Incident Plasma : Typical Parameters

Solar Wind / Magnetospheric Plasma

Few plasma parameters definition (in reference to ion specie 'i' impigned in a magnetic field B_0) :
Ion intertial length

$$\frac{c}{\omega_{pi}} = c\sqrt{\frac{\epsilon_0 m_i}{e^2 n_i}}$$

ion cyclotron frequency

$$\Omega_i = \frac{q_i B_0}{m_i}$$

thermal speed

$$v_{thi} = \sqrt{\frac{2k_B T_i}{m_i}}$$

Alfvèn speed of specie 'i'

$$V_A = \frac{B_0}{\mu_0 m_i n_i}$$

Sound speed

$$C_s = \sqrt{\frac{3T_e}{m_i}}$$

Ion specie 'i' plasma beta :

$$\beta_i = \frac{n_i k_B T_i}{\frac{B_0^2}{2\mu_0}}$$

Alfvèn Mach number

$$M_A = \frac{V_{incplasma}}{V_A}$$

Sonic Mach number

$$M_S = \frac{V_{incplasma}}{C_s}$$

Magnetosonic Mach number

$$M_{MS} = \frac{M_A M_s}{\sqrt{M_A^2 + M_s^2}}$$

Mars

Typical solar wind plasama parameters at the Martian orbit :
The main ion specie is H^+. Simulation values have been normalized with respect to H^+ parameters.
IMF :$B_{IMF} = (1.6, 2.5, 0.)nT$
Bulk speed : $V_{sw} = (400, 0, 0)km/s$
Electron temperature : $T_e = 3.10^5 K$.

H^+	He^{++}
m_{H^+}	$4m_{H^+}$
q_{H^+}	$2q_{H^+}$
$n_{H^+} = 2.5$ cm^{-3}	$n_{He^{++}}$ =$0.05 n_{H^+}$
$T_{H^+} = 5.10^4$ K	$T_{He^{++}} = 4T_{H^+}$

The derived quantites are listed in table 0.1.

TABLE 0.1: Solar wind plasma typical parameters

H^+	He^{++}
$\frac{c}{\omega_{pi}} = c\sqrt{\frac{\epsilon_0 m_i}{e^2 n_i}} = 150.15$ km	$\frac{c}{\omega_{pi}} = c\sqrt{\frac{\epsilon_0 m_i}{e^2 n_i}} = 671.48$ km
$\Omega_i = \frac{q_i B_0}{m_i} = 0.29 rad.s^{-1}$	$\Omega_i = \frac{q_i B_0}{m_i} = 0.14 rad.s^{-1}$
$v_{thi} = \sqrt{\frac{k_B T_i}{m_i}} = 28.7$ km/s	$v_{thi} = \sqrt{\frac{k_B T_i}{m_i}} = 28.7$ km/s
$\beta_i = \frac{n_i k_B T_i}{\frac{B_0^2}{2\mu_0}}$ =0.44	$\beta_i = \frac{n_i k_B T_i}{\frac{B_0^2}{2\mu_0}} = 0.09$
$V_A = \frac{B_0}{\mu_0 m_i n_i} = 39.38$ km/s	

TABLE 0.2: Normalized values in the simulation

Magnetic field : $B_0 = \|B_{IMF}\| = 3nT$	Electric charge : $q_0 = q_{H^+} \sim 1.602 \times 10^{-19}$ C
Mass : $m_0 = m_{H^+} \sim 1.67 \times 10^{-27}$ kg	Length : $L_0 = c/\omega_{pi}(H^+) = 150$ km
Time : $T_0 = \Omega_i^{-1}(H^+) \sim 3.44s$	Speed :$V_0 = V_A \sim 39.38$ km/s
Density : $n_0 = n_{H^+} = 2.5cm^{-3}$	

Simulation quantites are normalized to the dominant ion species of the incoming plasma. Therfore :

$$X^{physics} = X_0 \times X^{simulation}$$

For the Martian solar wind plasma, the characteristics plasma scales are in table 0.2
Values to set up in the simulation are in table 0.3

TABLE 0.3: Simulations values for the Martian Solar wind

$\beta_e = 2.79$	$\beta_i(H^+) = 0.44$	$\beta_i(He^{++}) = 0.09$
$V_{incoming} = 400./V_A = 10.15$	$v_{th}(H^+) = 0.728$	$v_{th}(He^{++}) = 0.728$
He_percent = 0.05		

Ganymede

Typical jovian plasma parameters at the Ganymede orbit :
The main ion specie is O^+. Simulation values are normalized with respect to O^+ parameters.
Incoming magnetinc field : $B_j = (0., 0., 120)nT$.
Bulk speed : $V_j = (180, 0, 0)km/s$
Elcetron temperature : $T_e = 100.eV$.
The derived quantites are listed in table 0.4.
For the jovian magnetospheric plasma at Ganymede, the characteristics plasma scales are in table 0.5
Values to set up in the simulation are in table 0.6

O^+	H^+
m_{O^+}	$1/16m_{O^+}$
q_{O^+}	q_{O^+}
$n_{O^+} = 2.96 \text{ cm}^{-3}$	$n_{H^+} = 0.2n_{O^+}$
$T_{O^+} = 360 \text{ eV}$	$T_{H^+} = 1/16T_{O^+}$

Table 0.4: Jovian plasma typical parameters

O^+	H^+
$\frac{c}{\omega_{pi}} = c\sqrt{\frac{\epsilon_0 m_i}{e^2 n_i}} = 529.42 \text{ km}$	$\frac{c}{\omega_{pi}} = c\sqrt{\frac{\epsilon_0 m_i}{e^2 n_i}} = 264.71 \text{ km}$
$\Omega_i = \frac{q_i B_0}{m_i} = 0.72 rad.s^{-1}$	$\Omega_i = \frac{q_i B_0}{m_i} = 11.49 rad.s^{-1}$
$v_{thi} = \sqrt{\frac{k_B T_i}{m_i}} = 46.42 \text{ km/s}$	$v_{thi} = \sqrt{\frac{k_B T_i}{m_i}} = 46.42 \text{ km/s}$
$\beta_i = \frac{n_i k_B T_i}{\frac{B_0^2}{2\mu_0}} = 0.03$	$\beta_i = \frac{n_i k_B T_i}{\frac{B_0^2}{2\mu_0}} = 0.007$
$V_A = \frac{B_0}{\mu_0 m_i n_i} = 377.39 \text{ km/s}$	

Table 0.5: Normalized values in the simulation

Magnetic field : $B_0 = \|B_j\| = 120nT$	Electric charge : $q_0 = q_{O^+} \sim 1.602 \times 10^{-19}$ C
Mass : $m_0 = m_{O^+} \sim 26.72 \times 10^{-27}$ kg	Length : $L_0 = c/\omega_{pi}(H^+) = 529$ km
Time : $T_0 = \Omega_i^{-1}(H^+) \sim 1.38s$	Speed :$V_0 = V_A \sim 377.39$ km/s
Density : $n_0 = n_{O^+} = 2.96cm^{-3}$	

Table 0.6: Simulations values for the Ganymede

$\beta_e = 0.021$	$\beta_i(O^+) = 0.03$	$\beta_i(H^+) = 0.007$
$V_{incoming} = 180./V_A = 0.477$	$v_{th}(H^+) = 0.123$	$v_{th}(He^{++}) = 0.123$
H_percent = 0.2		