d\Omega_2 \int_0^{\Omega_2} d\Omega_1\, p_{z_2}(z/\Omega_2)\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= 2\int_0^{\infty} d\Omega_1 \int_0^{\Omega_1} d\Omega_2\, p_{z_1}(z/\Omega_1)\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= 4\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{(i_1!)^2}\cdot x^{2i_1+1}\cdot\sum_{i_2=0}^{\infty}\frac{A^{2i_2}}{(i_2!)^2}\cdot$$

$$\cdot\frac{1}{i_2}x^{2i_2}\sum_{j_1=0}^{\infty}\frac{1}{(i_2+1)(j_1)}x^{2j_1} \cdot$$

$$\cdot\frac{1}{\Gamma(c)\left(1-\rho^2\right)\rho^{\frac{c-1}{2}}\Omega_0^{c+1}}\cdot\sum_{i_3=0}^{\infty}\left(\frac{\rho}{\Omega_0\left(1-\rho^2\right)}\right)^{2i_3+c}\frac{1}{i_3!\,\Gamma(i_3+c)}\cdot$$

$$\cdot\frac{1}{i_3+c}\cdot\frac{1}{\left(\Omega_0\left(1-\rho^2\right)\right)^{i_3+c}}\sum_{j_2=0}^{\infty}\frac{1}{(i_3+c+1)(j_2)}\left(\frac{1}{\Omega_0\left(1-\rho^2\right)}\right)^{j_2}\cdot$$

$$\cdot\int_0^{\infty} d\Omega_1 \cdot \Omega_1^{-1-1-2i_1-i_2-i_2-j_1+i_3+c+j_2+i_3+c-1}\cdot e^{-\frac{2x^2}{\Omega_1}-\frac{\Omega_1}{\Omega_0\left(1-\rho^2\right)}} =$$

$$= 4\sum_{i_1=0}^{\infty}\frac{A^{2i_1}}{(i_1!)^2}\cdot x^{2i_1+1}\cdot\sum_{i_2=0}^{\infty}\frac{A^{2i_2}}{(i_2!)^2}\cdot\frac{1}{i_2}x^{2i_2}\sum_{j_1=0}^{\infty}\frac{1}{(i_2+1)(j_1)}x^{2j_1}\cdot$$

$$\cdot\frac{1}{\Gamma(c)\left(1-\rho^2\right)\rho^{\frac{c-1}{2}}\Omega_0^{c+1}}\cdot\sum_{i_3=0}^{\infty}\left(\frac{\rho}{\Omega_0\left(1-\rho^2\right)}\right)^{2i_3+c}\frac{1}{i_3!\,\Gamma(i_3+c)}\cdot$$

$$\cdot\frac{1}{i_3+c}\cdot\frac{1}{\left(\Omega_0\left(1-\rho^2\right)\right)^{i_3+c}}\sum_{j_2=0}^{\infty}\frac{1}{(i_3+c+1)(j_2)}\left(\frac{1}{\Omega_0\left(1-\rho^2\right)}\right)^{j_2}\cdot$$

$$\cdot\left(2x^2\Omega_0\left(1-\rho^2\right)\right)^{-1-i_1-i_2-j_1/2+i_3+c+j_2/2}\cdot$$

$$\cdot K_{-2-2i_1-2i_2-j_1+2i_3+2c+j_2}\left(2\sqrt{\frac{2x^2}{\Omega_0\left(1-\rho^2\right)}}\right) \qquad (8)$$

Cumulative distribution function of macrodiversity SC receiver output signal is:

$$F_z(z) = \int_0^{\infty} d\Omega_1 \int_0^{\Omega_1} F_{z_1}(z/\Omega_1)\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2)\, d\Omega_2 +$$

$$= \int_0^{\infty} d\Omega_2 \int_0^{\Omega_2} d\Omega_1\, F_{z_2}(z/\Omega_2)\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= 2\int_0^\infty d\Omega_1 \int_0^{\Omega_1} d\Omega_2 F_{z_1}(z/\Omega_1) p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= \sum_{i_1=0}^{\infty} \frac{A^{2i_1}}{(i_1!)^2} \cdot \frac{1}{i_1} x^{2i_1} \sum_{j_1=0}^{\infty} \frac{1}{(i_1+1)(j_1)} x^{2j_1} \cdot$$

$$\cdot \sum_{i_2=0}^{\infty} \frac{A^{2i_2}}{(i_2!)^2} \cdot \frac{1}{i_2} x^{2i_2} \sum_{j_2=0}^{\infty} \frac{1}{(i_2+1)(j_2)} x^{2j_2} \cdot$$

$$\cdot \frac{1}{\Gamma(c)(1-\rho^2)\rho^{\frac{c-1}{2}} \Omega_0^{c+1}} \cdot \sum_{i_3=0}^{\infty} \left(\frac{\rho}{\Omega_0(1-\rho^2)}\right)^{2i_3+c} \frac{1}{i_3!\,\Gamma(i_3+c)} \cdot$$

