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Temperature effect on dissipative holographic screening-photovoltaic solitons in a biased dissipative system*

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In a biased dissipative photovoltaic–photorefractive system, this paper investigates the temperature effect on the evolution and the self-deflection of the dissipative holographic screening-photovoltaic (DHSP) solitons. The results reveal that, the evolution and the self-deflection of the bright and dark DHSP solitons are influenced by the system temperature. At a given temperature, for a stable DHSP soliton originally formed in the dissipative system, it attempts to evolve into another DHSP soliton when the temperature change is appropriately small, whereas it will become unstable or break down if the temperature departure is large enough. Moreover, the self-deflection degree of the solitary beam centre increases as temperature rises in some range, while it is decided by the system parameters and is slight under small-signal condition. The system temperature can be adjusted to change the formation and the self-deflection of the solitary beam in order to gain certain optical ends. In a word, the system temperature plays a role for the DHSP solitons in the dissipative system.

Keywords: dissipative holographic screening-photovoltaic solitons, temperature effect, dissipative system

PACC: 4265J, 7820, 7240

1. Introduction

Spatial solitons in photorefractive (PR) crystal recently have been the interesting research topic.[1−11] They are promising for applications in all-optical beam switching and steering, optical interconnects, adaptive waveguiding and the development of novel photonic devices. Generally speaking, there are two types of physical mechanisms supporting steady-state optical spatial solitons in PR crystals. One is the self-phase-modulation self-focusing mechanism, which is responsible for the formation of screening solitons,[10−14] photovoltaic solitons[15−17] and screening-photovoltaic (SP) solitons,[7,18,19] the other is holographic focusing mechanism supporting the so-called holographic solitons,[20] which has aroused extensive interests, especially in dissipative system.[21−26]

As a result of the co-operation of two mechanisms, the holographic screening-photovoltaic soliton was proposed.[23] Such solitons can be supported and exist in a dissipative system via two-beam coupling, which is composed of a signal beam and a strong pump beam. In addition, they result from the photovoltaic effect, spatially nonuniform screening of the applied field and holographic effect, we can also call them dissipative holographic screening-photovoltaic (DHSP) solitons.

As is known, the PR effect, such as two-beam coupling and four-wave mixing, is strongly dependent on the system temperature,[27,28] and the diffusion process is dependent on the system temperature, too. Especially, since the DHSP solitons in the dissipative system are result of a double balance, one of which is that the loss is balanced by the gain, moreover, the gain g is relative to the temperature T. As a result, the evolution, the spatial shape and the self-deflection of a DHSP soliton will be dependent on temperature of the dissipative system. In addition, the self-deflection can deflect from its original trajectory and change the

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propagation direction of the solitary wave,[8,9,18,29,30] thus it may affect the two-beam coupling process between pump and signal beams, even destroy the DHSP soliton formation. However, the temperature effect on DHSP solitons in the dissipative system has not been investigated yet.

In this paper, we have investigated the temperature effect on the evolution and the self-deflection of bright and dark DHSP solitons in a biased dissipative photovoltaic–photorefractive (PV-PR) system. On one hand, our results show that the amplitude and the width of bright and dark DHSP solitons are sensitive to temperature of the dissipative system. For a stable DHSP soliton originally formed in a dissipative system at a given temperature, when the system temperature deviates from the given temperature, it will become unstable and even break down if the temperature change is large enough, whereas it attempts to evolve into another stable DHSP soliton only when the temperature difference is quite small. On the other hand, it is evident that the self-deflection of the DHSP solitary wave in the dissipative system is affected by the temperature, and it relies strongly on the temperature and increases with the increase of temperature, but it is slight under small-signal condition. Moreover, the bright DHSP solitons are much more sensitive to system temperature than the dark DHSP ones.

