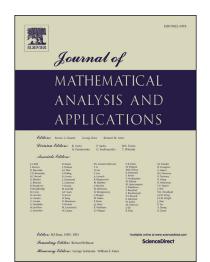
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## Segregated vector solutions with multi-scale spikes for nonlinear coupled elliptic systems

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#### Abstract

In this paper, we consider the following nonlinear coupled elliptic system

$$\begin{cases} -\varepsilon^2 \Delta u + P(x)u = \mu_1 u^3 + \beta u v^2 & \text{in } \mathbb{R}^N, \\ -\varepsilon^2 \Delta v + Q(x)v = \mu_2 v^3 + \beta u^2 v & \text{in } \mathbb{R}^N, \\ u > 0, \quad v > 0 & \text{in } \mathbb{R}^N, \\ u \to 0, \quad v \to 0 & \text{as } |x| \to +\infty, \end{cases}$$

$$(\mathcal{A}_{\varepsilon})$$

where  $\varepsilon > 0$  is a parameter,  $\mu_1, \mu_2 > 0$  and  $\beta > 0$  are constants, P(x) and Q(x) are two nonnegative, smooth functions which have different non-degenerate critical points and separated zero sets. Due to the Liapunov-Schmidt reduction method and the Maximum Principle, we show that when  $\beta$  less than a small positive number, there exist  $\varepsilon_0 > 0$  such that for any  $0 < \varepsilon < \varepsilon_0$ ,  $(\mathcal{A}_{\varepsilon})$  has a segregated vector solution  $(u_{\varepsilon}, v_{\varepsilon})$  with  $u_{\varepsilon}$  is trapped in a neighborhood of non-degenerate critical points of P(x) and also the zero sets of P(x),  $v_{\varepsilon}$  is trapped in a neighborhood of non-degenerate critical points of Q(x)and also the zero sets of Q(x). Moreover the amplitudes of the  $u_{\varepsilon}$  (res  $v_{\varepsilon}$ ) around the non-degenerate critical points and the zero sets of P(x) (res Q(x)) are of a different order of  $\varepsilon$ . As far as the authors know, these multi-scale solutions for system have not been obtained before.

**Keywords**:Nonlinear coupled elliptic systems; Liapunov-Schmidt reduction methods; Segregated vector solutions, Multi-scale spikes.

AMS Subject Classification: 35J60, 35J20

### **1** Introduction and main results

In this paper, we are concerned with the solitary wave solutions of time-dependent coupled nonlinear Schrödinger equations given by

$$\begin{cases} -i\frac{\partial\Phi_{1}}{\partial t} = \varepsilon^{2}\Delta\Phi_{1} - V_{1}(x)\Phi_{1} + \mu_{1}|\Phi_{1}|^{2}\Phi_{1} + \beta\Phi_{1}|\Phi_{2}|^{2} & \text{for } y \in \mathbb{R}^{N}, t > 0, \\ -i\frac{\partial\Phi_{2}}{\partial t} = \varepsilon^{2}\Delta\Phi_{2} - V_{2}(x)\Phi_{2} + \mu_{2}|\Phi_{2}|^{2}\Phi_{2} + \beta|\Phi_{1}|^{2}\Phi_{2} & \text{for } y \in \mathbb{R}^{N}, t > 0, \\ \Phi_{1}(y,t) \in \mathbb{C}, \quad \Phi_{2}(y,t) \in \mathbb{C}, \\ \Phi_{1}(y,t) \to 0, \quad \Phi_{2}(y,t) \to 0 & \text{as } |y| \to +\infty, t > 0 \end{cases}$$
(1.1)

where  $N = 1, 2, 3, \varepsilon, \mu_1, \mu_2$  are positive constants,  $\beta$  is a coupling constant and  $V_1(x), V_2(x)$  are two smooth potentials.

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