1. Plasma wave equations

We will start from this equation and replace the magnetic field intensity into the second equation by applying a second rotor:

$$rot\overline{H} = \frac{\partial \overline{D}}{\partial t} + \overline{J} \tag{1}$$

$$rot\overline{E} = -\frac{\partial \overline{B}}{\partial t} \tag{2}$$

$$rot(rot\overline{E}) = -\frac{\partial (rot\overline{B})}{\partial t} \tag{3}$$

$$rot(rot\overline{E}) = -\mu \frac{\partial^2 \overline{D}}{\partial t^2} - \mu \frac{\partial \overline{J}}{\partial t} \tag{4}$$

These are the material laws, with these we can express the electrical properties of every medium, his conductivity, permittivity and permeability:

$$\overline{J} = \sigma \cdot \overline{E} \text{ and } \overline{D} = \varepsilon \cdot \overline{E} \text{ and } \overline{B} = \mu \cdot \overline{H} \tag{5}$$

$$rot(rot\overline{E}) = -\mu\varepsilon \frac{\partial^2 \overline{E}}{\partial t^2} - \mu\sigma \frac{\partial \overline{E}}{\partial t} \tag{6}$$

The Laplacian is mathematically equal with:

$$\Delta\overline{E} = grad(div\overline{E}) - rot(rot\overline{E}) \text{ and } div\overline{E} = 0 \tag{7}$$

Wave equation for conductive or dissipative medium:

$$\Delta\overline{E} = \mu\varepsilon \frac{\partial^2 \overline{E}}{\partial t^2} + \mu\sigma \frac{\partial \overline{E}}{\partial t} \tag{8}$$

$$E = E_0 \cdot e^{j\omega(t - \frac{ar}{c})} \tag{9}$$

If we replace the solution in wave equation we obtain:

$$-\frac{\omega^2 \cdot a^2}{c^2} = -\mu\varepsilon \cdot \omega^2 + j\omega\mu\sigma \tag{10}$$

$$a^2 = c^2 \cdot \mu \cdot \left(\varepsilon - j\frac{\sigma}{\omega} \right) \tag{11}$$

So we want to create a powerful wave and fully absorb it into plasma or other medium. The wave can be fully absorbed when the refraction coefficient a is zero.

$$\varepsilon \cdot \omega = j\sigma \tag{12}$$

So conductivity must be a complex number, this situation occurs when we have a plasma medium, in plasma electrons are the main conduction charges because ions are oscillating much slower due to heavier mass. The oscillation amplitude of electrical particles is inverse proportional with the square root of mass and because an ion is 1800 times bigger than an electron, the ion oscillation can be neglected.

Our purpose is to find out the conductivity when a wave is totally absorbed in a plasma medium.

The plasma conduction current is generated only by electron oscillations:

$$\overline{J} = n \cdot e \cdot \overline{v} \tag{13}$$

Also we consider that we don't have a source of electrons in medium, electrons are moving only when we apply the electromagnetic field, the charge continuity equation must be satisfied:

$$div\overline{J} + \frac{\partial(n \cdot e)}{\partial t} = 0 \tag{14}$$

Because the movement of electrons is determined by the electromagnetic field we can write:

$$nm\frac{d\overline{v}}{dt} = ne(\overline{E} + \overline{v} \times \overline{B}) \tag{15}$$

$$\left|\overline{B}\right| = \frac{\left|\overline{E}\right|}{c} \tag{16}$$

$$nm\frac{d\overline{v}}{dt} = ne(\overline{E} + \frac{\overline{v} \times \overline{E}}{c}) \tag{17}$$

If we consider that $v << c$ then:

$$ne \cdot m\frac{d\overline{v}}{dt} = ne^2\overline{E} \tag{18}$$

$$\frac{\partial \overline{J}}{\partial t} = \frac{ne^2}{m}\overline{E} = \sigma \frac{\partial \overline{E}}{\partial t} = j\omega\sigma\overline{E} \tag{19}$$

$$\sigma = -j\frac{n \cdot e^2}{m \cdot \omega} \tag{20}$$

If we replace (20) in (12) then we will have:

$$\varepsilon \cdot \omega = \frac{n \cdot e^2}{m \cdot \omega} \text{ and } \omega^2 = \omega_p^2 = \frac{n \cdot e^2}{m \cdot \varepsilon} \tag{21}$$

From plasma theory we know that this is the frequency of resonance or plasma frequency.