$$\cdot \frac{1}{i_3+c} \cdot \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{i_3+c} \sum_{j_3=0}^{\infty} \frac{1}{(i_3+c+1)(j_3)} \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{j_3} \cdot$$

$$\cdot \int_0^\infty d\Omega_1 \cdot \Omega_1^{-1-i_1-i_1-j_1-1-i_2-i_2-j_2+i_3+c+j_3+i_3+c-1} \cdot e^{-\frac{2x^2}{\Omega_1} - \frac{\Omega_1}{\Omega_0(1-\rho^2)}} =$$

$$= \sum_{i_1=0}^{\infty} \frac{A^{2i_1}}{(i_1!)^2} \cdot \frac{1}{i_1} x^{2i_1} \sum_{j_1=0}^{\infty} \frac{1}{(i_1+1)(j_1)} x^{2j_1} \cdot$$

$$\cdot \sum_{i_2=0}^{\infty} \frac{A^{2i_2}}{(i_2!)^2} \cdot \frac{1}{i_2} x^{2i_2} \sum_{j_2=0}^{\infty} \frac{1}{(i_2+1)(j_2)} x^{2j_2} \cdot$$

$$\cdot \frac{1}{\Gamma(c)(1-\rho^2)\rho^{\frac{c-1}{2}} \Omega_0^{c+1}} \cdot \sum_{i_3=0}^{\infty} \left(\frac{\rho}{\Omega_0(1-\rho^2)}\right)^{2i_3+c} \frac{1}{i_3!\,\Gamma(i_3+c)} \cdot$$

$$\cdot \frac{1}{i_3+c} \cdot \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{i_3+c} \sum_{j_3=0}^{\infty} \frac{1}{(i_3+c+1)(j_3)} \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{j_3} \cdot$$

$$\cdot \left(2x^2 \Omega_0 (1-\rho^2)\right)^{-1-i_1-j_1/2-i_2-j_2/2+i_3+c+j_3/2} \cdot$$

$$\cdot K_{-2-2i_1-j_1-2i_2-j_2+2i_3+2c+j_3}\left(2\sqrt{\frac{2x^2}{\Omega_0(1-\rho^2)}}\right). \qquad (9)$$

Level crossing rate of macrodiversity SC receiver output signal envelope is:

$$N_z = \int_0^\infty d\Omega_1 \int_0^{\Omega_1} d\Omega_2\, N_{z_1/\Omega_1}\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) +$$

$$= \int_0^\infty d\Omega_2 \int_0^{\Omega_2} d\Omega_1\, N_{z_2/\Omega_2}\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= 2\int_0^\infty d\Omega_1 \int_0^{\Omega_1} d\Omega_2\, N_{z_1/\Omega_1}\, p_{\Omega_1\Omega_2}(\Omega_1\Omega_2) =$$

$$= 2 \cdot 2 \cdot \sum_{i_1=0}^{\infty} \frac{A^{2i_1}}{(i_1!)^2} \cdot \frac{1}{i_1} 2x^{2i_1} \sum_{j_1=0}^{\infty} \frac{1}{(i_1+1)(j_1)} x^{2j_1} \cdot$$

$$\cdot f_m \sqrt{2\pi} \cdot \sum_{i_2=0}^{\infty} \frac{A^{2i_2}}{(i_2!)^2} \cdot \frac{1}{i_2} x^{2i_2+1} \cdot \frac{1}{\Gamma(c)(1-\rho^2)\rho^{\frac{c-1}{2}} \Omega_0^{c+1}} \cdot$$

$$\cdot \sum_{i_3=0}^{\infty} \left(\frac{\rho}{\Omega_0(1-\rho^2)}\right)^{2i_3+c} \frac{1}{i_3!\,\Gamma(i_3+c)} \cdot \left(\Omega_0(1-\rho^2)\right)^{i_3+c} \cdot$$

$$\cdot \frac{1}{i_3+c} \cdot \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{i_3+c} \sum_{j_2=0}^{\infty} \frac{1}{(i_3+c+1)(j_2)} \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{j_2} \cdot$$

$$\cdot \int_0^\infty d\Omega_1 \cdot \Omega_1^{-1-i_1-i_1-j_1-1/2-2i_2+i_1+c-1+i_1+c+j_2} \cdot e^{-\frac{2x^2}{\Omega_1} - \frac{\Omega_1}{\Omega_0(1-\rho^2)}} =$$

$$= 4 \cdot \sum_{i_1=0}^{\infty} \frac{A^{2i_1}}{(i_1!)^2} \cdot \frac{1}{i_1} x^{2i_1} \sum_{j_1=0}^{\infty} \frac{1}{(i_1+1)(j_1)} x^{2j_1} \cdot$$

$$\cdot f_m \sqrt{2\pi} \cdot \sum_{i_2=0}^{\infty} \frac{A^{2i_2}}{(i_2!)^2} \cdot \frac{1}{i_2} x^{2i_2+1} \cdot$$

