Stational Expansion Shock fa Regularied
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1. Introduction

 \mathbb{F}^n is the time derivative of time derivatives, \mathbb{F}^n is the time derivatives, \mathbb{F}^n is the time derivatives, \mathbb{F}^n is the time derivative set of \mathbb{F}^n is the time derivative set of \mathbb{F}^n i $\left\{A_n\right\}_{n\in\mathbb{N}}$ and $\left\{A_n\right\}_{n\in\mathbb{N}}$ of new classes of solutions noted that n general laws and \mathbb{R} conservation laws and the three volution laws and the three volutions of \mathbb{R} dispersive regularizations such as the Kortegory such as the Kortegory such as the Kortegory of the Vries equation, the \mathcal{L} defocusion of nonlinear \mathcal{G}_a , \mathcal{G}_b , and \mathcal{G}_c equations exhibiting \mathcal{G}_c rich families of dispersive shock waves \mathbb{S}^3 . $3, 4$. New solutions in the theorem form of \mathbb{G} stationary, smooth, non-scientification shocks were found sh in 5 for the Benjamin-Bona-Mahony (BBM) equation, the B_1 $u_1, u_2, u_3 \in \mathbb{C}$ and system (1). The Boussiness (1) are a convenient mathematical model in \mathbb{R}^n

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$$
\int_{1}^{R} \mathcal{A}_{\tau} \quad (3) \qquad \qquad \int_{1}^{R} \mathcal{A}_{\tau} \quad \text{and} \qquad \int_{1}^{R} R H \text{ locus} \qquad u_{\pm} \qquad \tau \qquad h_{\pm} \qquad \ldots
$$

$$
u_{\pm} \quad h_{\mp} \left(\frac{2}{h-h} \right)^{1 \leq 2} . \tag{4}
$$

$$
\mathcal{A}(2) \leftarrow \mathcal{A}(3) \leftarrow \mathcal{A} \leftarrow
$$

2. Expansion shock Riemann data

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keeping the wave speed constant, whereas in the constant \mathcal{C} $s = \frac{1}{2}$ of θ the constant states is fixed. And one of the constant states is fixed. The purpose of \mathbb{R}^n parameter \mathbb{R}^n (h_{\pm} $\frac{1}{4^{16}}(r_{\pm} \quad s_{\pm})^2$ \leftarrow \leftarrow \mathbb{R}^n is the interval of \mathbb{R}^n (14) \mathbb{R}^n (15). If \mathbb{R}^n instead \mathbb{R}^n s_{\pm} , r_{\pm} in terms of the small parameter ϵ^{-1} 1, the small parameter ϵ Although using H 1 yields \mathcal{P} 1 \mathcal{P} \mathcal{P} in \mathcal{P} at \mathcal{P} solutions, the sustenance of the far-field \mathbb{R}^n or the far-field \mathbb{R}^n (10) is useful for comparing the asymptotic solution with the numerical solution \mathcal{C} will do in Section $5.$

3. BBM approximation and the structure of the expansion shock

$$
\mathcal{A}_{\mathcal{C}_1}
$$

We have now proceed with the detailed asymptotic analysis of \mathbb{R}^n and \mathbb{R}^n shocks shown shocks for the system (17). Similar to \mathbb{C}^2 , we use \mathbb{C}^2 of \mathbb{C}^2 , \mathbb{C}^2 , \mathbb{C}^2 as \mathbb{C}^2 . $T_{\rm eff}$ to the analytic construction in $[1]$ is the separator in $[1]$ Γ PDE describing the solution with \mathbb{C} \mathbb{C} \mathbb{C} \mathbb{C} \mathbb{R} , \mathbb{X} $T = \delta t$, $T = \frac{1}{2}$, $\frac{1}{2}$ $s = \frac{1}{2}$ and $s = \frac{1}{2}$ and $s = \frac{1}{2}$ and $s = \frac{1}{2}$ and $s = \frac{1}{2}$ and require a somewhat more what mo solve as \mathcal{G}_1 . \mathcal{G}_2 internal structure of the detailed internal struct the expansion shocks in $1\leftarrow$ \mathcal{L} first consider the inner problem, the initial smoothed is, near the initial smoothed initial smoothed initial smoothed in \mathcal{L} $t_{\rm max}$ transition. The smoothed Riemann data will be smoothed Riemann data will be small because \mathcal{L}_t c classified in the analysis below. Our construction ϵ e^{-1} e^{-1} (equation (13)) ϵ is jump spatial transition ϵ conditions. However, as we see, the resulting solution also provides and \mathcal{C} excellent approximation for \mathbb{R}^n of \mathbb{R}^n in H 1. *4.1. Inner solution: first -order approximation*

