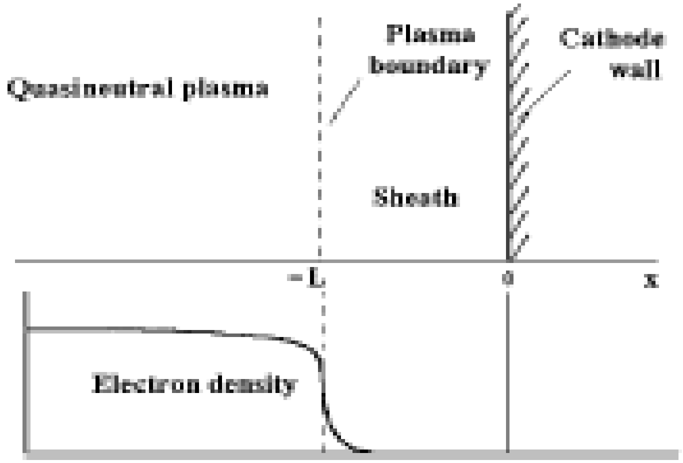
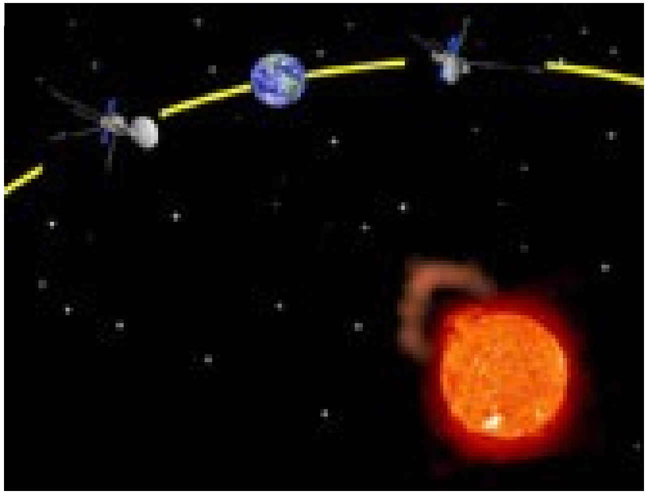
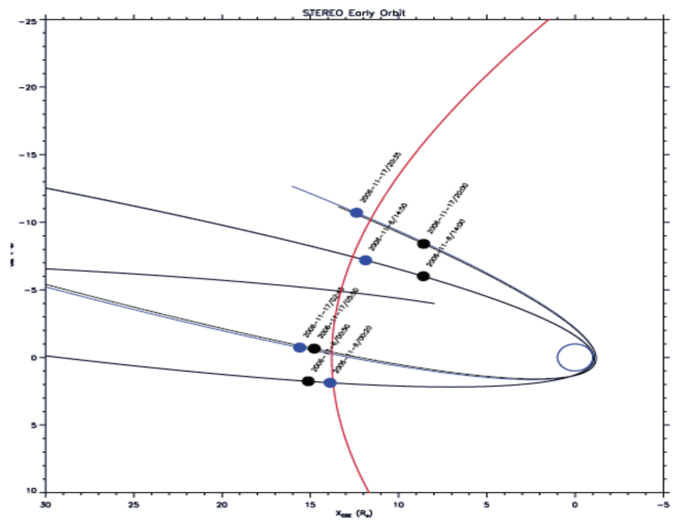
4 Items

- Direction finding easier when antennas orthogonal
- ...not like on STEREO...
- Direction finding never worked with Cassini, STEREO....
- Cygnus ... for in-flight calibration

The Physics of the plasma sheath







SOLAR ORBITER RPW antennas

Including the effect of space plasma

- Antenna behavior is influenced by the surrounding space plasma.
- The influence is highest near the plasma resonance frequencies but also noticeable at the higher parts of the typical radio experiment frequency range.
- Due to the trajectory it could be important for the SOLAR ORBITER RPW antenna calibration.
- A dielectric model of the space plasma can be incorporated in the numerical antenna calibration.