But $rot\overline{H} = \left(j\varepsilon\omega - j\frac{n \cdot e^2}{m \cdot \omega} \right) \cdot \overline{E}$ =0 when the wave is totally absorbed (a=0). (22)

Also $rot\overline{E} = -\frac{\partial \overline{B}}{\partial t} = 0$. (23)

If the refraction coefficient is not zero then $rot\overline{H} \neq 0$ and plasma will have a different behavior:

We can consider that plasma has an dielectric constant ε_p.

$$rot\overline{H} = j\omega\varepsilon\left(1 - \frac{\omega_p^2}{\omega^2}\right) \cdot \overline{E} = j\omega\varepsilon_p \cdot \overline{E}, \varepsilon = \varepsilon_0 \tag{24}$$

$$\varepsilon_p = \left(1 - \left(\frac{\omega_p}{\omega}\right)^2\right) \cdot \varepsilon_0 \tag{25}$$

$$a^2 = c^2 \cdot \mu \cdot \left(1 - j\frac{\sigma}{\omega \cdot \varepsilon}\right) \cdot \varepsilon = c^2 \cdot \mu \cdot \left(1 - \frac{n \cdot e^2}{m \cdot \varepsilon \cdot \omega^2}\right) \cdot \varepsilon = c^2 \cdot \mu \cdot \left(1 - \frac{\omega_p^2}{\omega^2}\right) \cdot \varepsilon \tag{26}$$

But in plasma $\mu = \mu_0, \varepsilon = \varepsilon_0$, in conclusion

$$a = \sqrt{1 - \frac{\omega_p^2}{\omega^2}} \tag{27}$$

For $\omega > \omega_p$, a=real value , plasma is like a dielectric and electromagnetic waves are easily traveling thru it.

For $\omega < \omega_p$, a=is a complex number, plasma behaves like a metallic conductive surface, the incident waves are totally reflected, waves can't propagate thru plasma in the absence of an magnetic field.

For $\omega = \omega_p$, a=0, it is the cutting frequency and plasma resonates, in this case there can't be an transversal wave, only a longitudinal wave can exist, it is called also an electrostatic wave.

$$E = E_m \cdot e^{-\omega_p \cdot t} \tag{28}$$

$$\overline{J_d} = -\overline{J_c} = \frac{\partial \overline{D}}{\partial t} = -\varepsilon \cdot \omega_p \cdot \overline{E} = -\sigma \cdot \overline{E} \tag{29}$$

$$\overline{J_c} = \varepsilon \cdot \omega_p \cdot \overline{E} \quad \text{and} \quad \sigma = \varepsilon \cdot \omega_p \tag{30}$$

The total wave is build by an amplitude modulation of two electromagnetic waves. Plasma behaves like an amplitude modulator used in radio circuits.

