Research Article

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Existence and concentration of solutions to Kirchhoff-type equations in $\mathbb{R}^2$ with steep potential well vanishing at infinity and exponential critical nonlinearities

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Abstract: We are concerned with the following Kirchhoff-type equation with exponential critical nonlinearities

$$-\left(a + b\int_{\mathbb{R}^2} |\nabla u|^2 dx\right)\Delta u + (h(x) + \mu V(x))u = K(x)f(u) \quad \text{in } \mathbb{R}^2,$$

where $a, b, \mu > 0$, the potential V has a bounded set of zero points and decays at infinity as $|x|^{-\gamma}$ with $\gamma \in (0, 2)$, the weight K has finite singular points and may have exponential growth at infinity. By using the truncation technique and working in some weighted Sobolev space, we obtain the existence of a mountain pass solution for $\mu > 0$ large and the concentration behavior of solutions as $\mu \to +\infty$.

Keywords: Kirchhoff-type equation, steep potential well, vanishing potential, Trudinger–Moser inequality, variational method

MSC 2020: 35A15, 35J60

1 Introduction and results

1.1 Background

In this article, we study the following Kirchhoff-type equation with steep potential well:

$$-\left(a + b\int_{\mathbb{R}^2} |\nabla u|^2 dx\right)\Delta u + (h(x) + \mu V(x))u = K(x)f(u) \text{ in } \mathbb{R}^2, \tag{1.1}$$

where $a, b > 0$ are constants, $\mu > 0$ is a parameter, the potential V decays at infinity as $|x|^{-\gamma}$ with $\gamma \in (0, 2)$, the nonlinearity f has exponential growth at infinity, and the weight K is singular at finite points and may have exponential growth at infinity. Here, we say the nonlinearity f has exponential subcritical growth if for any $\alpha > 0$,

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