Next-to-Leading Order Corrections to Capacity for Nondispersive Nonlinear Optical Fiber Channel in Intermediate Power Region

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The problem of information transmission through a noisy communication channel is considered more than 60 years. The problem was solved by Shannon in his seminal work [1,2]. In [1,2] Shannon considered the linear introduced communication channel with additive Gaussian noise. Shannon introduced such quantity as the channel capacity C, which gives the maximum amount of information that can be reliably transmitted over a noisy communication channel. He demonstrated that for the linear communication channel with additive Gaussian noise the result for the channel capacity has the form:

$$C \propto \log\left(1 + \mathrm{SNR}\right), \tag{1}$$

where $\mathrm{SNR} = P/N$ is the signal-to-noise power ratio, P is the signal power, and N is the noise power. In our previous paper [3, 4] we demonstrated that for the optical fiber channel modelled by the nonlinear Shrödinger equation with zero dispersion and additive Gaussian noise the behaviour of the channel capacity differs form result (1). For the channel the capacity grows as $\log\log P$ instead $\log P$ in the intermediate power region. In the present paper we find corrections to conditional probability density function, output signal distribution, conditional and output signal entropies, and the channel capacity at large signal-to-noise ratio for the optical fiber channel modelled by the nonlinear Shrödinger equation with zero dispersion using Feynman path-integral approach. We demonstrate that the correction to the channel capacity is positive for large signal power. Therefore, this correction increases the earlier calculated capacity for a nondispersive nonlinear optical fiber channel in the intermediate power region. This correction also extends the applicability region for the channel capacity obtained earlier.

References

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