$$\cdot \frac{1}{\Gamma(c)(1-\rho^2)\rho^{\frac{c-1}{2}} \Omega_0^{c+1}} \cdot$$

$$\cdot \sum_{i_3=0}^{\infty} \left(\frac{\rho}{\Omega_0(1-\rho^2)}\right)^{2i_3+c} \frac{1}{i_3!\,\Gamma(i_3+c)} \cdot \left(\Omega_0(1-\rho^2)\right)^{i_3+c} \cdot$$

$$\cdot \frac{1}{i_3+c} \cdot \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{i_3+c} \sum_{j_2=0}^{\infty} \frac{1}{(i_3+c+1)(j_2)} \left(\frac{1}{\Omega_0(1-\rho^2)}\right)^{j_2} \cdot$$

$$\cdot \left(2x^2 \Omega_0 (1-\rho^2)\right)^{-1/2-i_1-j_1/2-1/4-i_2+i_3+c+j_2/2} \cdot$$

$$\cdot K_{-1-2i_1-j_1-1/2-2i_2+2i_3+c+j_2}\left(2\sqrt{\frac{2x^2}{\Omega_0(1-\rho^2)}}\right) \qquad (10)$$

IV. Analysis of Numerical Results

In Fig. 3, normalized average level crossing rate of macrodiversity SC receiver output signal envelope is ploted versus SC receiver output signal envelope for several values of Rician factor, Gamma long term fading severity, parameter and correlation coefficient of Gamma shadowing.

When output signal envelope increases, the normalized average level crossing rate increases, achieves maximum, and after that decreases again.

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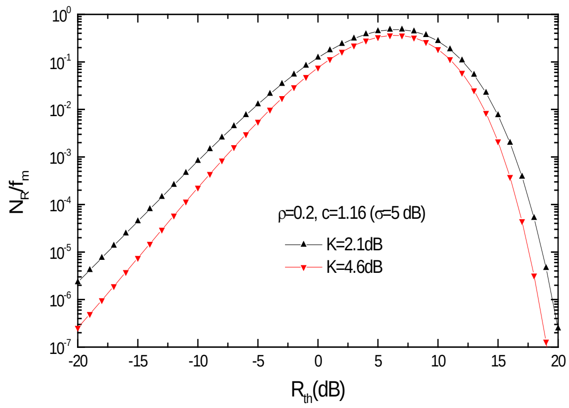

Fig. 3 Normalized average LCR versus normalized signal level for different values of Rician factor K

System performance is better for lower values of average level crossing rate. Average level crossing rate decreases and outage probability also decreases when Rician factor increases.

The Rician factor has lower values as dominant component power decreases or scattering components power increases. When Rician factor goes to infinity, Gamma shadowed Rician multipath fading channel becomes Gamma long term fading channel, and when Rician factor goes to zero, Rician multipath fading channel reduces to Gamma shadowed Rayleigh multipath fading channel. Average level crossing rate has higher values as Gamma shadowing severity parameter decreases.

The influence of Gamma parameter on average level crossing rate is higher for lower values of Rician factor. When Gamma parameter goes to infinity, Gamma shadowed Rician multipath fading channel becomes pure Rician multipath fading channel. Also, normalized level crossing rate of SC receiver output signal increases when correlation coefficient of Gamma shadow increases. When correlation coefficient goes to one, macrodiversity system becomes microdiversity system. Gamma long term fading is correlated due to both base stations are shadowed by the same obstacles. When correlation coefficient goes to one, the lowest sigbnal envelope occurs, simultaneously, on both base stations.

V. Conclusion

Macrodiversity system with macrodiversity selection combining receiver and two microdiversity SC receivers operating over shadowed multipath fading channel is considered. Received signal experiences Gamma long term fading and Rician short term fading. Macrodiversity SC receiver reduces Gamma long term effects and microdiversity SC receivers mitigate Rician short term fading effects on system performance. Microdiversity SC receiver selects the diversity branch with the highest signal envelope and macrodiversity SC receiver selects microdiversity receiver with the highest signal envelope average power at its inputs to provide service to user. Microdiversity SC receiver combine signals with multiple antennas at base stations and macrodiversity SC receiver combines signals envelope with two or more base stations geographically distributed in cell.

In this paper, probability density function and cumulative distribution function of SC receiver output signal envelope are calculated.Also, average level crossing rate at output of microdiversity SC receivers are evaluated and using these expressions, average level crossing rate of macrodiversity SC receiver output signal is calculated. These expressions rapidly converge for any values of Gamma shadowing severity parameter, correlation coefficient of shadowing and Rician factor. From obtained expressions for level crossing rate, level crossing rate of macrodiversity system in the presence of Rayleigh fading can be calculated as special case for Rician factor being zero.

In this paper, the influence of Gamma shadowing severity parameter, correlation coefficient of shadowing and Rician factor on average level crossing rate is studied. Average level crossing rate of macrodiversity SC receiver output signal envelope increases as Rician factor and Gamma shadowing severity parameter decrease. Shadowing correlation is resulting in diversity gain degradation. Average level crossing rate increases as correlation coefficient goes to one. The influence of correlation coefficient on average level crossing rate is highest when Sc receiver signal envelope has lower values.

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