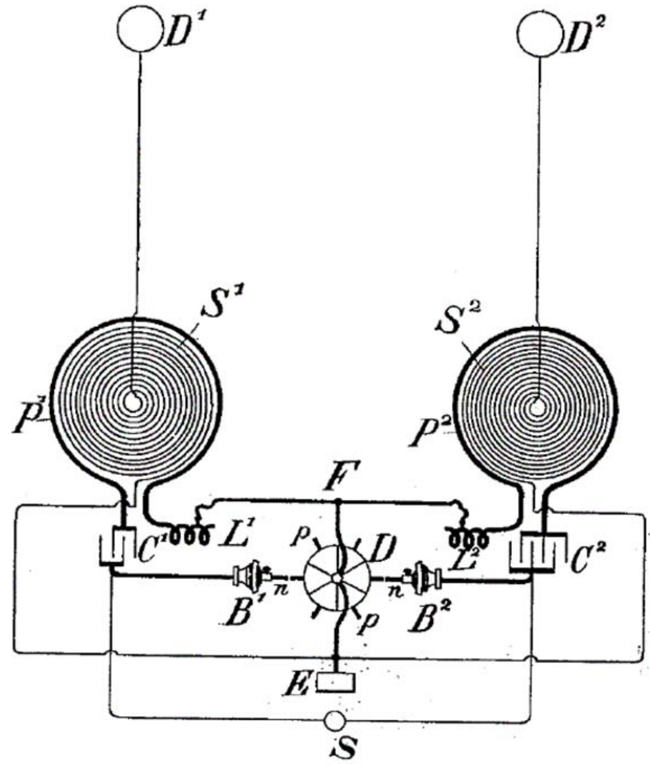
$$E_1 = E_{1m} \cdot e^{-\omega_1 \cdot t} \tag{31}$$

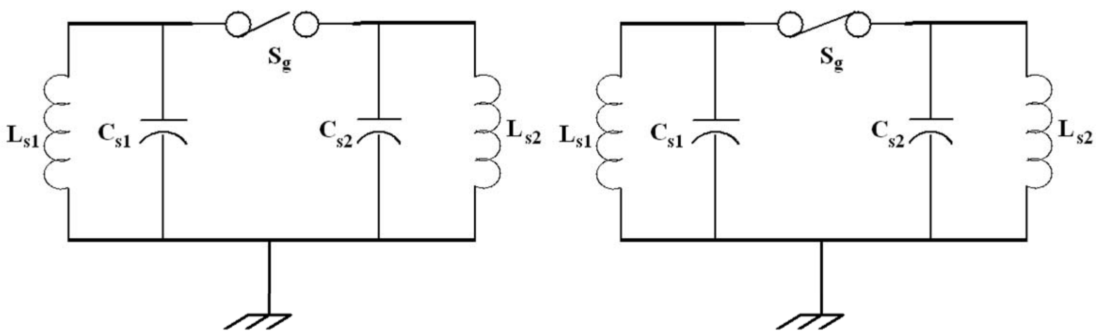
$$E_2 = E_{2m} \cdot e^{-\omega_2 \cdot t} \tag{32}$$

$$E = \left(E_{2m} + E_1\right) \cdot e^{-\omega_2 \cdot t} = E_2 + E_{1m} \cdot e^{-(\omega_2 + \omega_1) \cdot t} \tag{33}$$

$$E_m = E_{1m}, \omega_p = \omega_2 + \omega_1 \tag{34}$$

2. Tesla’s electrical circuit of ball lightning production

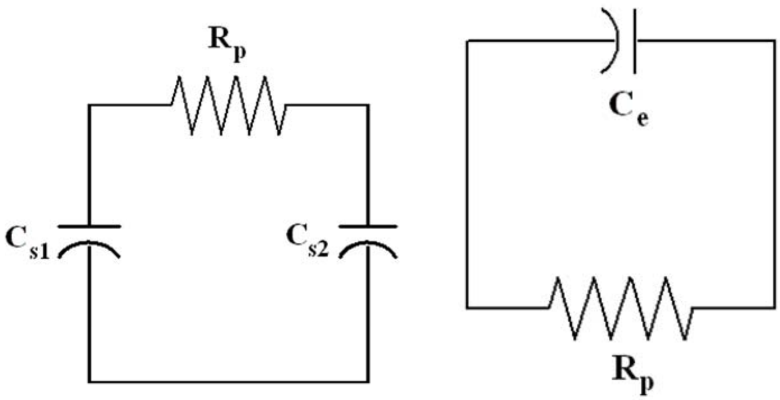




S_g is a giant spark gap, the switch behaves in the same way, like a normal spark gap. A normal spark gap ignites when we apply the peak voltage. This voltage is correlated with the distance between this two electrodes D_1, respectively D_2, so when the maximum voltage (ignition voltage) is reached, then we close the circuit, generating a conductive plasma path between D_1 and D_2.

