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# Asymptotic profile of solution for the Cauchy problem of beam equation with variable coefficient

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## Abstract

We consider the Cauchy problem for the linear beam equation:

$$u_{tt} + u_t + u_{xxxx} - a(t)u_{xx} = 0, \quad (t, x) \in \mathbb{R}^+ \times \mathbb{R},$$

where  $a(t) \sim (1+t)^\alpha$ . The purpose of this study is to clarify the behavior of solution depending on the rate  $\alpha$ . Here we shall give the asymptotic behavior of the equation in the case  $\alpha > -1/2$ , by using the method of scaling variables developed by Gallay and Raugel [3].

*Keywords:* asymptotic profile, beam, variable coefficient, scaling variables

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## 1. Introduction

In this note we study the Cauchy problem for the following one-dimensional linear beam equation with time dependent coefficient:

$$u_{tt} + u_t + u_{xxxx} - a(t)u_{xx} = 0, \quad (t, x) \in \mathbb{R}^+ \times \mathbb{R}, \quad (1)$$

$$u(0, x) = u_0(x), \quad u_t(0, x) = u_1(x), \quad x \in \mathbb{R}. \quad (2)$$

Suppose that the given function  $a(t)$  satisfies

$$a(t) \sim (t+1)^\alpha, \quad a(t) > 0, \quad |a'(t)| \leq \frac{C_a a(t)^2}{A(t) + 1} \quad (3)$$

for some constant  $C_a$  with  $A(t) := \int_0^t a(\tau) d\tau$ . The last assumption in (3) looks intricate but not strange. Indeed, a rough calculation implies  $|a'(t)| \leq C(t+1)^{\alpha-1}$ , which is compatible with the first assumption. Our interest is directed toward the asymptotic behavior of solution  $u$  as  $t \rightarrow \infty$ . In particular we aim at finding the thresholds of  $\alpha$ . It is well-known that the solution of the Cauchy problem for damped wave equation:  $u_{tt} + u_t - u_{xx} = 0$  behaves as the

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