Riemann–Hilbert Problem 1. *The function* $\Phi_1 : \mathbb{C} \setminus \mathbb{R} \to \mathbb{C}^{1\times 2}$, $\Phi_1(z) = \Phi_1(z; x, t)$, *satisfies*

$$\begin{aligned}
\Phi_1^+(s) &= \Phi_1^-(s)\begin{bmatrix} 1-|R_1(s)|^2 & -\overline{R_1}(s)\mathrm{e}^{2\mathrm{i}sx+8\mathrm{i}s^3t} \\ R_1(s)\mathrm{e}^{-2\mathrm{i}sx-8\mathrm{i}s^3t} & 1 \end{bmatrix}, \quad s \in \mathbb{R}, \\
\Phi_1^+(s) &= \Phi_1^-(s)\begin{bmatrix} 1 & 0 \\ -\frac{c(z_j)}{s-z_j}\mathrm{e}^{-2\mathrm{i}z_jx-8\mathrm{i}z_j^3t} & 1 \end{bmatrix}, \quad s \in \Sigma_j, \\
\Phi_1^+(s) &= \Phi_1^-(s)\begin{bmatrix} 1 & -\frac{c(z_j)}{s+z_j}\mathrm{e}^{-2\mathrm{i}z_jx-8\mathrm{i}z_j^3t} \\ 0 & 1 \end{bmatrix}, \quad s \in -\Sigma_j, \\
\Phi_1(z) &= \begin{bmatrix} 1 & 1 \end{bmatrix} + O(z^{-1}), \quad z \in \mathbb{C} \setminus \mathbb{R},
\end{aligned}$$

with the symmetry condition

$$\Phi_1(-z) = \Phi_1(z)\sigma_1, \quad z \in \mathbb{C} \setminus \Gamma, \quad \Gamma = \mathbb{R} \cup \bigcup_j (\Sigma_j \cup -\Sigma_j).$$

Riemann–Hilbert Problem 2. *The function* $\Phi_2 : \mathbb{C}\backslash\mathbb{R} \to \mathbb{C}^{1\times 2}$, $\Phi_2(z) = \Phi_2(z; x, t)$ *satisfies*

$$\Phi_2^+(s) = \Phi_2^-(s)\begin{bmatrix} 1-|R_\mathrm{r}(s)|^2 & -R_\mathrm{r}(-s)\mathrm{e}^{-2\mathrm{i}\lambda(s)x-8\mathrm{i}\varphi(s)t} \\ R_\mathrm{r}(s)\mathrm{e}^{2\mathrm{i}\lambda(s)x+8\mathrm{i}\varphi(s)t} & 1 \end{bmatrix}, \quad s^2 > c^2,$$

$$\Phi_2^+(s) = \Phi_2^-(s)\begin{bmatrix} 1 & -R_\mathrm{r}(-s)\mathrm{e}^{-2\mathrm{i}\lambda^-(s)x-8\mathrm{i}\varphi^-(s)t} \\ 0 & 1 \end{bmatrix}\sigma_1\begin{bmatrix} 1 & 0 \\ R_\mathrm{r}(s)\mathrm{e}^{2\mathrm{i}\lambda^+(s)x+8\mathrm{i}\varphi^+(s)t} & 1 \end{bmatrix}, \quad -c \le s \le c,$$

$$\Phi_2^+(s) = \Phi_2^-(s)\begin{bmatrix} 1 & 0 \\ -\frac{C(z_j)}{s-z_j}\mathrm{e}^{2\mathrm{i}\lambda(z_j)x+8\mathrm{i}\varphi(z_j)t} & 1 \end{bmatrix}, \quad s \in \Sigma_j,$$

$$\Phi_2^+(s) = \Phi_2^-(s)\begin{bmatrix} 1 & -\frac{C(z_j)}{s+z_j}\mathrm{e}^{2\mathrm{i}\lambda(z_j)x+8\mathrm{i}\varphi(z_j)t} \\ 0 & 1 \end{bmatrix}, \quad s \in -\Sigma_j,$$

$$\Phi_2(z) = \begin{bmatrix} 1 & 1 \end{bmatrix} + O(z^{-1}), \;\; z \to \infty, \quad \varphi(s) = \lambda^3(s) + 3/2c^2\lambda(s),$$

with the symmetry condition

$$\Phi_2(-z) = \Phi_2(z)\sigma_1, \quad z \in \mathbb{C}\setminus\mathbb{R}.$$