- The effect of plasma is encapsulated in the Green's tensor, which shape depends on the plasma model used.

$$\mathbf{E}(\mathbf{r},\omega) = \int_{V'} \mathbf{G}(\mathbf{r},\mathbf{r}')\, \mathbf{j}_{ant}(\mathbf{r}',\omega)\, dV'$$

- The general form of the response tensor is

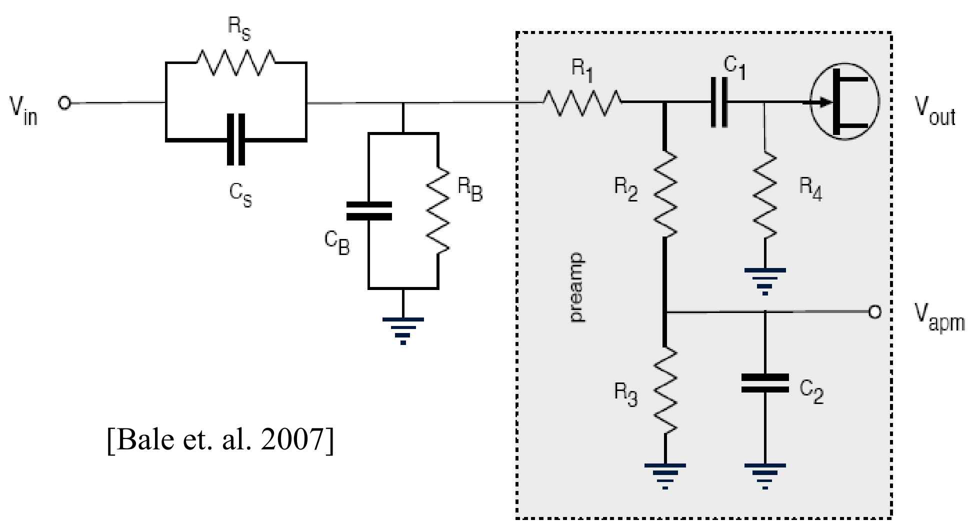
$$\mathbf{G}(\mathbf{r},\mathbf{r}') = \frac{\mu_0 \imath \omega}{(2\pi)^3} \int_{-\infty}^{\infty} \frac{adj(\lambda)}{\det(\lambda)} e^{\imath(k\cdot(\mathbf{r}-\mathbf{r}'))}\, d\mathbf{k}$$

- The resulting tensor can be incorporated into the electric field integral equation.

SOLAR ORBITER RPW antennas

Including the plasma sheath

- Spacecraft antennas are usually coupled to the surrounding space plasma.
- The electromagnetic coupling can be modeled by a system of a resistance and a capacitance.
- In rarefied plasma the coupling can not take place without photoelectrons.
- The sheath thickness must not be larger than the antennas.



[Bale et. al. 2007]

The Physics of the plasma sheath

Application

- STEREO operates in solar wind conditions at 1AU.
- The photo-electron production rate is higher than the thermal electron impact rate. --> positive charge.
- i_{ph}...$10^{-4}Am^{-2}$
- A_{rel}...0.5
- l=6m
- d=1in (0.0254m) on average
- Mean energy of photo-electrons=1.5eV
- Mean energy of thermal electrons=10eV

$$A_{rel} i_{ph} l d \sim 7.6 \cdot 10^{-6} A$$

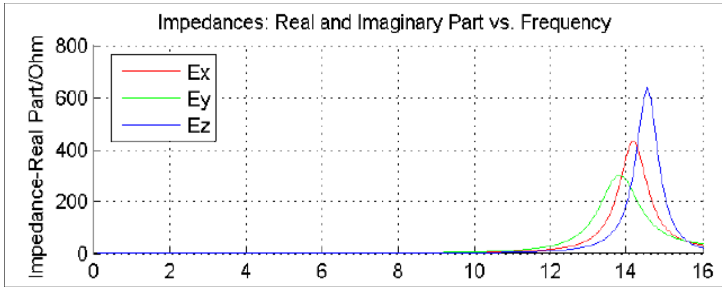
$$I_e = -e n_e d \pi \sqrt{\frac{\kappa T_e}{2\pi m_e}} \sim -2 \cdot 10^{-7} A$$