2. Theoretical model

The schematic configuration is shown in the Fig.1. We can consider an optical beam that propagates in a biased dissipative crystal along the z-axis and is permitted to diffract only along the x-direction which is also the direction of the applied field and the photovoltaic field of the crystal. The one-dimensional signal beam is extraordinary x polarized, it is permitted to diffract only along the y transverse dimension and confined in the x direction. The pump beam is also in linearly polarized direction making an angle φ with the x-axis, and it is of an uniform spatial distribution in both transverse dimensions. The signal and the pump beams are made to propagate in the dissipative system and each beam makes a small angle θ of its k vector with the z-axis. The two coherent beams couple to each other by two-beam coupling, then the signal beam obtains gain from the pump beam.[31,32] The slowly varying envelopes ($\phi_{\rm s}$ and $\phi_{\rm p}$) of the signal and pump beams are, respectively,

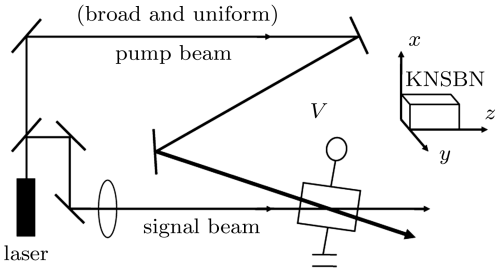


Fig.1. Illustration of the configuration for DHSP solitons in a biased dissipative PV-PR system via two-beam coupling. where c denotes the c axis of the system, V denotes the potential between the electrodes of the system.

$$\begin{aligned}
&\frac{1}{2k}\frac{\partial^2\phi_{\rm s}}{\partial x^2}+{\rm i}\cos\theta\frac{\partial\phi_{\rm s}}{\partial z}-k_0\frac{n_{\rm e}^3}{2}r_{33}E_{\rm sc}\phi_{\rm s}+\left(\Gamma_0-\frac{\rm i}{2}\Gamma\right)\frac{|\phi_{\rm p}|^2}{|\phi_{\rm s}|^2+|\phi_{\rm p}|^2}\phi_{\rm s}+{\rm i}\frac{1}{2}\vartheta_0\phi_{\rm s}=0,\\
&\frac{1}{2k}\frac{\partial^2\phi_{\rm p}}{\partial x^2}+{\rm i}\cos\theta\frac{\partial\phi_{\rm p}}{\partial z}-k_0\frac{n_{\rm e}^3}{2}r_{33}E_{\rm sc}\phi_{\rm p}+\left(\Gamma_0+\frac{\rm i}{2}\Gamma\right)\frac{|\phi_{\rm s}|^2}{|\phi_{\rm s}|^2+|\phi_{\rm p}|^2}\phi_{\rm p}+{\rm i}\frac{1}{2}\vartheta_0\phi_{\rm p}=0,
\end{aligned}\tag{1}$$

where $k=k_0n_{\rm e}$, $k_0=2\pi/\lambda_0$, λ_0 is the free-space wavelength, $n_{\rm e}$ is the unperturbed extraordinary refractive index, Γ and Γ_0 are the intensity and phase coupling coefficients, ϑ_0 is the absorption coefficient of the dissipative system, respectively. When the signal beam is much weaker than the pump beam, the space-charge field $E_{\rm sc}$ is

$$\begin{aligned}
E_{\rm sc}=&E_0\frac{I_\infty+I_{\rm b}}{I_{\rm s}+I_{\rm b}}+E_{\rm ph}\frac{I_\infty-I_{\rm b}}{I_{\rm s}+I_{\rm b}}\\
&-\frac{K_{\rm B}T}{e}\frac{1}{I_{\rm s}+I_{\rm b}}\frac{\partial I_{\rm s}}{\partial x},
\end{aligned}\tag{2}$$

where E_0 is the applied field strength, $E_{\rm ph}$ is the photovoltaic field constant, $I_\infty=I_{\rm s}(x\to\pm\infty,z)$, $I_{\rm s}=I_{\rm s}(x,z)$ is the signal beam intensity, $k_{\rm B}$ is the Boltzmann constant, e is the electron charge, T is the

absolute temperature and I_b is the back-ground light intensity. For the dissipative system considered in this paper, we have $I_\mathrm{b} = I_\mathrm{p} + I_\mathrm{d}$, where I_p is the pump beam intensity and I_d is the dark irradiance intensity. One has $I_\mathrm{b} = I_\mathrm{p}$ since $I_\mathrm{d} \ll I_\mathrm{p}$.