4. Expansion shock for the Boussinesq equations

where *^r*(0), *^r*(1), *^r*(2), *^s*(0), and *^s*(2) are *^O*(1) as [→] 0, ^δ [→] 0, [→] 0. The parameter is proportional to the initial jump in *^r* from Equation (15), and in the expansion for *s* we have assumed that *s*(1) 0, which is consistent with the discussion in the previous section, and could be readily deduced by modifying the analysis below. Inserting expansions (21) into Equation (20), we obtain *r*(1) +··· 1 4δ 3*r*(0) *s*(0) 3*r*(1) ² (3*r*(2) *^s*(2)) +··· *r* (1) ² *r* (2) +··· 6δ² *r* (1) ξξτ ² *r* (2) ξξτ *s* (2) ξξτ +··· (22) and μ² *^s*(2) +··· ¹ 4δ *^r*(0) ³*s*(0) +··· 2 *s* (2) +··· 6δ² *r* (1) ξξτ +··· (23) Because 1/δ, the leading order term in Equation (22) is

 \int_{δ}^{∞} δ $\Big)$: $\frac{1}{\overline{ }}$

 \pm 1 2*a* 9*a*² *f f* $\frac{f''}{f''}$ *K*. (30) $\leftarrow^{\mathbf{A}} K / 0$ is the separation constant. We determine a $\leftarrow^{\mathbf{A}} f \leftarrow^{\mathbf{A}} r$ BBM in [5] $a()$ $\frac{A}{a+H}$ $\frac{A}{\frac{9}{2}AK}$ *f* () *B* $\left(\frac{B}{2K}\right)$ $\frac{9}{2}AK$ 1 (31) \mathbb{A} \rightarrow \mathbb{A} \rightarrow 0 \rightarrow **B** \rightarrow 0 \rightarrow **1** and **p** determined. We choose the determined in \mathbb{A} 1 *B* 1, $K = \frac{1}{2}$ $\frac{1}{2}$ (32) \mathcal{O}_n \mathcal{O}_n \mathcal{O}_n \mathcal{O}_n and \mathcal{O}_n \mathcal{O}_n \mathcal{O}_n and \mathcal{O}_n are RHH \mathcal{O}_n and \mathcal{O}_n and \mathcal{O}_n are RHH \mathcal{O}_n and \mathcal{O}_n and \mathcal{O}_n are RHH \mathcal{O}_n and \mathcal{O}_n and $\mathcal{$ locus, so that the solution (31) is $a()$ $\frac{A}{a}$ $\frac{1}{94}$, $f()$ $\left(\begin{matrix} 4 \\ 7 \end{matrix} \right)$ (33) $\frac{9}{4}A$ 1 Then, the (11) such as 1 (1) , the approximate inner expansion of ϵ be written $r^{(\ldots)}(\ldots) = \frac{s^{(0)}}{3}$ *A* $\frac{9}{4}A$ 1 ϵ^2 () ϵ^2 (34) $s^{(.)}(.) \quad s^{(0)} \quad (\epsilon^2)$ (35) T and T and T and T and T and T and T in terms of the initial i $dA = (44 - (34), (35) (-4 - 0, \rightarrow 2)$, $(-1, 1)$
data is not computed it with the first-order small-jump expansions (12) incorporation \mathcal{A} incorporation the RH locus \mathcal{A} r_{\pm} $\frac{s^{(0)}}{3}$ \pm \leq A \leq \leq \approx 10 **6A.Eleval.**

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 $r^{(1)}(.)$ $\frac{s^{(0)}}{3}$ $\frac{6A}{4A-1}$ $\left(1\right)$ $\left(\frac{6A}{2}\right)$. (34)
 $s^{(1)}(.)$ $s^{(0)}$ $\left(\frac{6A}{2}\right)$ (35)
 $\left(\frac{6A}{12}\right)$ $\left(\frac{6A}{12}\right)$ $\left(\frac{6A}{12}\right)$ (34), (35) $\left(\frac{6A}{12}\right)$ (35)
 $\left(\frac{6A}{12}\right)$ $\left(\frac{6A}{12}\right)$ \mathbf{s}^{\prime}

