

3 (dispersive operator)

$$D(u) = \int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx \quad (2.2)$$

$$u_0 k \pm o(k, 0), \quad (2.3)$$

$$o(k, 0) = u_0 \int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx \pm o(k^2) \quad (2.3)$$

$$o(k, 0) \geq 0, \quad k \geq 0, \quad 0 \geq 0.$$

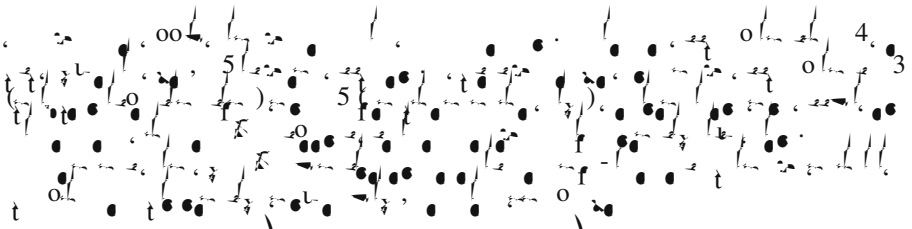
$$o(k, 0) = c_0 k + \mu k^3 + o(k^3), \quad k \rightarrow 0, \quad \mu > 0. \quad (2.4)$$

$$o(k, 0) = \int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx \quad (2.4)$$

$$\int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx = \frac{2}{k^2} o(k, 0).$$

4 (Whitham averaging)

$$\int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx = \int_{\mathbb{R}^n} \frac{D(u)}{|x|} dx \quad (2.1)$$



$$u(x, 0) \begin{cases} u_1 & x < 0 \\ u_2 & x > 0 \end{cases}, \quad (x, 0) \begin{cases} 1 & x < 0 \\ 2 & x > 0 \end{cases} \quad (2.5)$$

••• $u_j \in \mathbb{R}$,

f

$$u = V \frac{A}{\dots} \quad (3.7)$$

$$f(\dots) = B^2 C \frac{A^2}{2} \equiv G(\dots) \quad (3.8)$$

... G ... $1 \leq 2 \leq 3$... A, B, C ... 0 ... 2 ... 1 ... V ... (II)

$$\mathcal{E} \equiv \frac{u^2}{2} - \frac{2}{x} f(\dots)$$

$$\mathcal{E}_t = u \mathcal{E} - P(x) - \frac{1}{4} u_{xx} \frac{(u)_x}{x}$$

... 4 ... 6 ... (t) ...

$$u_0 \equiv \lim_{x \rightarrow \infty} u(x), \quad 0 \equiv \lim_{x \rightarrow \infty} (\dots), \quad \dots \equiv \lim_R (\dots)$$

... (3.9) ... G ... 1 ... 2 ... s ... V ...

$$(s, u_0)^2 = \frac{2}{(0, \dots)^2} f(0) f(\dots) \quad (3.10)$$

... (3.9) ... $(t, 0)$... $(t, 5)$... (200) ... (2011) ... (2012) ...

3.2

... 0 ... 0 ... 0 ... 0 ...

Two-temperature collisionless plasma:

$$\frac{d}{dt} \left(\frac{1}{2} m_e n_e v_e^2 + \frac{1}{2} m_i n_i v_i^2 \right) + \nabla \cdot \left(\frac{1}{2} m_e n_e v_e v_e^2 + \frac{1}{2} m_i n_i v_i v_i^2 \right) = - \nabla \cdot \left(\frac{1}{2} m_e n_e v_e v_e^2 + \frac{1}{2} m_i n_i v_i v_i^2 \right) + \dots$$

1 4 (2010). (2006). (3.11) 1, 2 (2001). (1, 4). 10.