Adopting $s = x/x_0$, $\xi = z/(z_0\cos\theta)$, where $z_0 = kx_0^2$, x_0 is an arbitrary spatial width and $\vartheta = z_0\vartheta_0/2$, we get the evolution equations about the normalized envelope of the couple-wave equations

$$\begin{aligned}
&\mathrm{i}\frac{\partial U_\mathrm{s}}{\partial\xi} + \frac{1}{2}\frac{\partial^2 U_\mathrm{s}}{\partial s^2} - \left[\beta(\rho+1)|U_\mathrm{p}|^2 + \alpha(\rho|U_\mathrm{p}|^2 - |U_\mathrm{s}|^2) - \gamma(|U_\mathrm{s}|^2)_\mathrm{ps}\right]\frac{U_\mathrm{s}}{|U_\mathrm{p}|^2+|U_\mathrm{s}|^2} \\
&+(g_0 - \mathrm{i}g)\frac{|U_\mathrm{p}|^2}{|U_\mathrm{p}|^2+|U_\mathrm{s}|^2}U_\mathrm{s} + \mathrm{i}\vartheta U_\mathrm{s} = 0, \\
&\mathrm{i}\frac{\partial U_\mathrm{p}}{\partial\xi} + \frac{1}{2}\frac{\partial^2 U_\mathrm{p}}{\partial s^2} - \left[\beta(\rho+1)|U_\mathrm{p}|^2 + \alpha(\rho|U_\mathrm{p}|^2 - |U_\mathrm{s}|^2) - \gamma(|U_\mathrm{s}|^2)_\mathrm{ps}\right]\frac{U_\mathrm{p}}{|U_\mathrm{p}|^2+|U_\mathrm{s}|^2} \\
&+(g_0 + \mathrm{i}g)\frac{|U_\mathrm{s}|^2}{|U_\mathrm{p}|^2+|U_\mathrm{s}|^2}U_\mathrm{p} + \mathrm{i}\vartheta U_\mathrm{p} = 0,
\end{aligned} \tag{3}$$

where $\rho = I_\infty/I_\mathrm{p}$, $\beta = \chi r_{33}E_0$, $\alpha = \chi r_{33}E_\mathrm{ph}$, $\gamma = \chi r_{33}k_\mathrm{B}T/(ex_0)$, $g_0 = z_0\Gamma_0$, $g = z_0\Gamma/2$, $\chi = (k_0x_0)^2(n_\mathrm{e}^4/2)$ and $(|U|^2)_\mathrm{ps} = \partial|U|^2/\partial s$.

According to the theory of PR nonlinear optics, one can obtain that $\Gamma/2 + \mathrm{i}\Gamma_0 = \delta\tilde{E}E_\mathrm{sa}/(\tilde{E} + E_\mathrm{sa})$, where $\delta = \pi n_\mathrm{e}^3 r_\mathrm{eff}/\lambda_0$, $\tilde{E} = E_\mathrm{d} + \mathrm{i}E_0$, $E_\mathrm{d} = 4\pi k_\mathrm{B}T\sin\theta/(\lambda_0 e)$ is the diffusion field, the $E_\mathrm{sa} = eN_\mathrm{A}\lambda_0/(4\pi\varepsilon_\mathrm{r}\varepsilon_0\sin\theta)$ is the saturation field, N_A is the acceptor density, ε_r and ε_0 are the effective dielectric constant and the permittivity of vacuum, respectively, the effective electro-optic coefficient is $r_\mathrm{eff} = [\bar{n}^3 r_{33}\cos\theta\cos(\theta/2) + \bar{n}r_{42}\sin\theta\sin(\sin\theta/2)]\cos\varphi$ in this configuration,[23,32] where $\bar{n} = n_\mathrm{e}/n_0$, n_0 is the ordinary index of refraction, n_e is the unperturbed extraordinary index of refraction, r_{33} and r_{42} are the electro-optic coefficients. Thus one has

$$g = \chi r_\mathrm{eff}\frac{E_\mathrm{sa}(E_0^2 + E_\mathrm{d}E_\mathrm{sa})}{E_\mathrm{ds}^2 + E_0^2},$$
$$g_0 = \chi r_\mathrm{eff}\frac{E_0E_\mathrm{sa}^2}{E_\mathrm{ds}^2 + E_0^2},$$

where $E_\mathrm{ds} = E_\mathrm{d} + E_\mathrm{sa}$.

