THE INFLUENCE OF STOCHASTIC FILTER EFFECT ON SOLITON TRANSMISSION SYSTEM

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Abstract
The model of stochastic filter effect is built in soliton transmission system, the influence is studied of the stochastic filter effect on soliton transmission system. The results show: the stochastic filter effect leads to the time jitters in arrival, and reduces the capacity of soliton transmission system. Enhancing the strength of filter can suppress well the influence.

Key words: soliton transmission system; stochastic filter effect; time jitters in arrival; filter.

Introduce
The soliton communication, which carries message with stable optical soliton pulse, and entirely undoes limit of fiber dispersion for signal transmission rate, is a long distance high rate optimal future communication scheme, recently the soliton communication has been considered to be promising and studied actively. When optical soliton pulses is transmitting in transmission line, they need periodically optical amplifiers to compensate loss, the meantime the amplifier spontaneous emission noise also is amplified, the ASEN leads to the random walk of coherently amplified solitons in optical fiber transmission, this limits the capacity of long distance communication (G-H effect)[1]. In ultra long distance soliton transmission, the main limit to the single-channel bit rate is caused by the time jitters in soliton pulse arriving time from Gordon-Haus effect limit, in order to suppress the G-H effect, soliton control in times and in frequency domains are used[2,3].
The stochastic perturbations are unneglected stochastic process in soliton communication, they have some bad influences on soliton transmission system, such as increasing the time jitters in arrival, reducing the communication capacity of soliton system[4]. In this paper, the model of stochastic filter effect is built in soliton transmission system, the influence is studied of the stochastic filter effect on soliton transmission system, by the perturbation method of the conservation of momentum and energy.

Theory

The soliton pulse transmitting in fiber can be described by nonlinear Schrodinger equation

\[ i \frac{\partial u}{\partial \xi} + \frac{1}{2} \frac{\partial^2 u}{\partial \tau^2} + |u|^2 u = iG + i\beta \frac{\partial^2 u}{\partial \tau^2} \]  

(1)

here, \( u \) is the dimensionless envelop function, \( \xi = z / L_o \), \( \tau = t / T_o \), \( T_o \) is pulse width, \( L_o \) is the dispersion length, \( G \) is the gain of system, \( \beta \) is the second order effect of filter.

In order to ensure the stable soliton pulse transmitting in transmission line, the interaction between soliton pulses should be reduced, the soliton self frequency shift and the G-H effect should be suppressed, so the filters should be set periodically in transmission line, such as the band-limit amplifier system. But because there is difference of structure and the working condition among filters, the performance property of every filter is different, the role of filters have some stochastic and fluctuation, from accurate condition, the second order effect of filter \( \beta \) should be the function of both distance \( \xi \) and frequency \( \omega \), for transmitting distance variation \( \Delta \xi \), the \( \beta(\xi + \Delta \xi, \omega - \omega_0) \) can be described as

\[ \beta(\xi + \Delta \xi, \omega - \omega_0) = \beta_0 + \frac{\partial \beta(\xi, \omega)}{\partial \xi} |_{\xi} \Delta \xi \]

(2)

\[ + \frac{\partial \beta(\xi, \omega)}{\partial \omega} |_{\omega = \omega_0} (\omega - \omega_0) \]

here, \( \beta_0 \) is the average second order effect of filter, \( \omega_0 \) is the center frequency of soliton pulse, the second and third term of the right of the eqn. (2) is equal to