4 Background: Dispersionless Limit

(2.1)
$$\begin{aligned} t & (u)_x = 0, \\ (u)_t & = u^2 P(\cdot) \Big|_x = 0, \end{aligned} \tag{4.1}$$

$D \equiv 0$. (4.1) $P(\cdot)$ (1, 5). (1, 4)

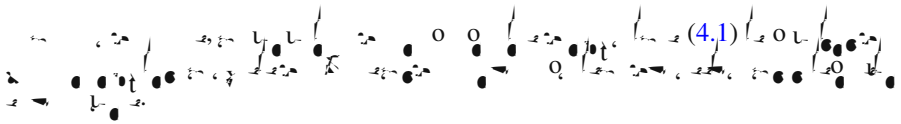
$$r_1 = u \frac{c(\cdot)}{\cdot}, \quad r_2 = u \frac{c(\cdot)}{\cdot}, \tag{4.2}$$

$$1 = u \frac{c(\cdot)}{\cdot}, \quad 2 = u \frac{c(\cdot)}{\cdot}, \tag{4.3}$$

$$\frac{r_j}{t} = j \frac{r_j}{x} = 0, \quad j = 1, 2. \tag{4.4}$$

$$g(\cdot) = \frac{c(\cdot)}{\cdot},$$

(4.3)
$$u = \frac{1}{2} (1 - r_2), \quad g = \frac{1}{2} (1 - r_1). \tag{4.5}$$



4.1

I \dots

$$\begin{aligned}
 & > 0, \dots, a(t), \dots, a > 0, \dots, z \\
 & A \int_{R_A} a, \quad B \int_{R_B} a, \quad (4)
 \end{aligned}$$

$$R_A t, \quad R_B, \quad m, \quad \dots, \dots, \dots$$

$$x_0 \int_{x_R} z(0) \int_{x_R} \frac{u}{x} + \frac{c(\cdot)}{x} \frac{c(\cdot)^{1/2}}{x}$$

$a/r_1 < 0$,
 (4.10), (4.10), $m > 0$, x_0 , m ,
 $a/r_1 < 0$, R_A , R_B , (4.12), (4.12), A ,
 B , (4.11),
 (4.10), (4.10),
 R_A , R_B , $r_2(x_0, 0)$

4.3

(4.1)

$$1 \quad u_1 \quad u_2 \quad \left[\frac{2c(\cdot)}{1}, \quad 1 > 2, \quad (4.16) \right]$$

$$2 \quad u_1 \quad u_2 \quad \left[\frac{2c(\cdot)}{1}, \quad 2 > 1, \quad (4.16) \right]$$

increase

(4.1)

200

$O(t^{1/2})$ $O(t^{2/3})$ $O(t)$

(1, 3) (1, 4)

4.4

$u_1 \quad u_2 \quad 0$

(1, 5) (1, 3) (1, 4)

(4.13) $P(\cdot)$

(4.16)

$$1 \quad u \quad \frac{(\cdot)(\cdot)}{1} \uparrow^{1/2}$$

$$2 \quad u \quad \left[\frac{2(\cdot)^{1/2}}{3}, \quad (\cdot)^{1/2}, \quad (\cdot)^{1/2} \right] \quad (4.1)$$

5 Background: Simple DSWS

(2005)

(2.1)

A handwritten musical score consisting of four staves. The notation is dense and includes various musical symbols such as notes, rests, and dynamic markings. The first staff begins with a treble clef and a common time signature. A circled annotation '(4.1)' is present in the second measure of the first staff. The second staff contains a circled '2' above the first measure. The third and fourth staves continue the musical notation. The handwriting is in black ink on a white background.