Under the undepleted pump approximation and neglecting the effect of self-focusing nonlinearity of the pump beam, i.e., under the small-signal condition, we can regard $U_\mathrm{p}(x,z)$ as a constant.[23] As a result, the coupled-wave equation (3) induces the small-signal equation

$$\begin{aligned}
&\mathrm{i}\frac{\partial U}{\partial\xi} + \frac{1}{2}\frac{\partial^2 U}{\partial s^2} - [Q_\mathrm{d} - \gamma(|U|^2)_\mathrm{ps} + \mathrm{i}G]U \\
&+[P_\mathrm{d} - \gamma(|U|^2)_\mathrm{ps} + \mathrm{i}g]|U|^2U = 0,
\end{aligned} \tag{4}$$

where $G = g - \vartheta$, $Q_\mathrm{d} = (1+\rho)\beta + \rho\alpha - g_0$ and $P_\mathrm{d} = (1+\rho)(\beta+\alpha) - g_0$.

When the diffusion effect is neglected, i.e., $\gamma = 0$, the bright and dark solitary solutions of the small-signal equation (4) are, respectively,[6,13]

$$\begin{aligned}
&U(s,\xi) \\
&= F\mathrm{sech}(Bs)\exp\{\mathrm{i}b\ln[\mathrm{sech}(Bs)]\}\exp(-\mathrm{i}\nu\xi), \quad (5) \\
&U(s,\xi) \\
&= D\tanh(Hs)\exp\{\mathrm{i}d\ln[\cosh(Hs)]\}\exp(-\mathrm{i}\omega\xi), \quad (6)
\end{aligned}$$

where $F = [3G/(2g)]^{1/2}$ and $D = (G/g)^{1/2}$ are the amplitudes, $B = (G/b)^{1/2}$ and $H = (2G/3d)^{1/2}$ are the parameters associated with width, $b = [-3P_\mathrm{b} + (9P_\mathrm{b}^2 + 8g^2)^{1/2}]/(2g)$ and $d = [3P_\mathrm{d} + (9P_\mathrm{d}^2 + 8g^2)^{1/2}]/(2g)$ are the chirp parameters, $\nu = (b^2 - 1)G/(2b) + Q_\mathrm{b}$ and $\omega = 2G/(2d) + Q_\mathrm{d}$ are the parameters representing the nonlinear shift of the propagation constant, and $Q_\mathrm{b} = \beta - g_0$, $P_\mathrm{b} = \beta + \alpha - g_0$. The solutions (5) and (6), respectively, show that bright and dark solitons can exist in a dissipative system with a two-beam coupling gain. As mentioned above, we call them DHSP solitons.

3. The temperature characteristics of the DHSP solitons

In fact, the PR effect is dependent on the dark irradiance (the dark irradiance can be viewed as the part of back-ground light) of the dissipative system,

the dark irradiance of the system depends on the temperature.[27,28] The dark irradiance is only a part of the back-ground light and much weaker than the pump beam, we can neglect it in the dissipative system mentioned in this paper, the DHSP soliton is a result of a double balance, viz, diffraction is balanced by nonlinearity and loss is balanced by gain, yet, the gain g of system is relative to the temperature T. In addition, the diffusion process is dependent on the system temperature. So the system temperature must affect the formation, the evolution and the self-deflection of the DHSP solitons in the dissipative system. As is known to all, the dimensionless quantities α, β and γ are associated with the processes of photovoltaic, drift and diffusion, respectively. Generally, α and β do not depend strongly on temperature, so we pay our attention on the temperature T dependence of γ and g in this paper.

As the statement above, when the diffusion process is ignored, these stable DHSP solitons in the dissipative system will propagate along a straight line with its shape kept unchanged in the given temperature. For example, Fig.2 describes the evolution of the bright DHSP soliton at $T = 300\,\mathrm{K}$ in dissipative system. However, when the temperature changes, it induces variations of some system parameters, so the solitary wave supported by the system will change. Moreover, the diffusion process introduces an asymmetric tilt and affects the propagation characteristics of these stable DHSP solitons. As a result, when the diffusion process is taken into account, the DHSP solitary beam centre shifts quadratically with the propagation distance in the dissipative system. It is also shown in Fig.3 as an example. We will discuss the temperature effect on evolution and self-deflection of the DHSP solitons in the following subsections, respectively.