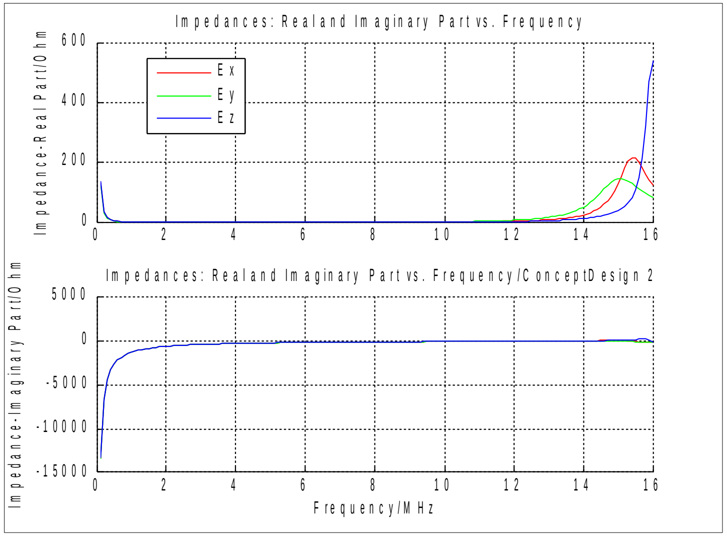
- -->V=5.5V
- $\overline{n}_e=10^6m^{-3}$
- -->$n_{ph}(0)=2x10^8m^{-3}$
- -->2.5% of the photo-electrons reach the plasma.
- -->λ_{sh} =85cm, using the photo-electron Debye length at the surface.

The Physics of the plasma sheath

Application

- Using the appropriate equations, one finds:
  - $R_s = 0.2 M\Omega$
  - $C_s = 87 pF$
- Via these parameters the sheath can be included into the numerical antenna calibration (wire-grid).
- No calculations for the effective length vectors where done so far.
- Computation of the impedances show that the inclusion of the sheath has an effect.

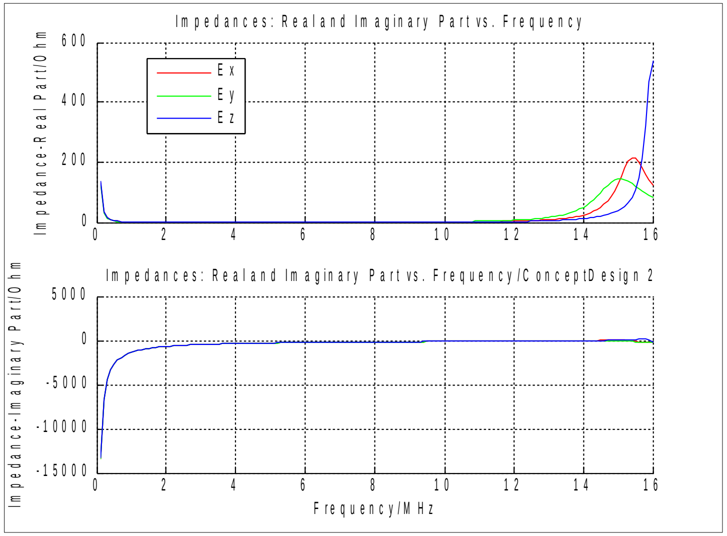


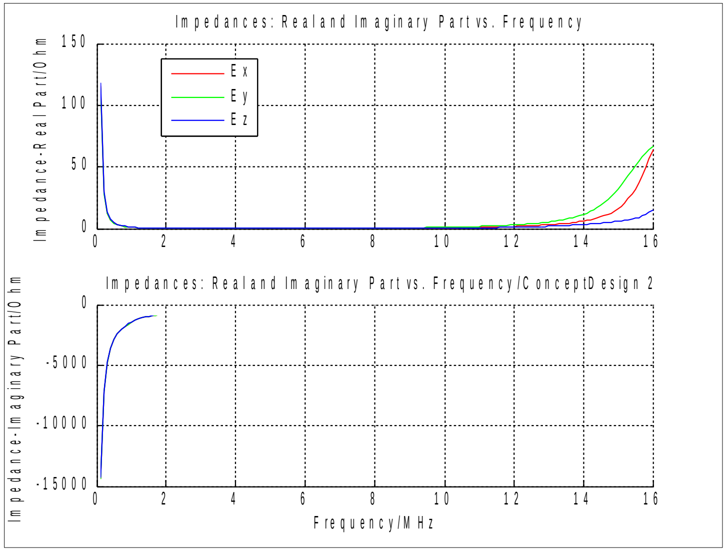


The Physics of the plasma sheath

Application

- Stuart Bale estimates
  - $R_s = 0.75 M\Omega$
  - $C_s = 40 pF$
- The figures show the impedances using Bale's values in relation to the results using our theoretical model.





The Physics of the plasma sheath

Application

- Comparing the location of the second resonance of antenna E_z with measured data shows that the inclusion of the sheath capacitance has a corrective effect.
- Further and more accurate data is needed to verify the model.