(200) (2012)
 (2011)
 (4.2)
 (2005)

$$1 \quad u_2 \quad u_1 \quad \frac{c(\cdot)}{\cdot}, \quad 2 > 1, \quad (5.1)$$

$$2 \quad u_2 \quad u_1 \quad \frac{c(\cdot)}{\cdot}, \quad 1 > 2. \quad (5.2)$$

$(5.1), (5.2)$ $r_2 (r_1)$ $DSW \text{ loci}$
 (4.13)
 (4.16) (4.16)
inadmissible
Temple systems $(1, 3)$
 4.2 $(5.1), (5.2)$ (4.13)

5.1

$$k \quad a \quad 0 \quad \frac{k}{\bar{u}(\cdot)} \quad \frac{-}{\bar{u}(\cdot) \quad c(\cdot)} \quad \frac{-}{k} \quad (5.3)$$

(5.1)

$$\bar{u}(\cdot) \quad u_1 \quad \frac{c(\cdot)}{\cdot} \quad (5.4)$$

I ...

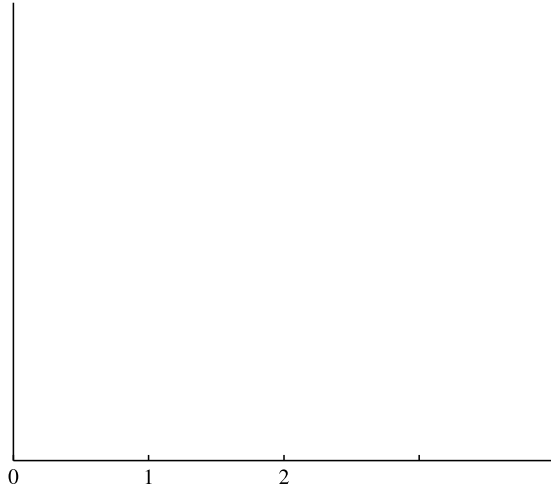
$$\begin{aligned} (k, -) & \quad \left(\begin{array}{c} \uparrow \\ \downarrow \end{array} \right) \quad \bar{u}(-)k \quad \left(\begin{array}{c} \uparrow \\ \downarrow \end{array} \right) \quad {}_0(k, -) \\ \bar{u}(-)k & \quad {}_0(k, -). \end{aligned} \quad (5.)$$

$k \rightarrow 0$

$$\frac{k}{c(-)} = \frac{c(-)k / 0}{c(-) \quad 0_k}, \quad (5.)$$

(5.3) $k \rightarrow 0$ (5.6)

$k(j)$



$\Gamma \rightarrow \Gamma \cdot \mathbb{Z}$

$$k > 0, \quad k(-2) \quad (2.4) \quad (5.5) \quad (2.3) \quad k(2) \quad 0,$$

1- (5.1)

0 0 (1, 2, u₁, u₂)

(5.11) (5.)

1

x/t , $k' \rightarrow \infty$, $v/2$
 (6.16)
 2002, 2006, 200
 (2013)
 1, 4, 15.4
 (5.11)

$$k \rightarrow 0 \quad \frac{2}{k} \quad k_{2,-} \quad 2, \bar{u} \quad u_2 \quad \left| \quad \frac{0}{k} \quad k' \quad \right| \quad \frac{0}{k} \quad \bar{u} \quad k_{2,-} \quad 2, \bar{u} \quad u_2 \quad 0.$$

1- (5.1) $(5,)$

$$kc \quad 0 \quad 0 \quad \frac{ck}{k_{2,-} \quad 2} \quad 0.$$

(6.3)

$$0 \quad \frac{ck}{k_{2,-} \quad 2} \quad 0, \quad (6.1)$$

(2.3) , (6.1) , (6.1) , (6.1) , (6.4)

$$\frac{0}{k} \dots k_2, -2 \quad 0.$$

$$V_j(1, 1) \sim \sum_{2 \rightarrow 1} V_j(1, 2) - V_j(1, 2) \quad (.1)$$

$$\dots (2.4) \dots (5.6)$$

$$\sum_{2 \rightarrow 1} V_j(1, 2) u_1 \Big|_{k \rightarrow 0} 0_k u_1 \Big|_{c_1}$$