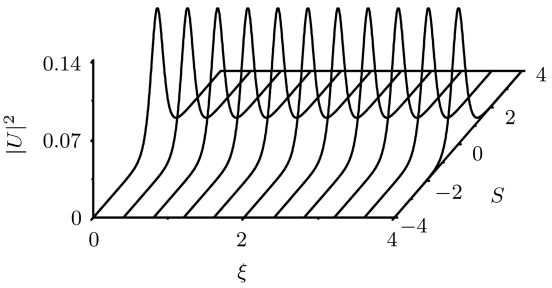


Fig.2. Numerical solution of bright DHSP soliton in the dissipative PV-PR system at $T = 300\,\mathrm{K}$, with parameters $\alpha = 18.8684$, $\beta = 14.7174$, $F = 0.3481$, $b = 0.0055$, $B = 2.0001$ and $\nu = 12.1343$.

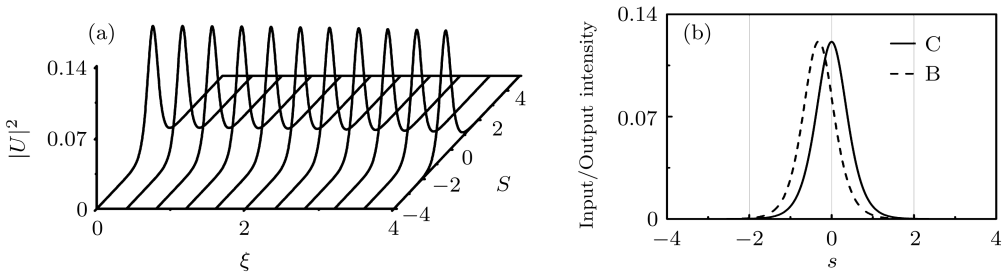


Fig.3. Dynamical evolution and the spatial shift of an incidence bright DHSP soliton taking diffusion effect into account, in the dissipative PV-PR system at $T = 300\,\mathrm{K}$: (a) dynamical evolution; (b) input/output intensity envelope of the soliton at the input/output port.

3.1. Temperature effect on evolution of DHSP solitons

Here, we investigate the temperature effect on the evolution of the bright DHSP solitons in a biased dissipative PV-PR system. A bright DHSP soliton is obtained from both the coupled-wave equation (3) and the small-signal equation (4) with the system parameters chosen to be $\alpha = 18.8684$, $\beta = 14.7174$, $F = 0.3481$, $b = 0.0055$, $B = 2.0001$ and $\nu = 12.1343$ at $T = 300\,\mathrm{K}$. The bright solitary state is regarded as the input beam, its evolution in the dissipative system is analysed by numerically solving the small-signal equation (4) at $T = 240\,\mathrm{K}$, $T = 280\,\mathrm{K}$, $T = 290\,\mathrm{K}$, $T = 300\,\mathrm{K}$, $T = 310\,\mathrm{K}$, $T = 320\,\mathrm{K}$ and $T = 360\,\mathrm{K}$, respectively. We have compared the corresponding results by numerical simulation. Firstly, when $T = 300\,\mathrm{K}$, as expected, the result confirms that the bright soliton beam remains invariant with propagation distance, shown in Fig.2. Secondly, when the temperature deviates little from $T = 300\,\mathrm{K}$, for instance, $T = 290\,\mathrm{K}$ and $T = 310\,\mathrm{K}$, respectively, the incident beam can reshape itself and tends to evolve into another gross stable bright DHSP soliton. While the temperature

deviates much from $T = 300\,\mathrm{K}$, e.g., $T = 280\,\mathrm{K}$ and $T = 320\,\mathrm{K}$, respectively, the incident beam can still evolve into another unstable DHSP soliton. One can further find that, when the temperature drops much, the gain is much smaller than the loss, the signal beam experiences the overfull loss, this is an over-loss case. However, when the temperature rises enough, the system gain g is much bigger than the loss, the signal beam obtains the overfull gain, this is an over-gain case. Finally, when the system temperature deviates significantly from $T = 300\,\mathrm{K}$, the incident beam cannot evolve into a stable bright DHSP soliton, but it tends to experience serious instability, the amplitude and the width vary obviously. When the temperature lowers enough, e.g., $T = 240\,\mathrm{K}$, the amplitude decreases and the width swells with propagation distance. When the gain is so small that the signal beam is completely absorbed by the dissipative system, we can realize optical-switching. Whereas the amplitude increases and the width narrows when temperature rises enough, e.g., $T = 360\,\mathrm{K}$. When the gain is much bigger than the loss, the amplitude of the DSHP soliton becomes larger and larger, it can realize optical-repeater. More results show that the optical beam becomes more unsteady or even collapses when the temperature deviates significantly from $T = 300\,\mathrm{K}$. Thus one can realize some functions of all-optical implement.

