- Lemma
- proof
- Python solver

## Lemma

Rankine-Hugoniot condition for anisotropic plasmas is<sup>[1]</sup>

$$egin{aligned} \Lambda_a(\epsilon_2, heta_1,M_{n2}^2)\cdot\epsilon_1^2M_{n1}^4 + 2\Lambda_b(\epsilon_1,\epsilon_2, heta_1,eta_1,M_{n2}^2)\cdot\epsilon_1M_{n1}^2 \ &+ \Lambda_c(\epsilon_1,\epsilon_2, heta_1,eta_1,M_{n2}^2) = 0 \end{aligned}$$

where

$$egin{aligned} \Lambda_a &= rac{\gamma-1}{\gamma} \cdot rac{\xi_2}{\cos^2 heta_1} - \xi_1 M_{n2}^2 an^2 heta_1, \ \Lambda_b &= \xi_2 \left[rac{\gamma-1}{\gamma} rac{2(1-\epsilon_1)}{3\cos^2 heta_1} + rac{\epsilon_1eta_1}{2\cos^2 heta_1} - \epsilon_2 M_{n2}^2
ight] + \epsilon_1\xi_1 M_{n2}^2 an^2 heta_1, \ \Lambda_c &= M_{n2}^2 \left\{\epsilon_2^2\xi_2 \left[rac{\gamma+1}{\gamma} M_{n2}^2 - rac{\epsilon_1eta_1}{\epsilon_2\cos^2 heta_1} + \left(rac{\epsilon_1}{\epsilon_2} - 1
ight) 
ight. \ &+ rac{2}{3} \left(1 - rac{1}{\epsilon_2}
ight) \left(rac{2\gamma-2}{\gamma} - an^2 heta_1
ight)
ight] - \epsilon_1^2\xi_1 an^2 heta_1 
ight\} \end{aligned}$$

and

$$egin{aligned} \xi_1 &= rac{\gamma-1}{\gamma} \left( M_{n2}^2 - 2 + rac{1}{\epsilon_2} 
ight) - rac{1}{3\gamma} \left( 2 + rac{1}{\epsilon_2} 
ight), \ \xi_2 &= \left( M_{n2}^2 - 1 
ight)^2 \end{aligned}$$

## <u>proof</u>

RH relations are as follows<sup>[2]</sup>

Processing math: 100%

$$[\rho V_n]_2^1 = 0, (1)$$

$$\left[
ho V_n^2 + ar{p} + rac{1}{3}\left(\epsilon + rac{1}{2}
ight)rac{\left|oldsymbol{B}^2
ight|}{4\pi} - \epsilonrac{B_n^2}{4\pi}
ight]_2^1 = 0, \hspace{1cm} (2)$$

$$\left[\rho V_n V_t - \epsilon \frac{B_n B_t}{4\pi}\right]_2^1 = 0, \tag{3}$$

$$\left[\rho V_n \left(V^2 + \frac{\gamma}{\gamma - 1} \frac{\bar{p}}{\rho}\right) + \frac{\epsilon + 2}{3} V_n \frac{\left|\boldsymbol{B}^2\right|}{4\pi} - \epsilon V_n \frac{B_n^2}{4\pi} - \epsilon V_t \frac{B_n B_t}{4\pi}\right]_2^1 = 0, \tag{4}$$

where  $ar{p}=(p_{\parallel}+2p_{\perp})/3$ .

## Python solver

- download
- example

- 1. Higashimori *←*
- 2. Karimabadi 🗠