$$\dots (1) \dots j \dots (5.5) (5.)$$

$$\sum_{2 \rightarrow 1} \frac{1}{2} V_1(1, 2) \Big|_{k \rightarrow 0} 0_{kk} \frac{k}{2} \Big|_{2 \rightarrow 1} 0_{kk} \frac{k}{1} \Big|_{c_1 k / 1} 0 \Big|_{0_k} \frac{c_1}{2} \frac{c_1}{1} \quad (.2)$$

$$2, \dots (2) \dots$$

$$\frac{k}{2} (1, 2) \Big|_{1} \frac{k}{1} (1, 2) \quad (.3)$$

$$\dots (2) \dots (2.4) \dots$$

$$\sum_{2 \rightarrow 1}$$

$$s_j(1, 1) = \sum_{2 \rightarrow 1} s_j(1, 2) = \sum_{2 \rightarrow 1} s_j(1, 2) \dots$$

$$s_j(1, 1) \sim u_1 | c_1$$

$$s_j(1, 1) \sim u_1 | c_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1$$

$$s_j(1, 1) \sim u_1 | c_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1$$

(2.4), (5.10), (5.11), (5.11)

$$\sum_{2 \rightarrow 1} s_j(1, 2) = u_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1$$

$$j. \sum_{2 \rightarrow 1} s_j(1, 1) \sim u_1 | c_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1$$

$$\begin{aligned} \sum_{2 \rightarrow 1} \frac{0_k k | 0}{k^2} \frac{k}{2} \\ \sum_{2 \rightarrow 1} \frac{0_k k | 0}{k^2} \frac{k}{1} \\ \sum_{k=0}^{\infty} \frac{(0_k k | 0)(c_1 k / 1 | 0-)}{k^2 (c_1 | 0_k)} \\ \frac{2}{3} \frac{c_1}{1} c'_1 \end{aligned}$$

$$j = 2, \dots$$

$$\begin{aligned} \sum_{2 \rightarrow 1} \frac{0}{2} s_2(1, 2) & \sim \sum_{2 \rightarrow 1} u'(1) \frac{0-}{k} \frac{0_k k | 0}{k^2} \frac{dk}{d-} \\ & \sum_{k=0}^{\infty} \frac{c_1}{1} \frac{0-}{k} \frac{(0_k k | 0)(c_1 k / 1 | 0-)}{k^2 (c_1 | 0_k)} \\ & \frac{1}{3} \frac{c_1}{1} c'_1 \end{aligned}$$

$$s_j(1, 1) \sim u_1 | c_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1$$

$$s_j(1, 1) \sim u_1 | c_1 \sum_{k=0}^{\infty} \frac{0(k, 1)}{k} u_1 | c_1 \ll 1. \quad (.5)$$

3

(4) (5)
 (6.1) (6.2)
 (6.6)

$$s_{\pm}^{(1)}(1, 1) \sim u_1 |c_1| \frac{3 \mp 1}{6} \frac{c_1}{1} |c'_1|, \quad (6)$$

$$v_{\pm}^{(1)}(1, 1) \sim u_1 |c_1| \frac{1 \pm 3}{2} \frac{c_1}{1} |c'_1|, \quad 0 < \ll 1, \quad (6)$$

(6) (5.2) negative (4.14)

$$s_{\pm}^{(2)}(2, 2) \sim u_2 |c_2| \frac{3 \mp 1}{6} \frac{c_2}{2} |c'_2|,$$

$$v_{\pm}^{(2)}(2, 2) \sim u_2 |c_2| \frac{1 \pm 3}{2} \frac{c_2}{2} |c'_2|, \quad 0 < \ll 1.$$

4

$s_{\pm}^{(1)} = 0$

$$\pm \sim \frac{2 |c_1|}{(1 \mp 1/3)(c_1 |c'_1|)} (M_1 |1|),$$

$$M_{2,\pm} \sim 1 |2^{\pm 1} (M_1 |1|), \quad 0 < M_1 |1| \ll 1,$$

(4.15)