For a whole view, we have compared the output amplitudes of the same input DHSP solitary beam at different temperatures above. Figure 4 gives the intensity profiles of the incident beam at $\xi = 2$ output port at different temperatures of the dissipative system. It reveals that the amplitude and the width of the bright DHSP soliton change with temperature, which means that the formation of the spatial DHSP soliton will be affected by the system temperature. So the spatial shape of a stable bright DHSP soliton can be reshaped by appropriately adjusting the system temperature.

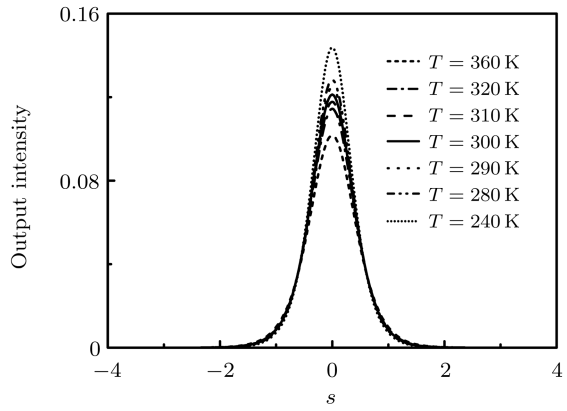


Fig.4. Intensity profiles of bright DHSP solitons formed in the dissipative system with $\alpha = 18.8684$, $\beta = 14.7174$ at output cross section, the curves from top to bottom represent the cases at $T = 360\,\mathrm{K}$, $T = 320\,\mathrm{K}$, $T = 310\,\mathrm{K}$, $T = 300\,\mathrm{K}$, $T = 290\,\mathrm{K}$, $T = 280\,\mathrm{K}$ and $T = 240\,\mathrm{K}$ respectively.

Adopting the same way above, we now investigate the temperature effects on the evolution of dark DHSP solitons in biased PV-PR system. Here, the same crystal is adopted, a dark DHSP soliton obtained from Eq.(6) is regarded as the incident beam, with the parameters $\alpha = -18.8684$, $\beta = -14.7174$, $D = 0.2843$, $d = 0.0053$, $H = 1.6565$ and $\omega = -12.3451$ at $T = 300\,\mathrm{K}$. The evolution of the incident dark DHSP soliton in the dissipative system at $T = 300\,\mathrm{K}$ is shown in Fig.5. Moreover, its intensity profile at $\xi = 2$ output port is shown in Fig.6 by solid curve. As expected, the dark DHSP soliton beam remains invariant with propagation distance. However, when the temperature deviates little from 300 K, the incident beam cannot remain invariant with the propagation distance, instead, it will reshape itself and attempt to evolve into another stable dark DHSP soliton at $T = 290\,\mathrm{K}$ and $T = 310\,\mathrm{K}$, respectively. The numerical results indicate that the system temperature deviates significantly from $T = 300\,\mathrm{K}$, the dark DHSP soliton cannot reshape a fairly stable one, e.g., at $T = 280\,\mathrm{K}$ or $T = 320\,\mathrm{K}$, the amplitude and the width of the dark DHSP soliton vary obviously. When the same dark DHSP soliton illumines the dissipative system with $T = 240\,\mathrm{K}$ or $T = 360\,\mathrm{K}$, one can find that the dark DHSP soliton becomes unstable at $T = 240\,\mathrm{K}$ or at $T = 360\,\mathrm{K}$, the amplitude and the width have some variations. One can make full use of this to realize the optical-repeater or optical-switching by adjusting the system temperature.