S_g-open switch, $V_1 < V_{1m}$, condensers are charging separately, circuits are oscillating separately.

S_g-closed switch, $V_1 = V_{1m,} V_2 = V_{2m}$, both condensers are discharging the accumulated energy in plasma.



$$C_e = \frac{C_{s1} C_{s2}}{C_{s1} + C_{s2}}$$

$$V_{s1} = V_{1m} \cdot e^{-t/\tau_1}, \tau_1 = R_p \cdot C_{s1}$$

$$V_{s2} = V_{2m} \cdot e^{-t/\tau_2}, \tau_2 = R_p \cdot C_{s2}$$

$$V_e = (V_{1m} + V_{2m}) \cdot e^{-t/\tau_e}, \tau_e = R_p \cdot C_e$$

If $V_{2m} << V_{1m}$ and $C_2 << C_1$ we will have :

$C_e \cong C_2$

$$V_e = V_{1m} \cdot e^{-t/\tau_2}, \tau_2 = R_p \cdot C_2$$

R_p is plasma resistance, if we consider that plasma resonates at $\omega_p = \omega_2$ then we will have $\sigma = \varepsilon \cdot \omega_2$

But $R_p = \frac{1}{\sigma} \cdot \frac{l}{S} = \frac{l}{\varepsilon \cdot \omega_2 \cdot S}$ and $C_2 = \varepsilon \cdot \frac{S}{l}$ so $R_p = \frac{1}{\omega_2 C_2}$ when plasma resonates.

In a similar way a bigger capacity, like Earth's spherical capacity, can be replaced by a smaller capacity used by a Tesla coil. This kind of Tesla coil use Schumann resonances to create a standing wave (like the conductive path in plasma) between Earth's cavity and Tesla coil.

In conclusion $\tau_e = \tau_2 = \frac{1}{\omega_2 C_2} \cdot C_2 = \frac{1}{\omega_2}$

$$V_e = V_{1m} \cdot e^{-\omega_2 \cdot t}$$

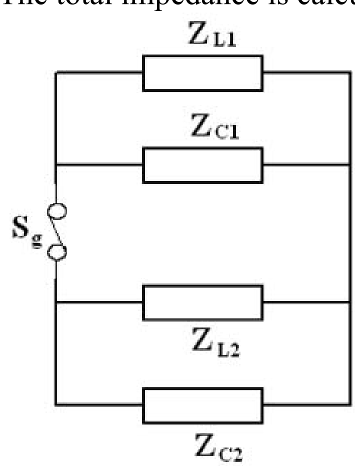
$$I_p = \frac{V_{1m}}{R_p} \cdot e^{-\frac{1}{R_p \cdot C_e} \cdot t} \quad I_p = \omega_2 \cdot V_{1m} \cdot C_2 \cdot e^{-\omega_2 \cdot t}$$

When t=0 we will have the maximum current.

$$I_{pm} = \omega_2 \cdot V_{1m} \cdot C_2$$

If we consider that S_g is an ideal switch or a transistor than we will have two resonant parallel circuits connected also in parallel.
This is useful to examine the total impedance for this two combined circuits with different resonance frequencies.

The total impedance is calculated for the case when S_g is closed.