s±

 $v_t \gg x \quad 0, \quad \tau > \frac{1}{4}(s^{(0)} - 3r) \left(\tau \right)$ (19)). The dispersionless limit of the BBM equation (18). see that the first-order solution \mathcal{A} and \mathcal{A} solution for the BBM expansion shock obtained in \mathbb{R}^4 shock obtained in \mathbb{R}^4

$$
r^{(1)}(1) \sim 1 \times \left(\frac{1}{4} \frac{A}{1-\frac{9}{4}}\right)
$$

$$
r^{(2)}(1) \sim 1 \times \left(\frac{1}{4} \frac{A}{1-\frac{9}{4}}\right)
$$

$$
\frac{1}{3} \left(C - \frac{2}{17} \frac{17}{16(1-\frac{9}{4})^2} - \frac{2}{16(1-\frac{9}{4})^2}\right).
$$

 ϵ $\epsilon r^{(\tau)} = \frac{1}{4} (3r^{(\tau)} - s^{(\tau)}) r_X^{(\tau)} = 0.$ $s(s^{(\tau)})$ $\frac{1}{4}(r^{(\tau)})$ $3s^{(\tau)})s_X^{(\tau)}$ 0. (51) \blacksquare expect a simple wave solution, which we expand as $1\in\mathbb{R}$. $s^{(\gamma)}(X,)$ 3 $\frac{3}{4}$ $\frac{3}{4}$ $\frac{1}{32}$ \cdots . $r^{(\gamma)}(X, \gamma) = 1 \quad \text{and} \quad \frac{1}{4}$ $\frac{1}{4}$ $r_1(X) \quad \frac{1}{96}$ $\frac{1}{96}$ $r_2(X)$... (52) With the \mathbb{R}^n for \mathbb{R}^n (51) for $s^{(n)}$ is identically satisfied. $T_{\rm eff}$ equation for $r^{(\nu)}$, expanding in powers of powers

$$
r \left(\frac{1}{2} \right) \left(58 \right) \left(\frac{1}{1 - \frac{9}{4}} \right) \left(50 \right) \qquad (50), \qquad \dots \left(\frac{1}{24 \left(1 - \frac{9}{4} \right)^2} \right) \qquad (60)
$$

$$
r_2(X) = \frac{1 - 3X}{24(1 - \frac{9}{4})^2}
$$
(61)

$$
\mathbf{A}_T = \mathbf{A}_T \mathbf{a}_T + \mathbf{a}_T \mathbf{a}_T + \mathbf{A}_T \mathbf{a}_T
$$

$$
r^{(+)}(X) = 1 \cdot \left(\frac{1}{4} - \frac{X - 3X}{1 - \frac{9}{4}} \right)
$$

$$
\frac{\sqrt{2}}{24} \left(\frac{1}{4} - \frac{1}{1 - 3} \right)
$$

6. Discussion

 \mathbf{r}

$$
g_n(t) = \begin{cases} \frac{2L}{N} \sum_{m=-N+2}^{N+2} x_m g(x_m, t) & n = 0 \\ \frac{g_n(t)}{ik_n} & n = 0 \end{cases}
$$
 (A4)

 $T_{\rm eff}$ is a $n = 0$ in $(A4)$ is $C_{\rm eff}$ the integral approximation of $\int_{-1}^{L} xg(x,t)dx$ and $\int_{-1}^{L} \left(\sum_{k=1}^{L} \sum_{r=1}^{K} \frac{f^{(k)}(x)}{r} \right) dx$ and *h* from *g* is

The second on the spectral on the spectral, $\mathcal{F}_{\text{total}}$ and $\mathcal{F}_{\text{total}}$ $t = \frac{C_1}{C_1}$ standard fourth-order Runge–Kutta method. The nonlocal character of $\frac{C_1}{C_1}$ the dispersive term via $\left\{\begin{array}{ccc} \lambda & \lambda & \lambda \\ \lambda & \lambda & \lambda \end{array}\right\}$ is not stiff so we use a stiff so λ $t = 45.$ The $t = 0.002$ G_{max} is $t = 45.$ The domain size is $L = 120$ (Figs. $2 \sqrt{3}$ show only a point of the domain $\sqrt{3}$ and the Fourier truncation of the Fourier $N = 2^{14}$. The accuracy of the numerical computation is monotored in \mathbb{R}^n by ensuring the conserved \mathcal{C} and the conserved \mathcal{C}