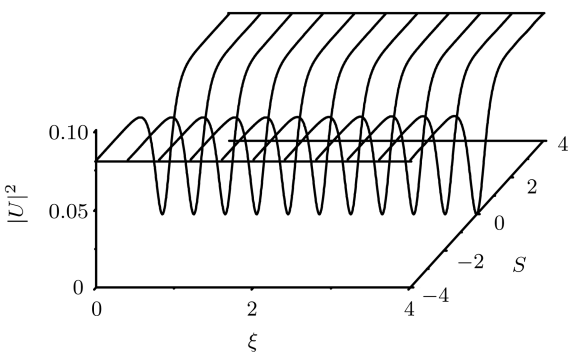


Fig.5. Numerical solution of dark DHSP soliton in the dissipative PV-PR system at $T = 300\,\mathrm{K}$, with parameters $\alpha = -18.8684$, $\beta = -14.7174$, $D = 0.2843$, $d = 0.0053$, $H = 1.6565$ and $\Omega = -12.3451$.

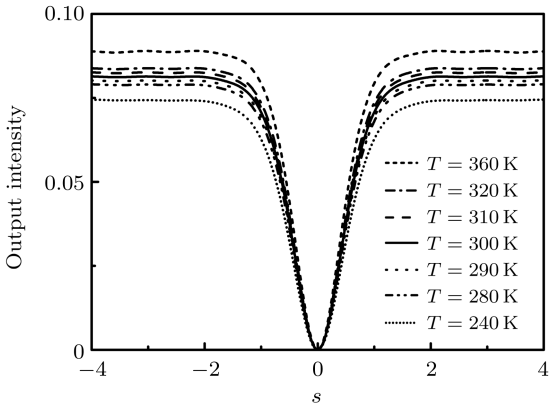


Fig.6. Intensity profiles of dark DHSP solitons formed in the dissipative system with $\alpha = -18.8684$, $\beta = -14.7174$ at output cross section, the curves from top to bottom represent the cases at $T = 360\,\mathrm{K}$, $T = 320\,\mathrm{K}$, $T = 310\,\mathrm{K}$, $T = 300\,\mathrm{K}$, $T = 290\,\mathrm{K}$, $T = 280\,\mathrm{K}$ and $T = 240\,\mathrm{K}$ respectively.

Furthermore, Fig.6 gives the intensity profiles of the same incident beam at $\xi = 2$ output port at different temperatures. It reveals that the amplitude and the width of the dark DHSP soliton will change with temperature, so the spatial shape of a stable dark DHSP soliton can be reshaped by appropriately adjusting the system temperature. In contrast to the case of bright DHSP solitons, dark DSHP solitons are more insensitive to system temperature.

3.2. Temperature effect on the self-deflection of DHSP solitons

Since self-deflection can change the propagation direction of the solitary wave and deflect from its original trajectory,[8,9,18,29,30] it may affect the two-beam coupling process between pump and signal beams. Here, it is necessary to investigate the temperature effect on the self-deflection of bright and dark DHSP solitary beam in biased dissipative PV-PR system. Let $\gamma_0 = 150(k_0^2 x_0 n_\mathrm{e}^4 r_{33})k_\mathrm{B}/e$ denote the value of γ at $T = 300\,\mathrm{K}$, the diffusion coefficient γ can be expressed as $\gamma = \gamma_0 T/300$, it shows that the diffusion coefficient γ increases linearly with temperature T.

We ignore the diffusion effect and regard the bright/dark soliton solution of the Eqs.(5)/(6) as the incident beam, the dynamical evolution of this input beam in the dissipative system can be gained by numerically solving the small-signal equation (4) taking the diffusion effect into account at different temperatures. For factual examples, Figs.3 and 7 show the evolution including self-deflection of the bright and dark DHSP soliton at $T = 300\,\mathrm{K}$, respectively. Here, the transverse distribution at the input port are in contrast with that at the output port in order to get a full grasp of the self-deflection.