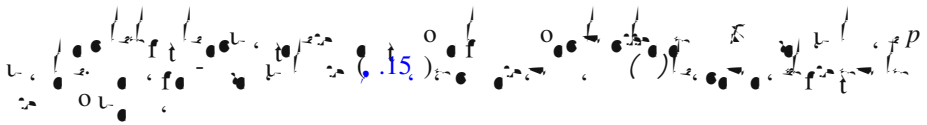
5

$$u = u_1 + u^{(1)}(\cdot, T) + u^{(2)}(\cdot, T) + \dots,$$



Handwritten musical notation on a staff. The notation includes notes, rests, and dynamic markings. Key elements include:

- Dynamic markings: f (forte), < 0 (piano), f (forte), $<$ (piano).
- Performance instructions: f (3.), s (sostenuto).
- Measure numbers in blue: $(.11)$, (6.1) , (6.1) , (6.1) .
- Other markings: 0 , t , 0 , t , 0 , t .

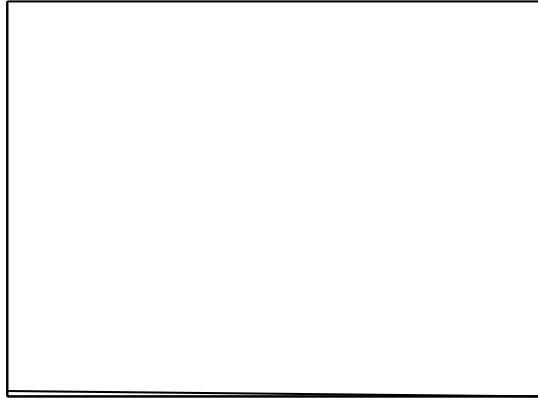


$$() \searrow \frac{p-2}{2p} > \frac{1}{2}, \quad \rightarrow \infty, \quad p > 1, \quad (1.1)$$

$\Gamma \rightarrow \Gamma \cdot \mathbb{Z} \cdot \mathbb{Z}$

$$0 < p < 1, ()$$







A complex musical score consisting of multiple staves. The notation includes various note values, rests, and dynamic markings such as *ff* and *kk*. There are also some numerical annotations like 3, 4, and 200. A blue circle highlights a specific note in the upper staff. The score is dense and appears to be a transcription of a piece of music.

Acknowledgments

Appendix: Numerical Methods

$$\int_{t_0}^{t_1} f(x, y, t) dt \approx \sum_{i=0}^{n-1} f(x_i, y_i, t_i) \Delta t \quad (3.1)$$

(x,

The image shows a musical score for a string quartet, specifically the first movement, first section. The score is written on a single staff with various notes, rests, and dynamic markings. The notation includes quarter notes, eighth notes, and sixteenth notes, along with rests and slurs. Dynamic markings such as *f* (forte) and *sfz* (sforzando) are present. The score is divided into measures by vertical bar lines. The overall appearance is that of a handwritten musical manuscript.

31(5), 24 422 (200)
 45, oo. 1 6 15 5 6 5 3. 2 0. (200).
 78(1), 013 2 (200)
 41(1), 26 5 (200)
 5(5), 611 613 (1, 64)
 (1, 3)
 36(3), 253 2, 0 (1, 3)
 36(5), 5 1 5, 3 (1, 3)
 36(6), 0 30 (1, 3)
 I. I. 21(10),
 23, 1 240 (200)
 (1, 5)
 524 55 (2013)
 40(3 4), 322 326 (1, 2)
 73(5), 05 602
 (2006)
 (1), 013 61 (200).
 80(4), 043 60 043 60 (200)

(1, 6)

I.5(3), 506 51

10(3), 536 53, (1, 6)

(1, 3)

24,

206 20, (1, 0)

17(143), 151 (1, 3)

31, 4 4, I (1, 5)

38, 125 155 (1, 5)

68(I), 136 (1,)

3(1), 46 51 (200)

104(), 0 3, 03 (2010)

283, 23 261 (1, 65)

(1, 4)