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## ON A RIEMANN-HILBERT PROBLEM FOR THE FOKAS-LENELLS EQUATION

LIPING AI AND JIAN XU\*

ABSTRACT. The solution of the initial value problem (IVP) for the Fokas-Lenells equation (FLE) was constructed in terms of the solution  $M(x, t, k)$  of a  $2 \times 2$  matrix Riemann-Hilbert problem (RHP) as  $k \rightarrow \infty$ , and the one-soliton solution of the FLE was derived based on this Riemann-Hilbert problem, in *Nonlinearity* 22(2009), [1]. However, in fact, the derivative with respect to  $x$  of the solution of the FLE ( $u_x(x, t)$ ) was recovered from the RHP as  $k \rightarrow \infty$ . In this paper, we construct the solution of the FLE in terms of the RHP as  $k \rightarrow 0$ , because the Lax pair of the FLE contains the negative order of the spectral variable  $k$ . We show that the one-soliton solution of the FLE obtained in this paper is the same as [1], but avoiding a complex integral.

### 1. INTRODUCTION

The Fokas-Lenells equation (FLE)

$$u_{tx} + \alpha\beta^2 u - 2i\alpha\beta u_x - \alpha u_{xx} + \sigma i\alpha\beta^2 |u|^2 u_x = 0, \quad \sigma = \pm 1, \quad (1.1)$$

where  $\alpha > 0$  and  $\beta$  are real constant,  $u(x, t)$  is a complex-valued function, while the subscripts  $t$  and  $x$  denote the partial derivativations. It is a completely integrable nonlinear partial differential equation (here "integrable" we mean it admits a Lax pair) which has been derived as an integrable generalization of the nonlinear Schrödinger equation (NLSE) using bi-Hamiltonian methods [2]. In the context of nonlinear optics, the FLE models the propagation of nonlinear light pulses

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*Key words and phrases.* Riemann-Hilbert problem, Fokas-Lenells equation, Initial value problem, Negative order Lax pair.

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