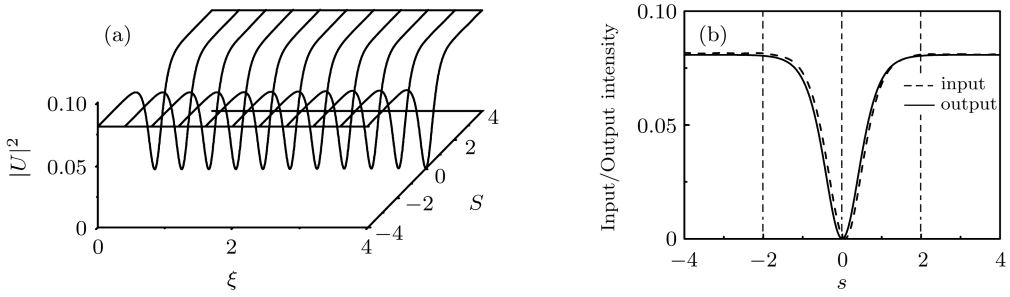


Fig.7. Dynamical evolution and the spatial shift of an incidence dark DHSP soliton taking diffusion effect into account, in the dissipative PV-PR system at $T = 300\,\mathrm{K}$: (a) dynamical evolution; (b) input/output intensity envelope of the soliton at the input/output port.

The spatial shifts (Δs) of the beam centre at different temperatures are illustrated in Figs.8(a) (bright) and 8(b) (dark), respectively. The results show that, the centre of the beam moves approximately on a parabolic trajectory, moreover, the temperature effect on self-deflection of the solitary beam is obvious, i.e., the spatial shift (Δs) of the beam centre is dependent on the temperature of the dissipative system. But the self-deflection of the bright and dark DHSP soliton are slight under the small-signal condition, moreover, the self-deflection direction of the dark DHSP soliton is adverse to that of the bright DHSP soliton, also the self-deflection of the dark one is slighter than that of the bright one, i.e., the former is more insensitive to the system temperature than the latter. These results above indicate that the self-deflection degree (i.e., the spatial shift) of DHSP solitons in the dissipative system is sensitive to the system temperature. As a result, one can adjust the system temperature to change the self-deflection degree of a bright or dark DHSP solitary beam propagating in the biased dissipative PV-PR system.

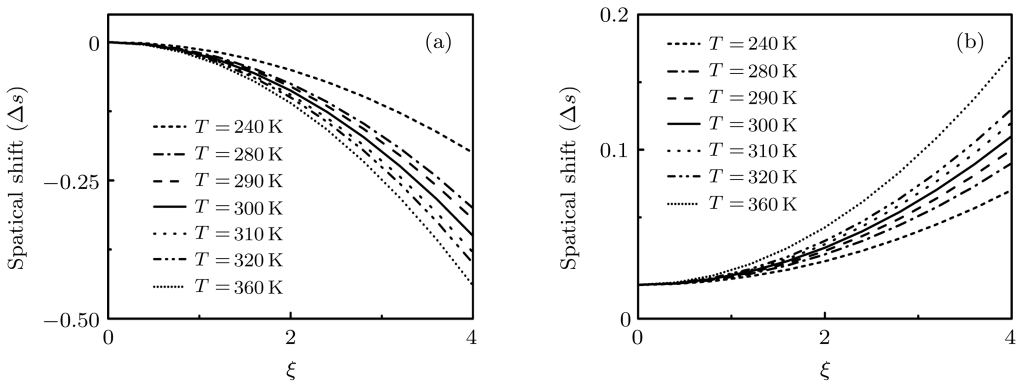


Fig.8. Spatial shift (Δs) of the beam centre for an incidence bright/dark DHSP soliton in the dissipative crystal at different temperatures, the corresponding curves represent $T = 240$ K, $T = 280$ K, $T = 290$ K, $T = 300$ K, $T = 310$ K, $T = 320$ K and $T = 360$ K, respectively: (a) the case of the bright DHSP solitons, corresponding curves from top to bottom; (b) the case of the dark DHSP solitons, corresponding curves from bottom to top.

4. Conclusion

In summary, we have presented a theoretical investigation of temperature effect on the evolution and the self-deflection of bright and dark DHSP solitons in a biased dissipative PV-PR system. Our results predict that the system temperature effect on the evolution and the self-deflection of the solitary wave is very obvious. The self-deflection degree, the amplitude and the width of the beam are strongly dependent on the dissipative system temperature. One can adjust the system temperature to change the formation and the self-deflection degree of a bright or dark DHSP solitary beam to avoid it being ruined by two-beam coupling process. Moreover, the self-deflection of the bright and dark DHSP soliton is slight under the small-signal condition although it is sensitive to system temperature, the former is more insensitive to the system temperature than the latter. In a word, the system temperature plays a role in the formation and the self-deflection of the DHSP solitons. One can gain certain optical-repeater or optical-switching function by adjusting the temperature of the dissipative system.

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