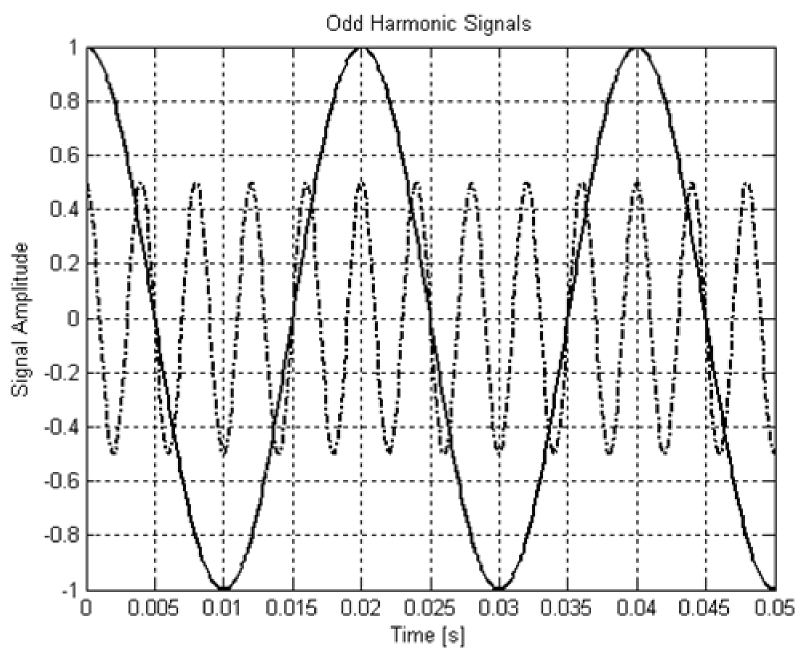
$Z_{C1} = \frac{1}{j\omega_1 C_1}; Z_{C2} = \frac{1}{j\omega_2 C_2};$

$$Z_{L1} = j\omega_1 L_1; Z_{L2} = j\omega_2 L_2;\ Z_{Lt} = j\frac{\omega_1\omega_2 L_1 L_2}{\omega_1 L_1 + \omega_2 L_2}; Z_{Ct} = \frac{1}{j(\omega_1 C_1 + \omega_2 C_2)}$$

$$Z_t = \frac{Z_{Lt}\cdot Z_{Ct}}{Z_{Lt} + Z_{Ct}} = \frac{j}{\frac{1}{\omega_1 L_1} + \frac{1}{\omega_1 L_1} - \omega_1 C_1 - \omega_2 C_2}$$

When both systems are resonating and the peak value for voltage is reached at a common time coordinate (both condensers are fully charged in that time) we will have: $\omega_1^2 = \frac{1}{L_1 C_1}; \omega_2^2 = \frac{1}{L_2 C_2}$ and $Z_t \to \infty, I = 0, V = V_{1m}, S_g = closed$. In conclusion the hole energy will flow into plasma and can't return back.

$f_2 = k \cdot f_1$, where k is an odd number.
Frequency f_2 is the carrier frequency and also the resonant frequency of plasma, so f_1 must be selected in function of f_2 and k .



3. Plasma and the laws of nature, the influences of magnetic fields

The ionosphere or a tenuous plasma has almost no damping due to the fact that the motion of free electrons caused by collisions is negligible. The conduction has no resistive losses of energy like we saw in chapter 1.
Now, if we add an external magnetic field, this is also the case of ionosphere where the earth's dipole field provides the external magnetic induction, we will change the index of refraction for plasma.

$$E_t = E(1_x \pm j1_y) \cdot e^{-j\omega \cdot t}$$

$$m \cdot \frac{d\overline{v_t}}{dt} = e \cdot (E_t + \overline{v} \times \overline{B})$$

$$v_t = v(1_x \pm j1_y) \cdot e^{-j\omega t}$$

$$\begin{cases} -j\omega \cdot m \cdot v_x = e(E_x + v_y B) \\ -j\omega \cdot m \cdot v_y = e(E_y - v_x B) \end{cases}$$

In order to have the same characteristics in each direction $v_x = v, v_y = \pm jv, E_x = E, E_y = \pm jE$

$$\begin{cases} -j\omega \cdot m \cdot v \mp j \cdot v \cdot e \cdot B = e \cdot E \\ \mp j\omega \cdot m \cdot jv + v \cdot e \cdot B = \pm je \cdot E \end{cases}$$

$$v = \frac{je}{m(\omega \pm \omega_b)} E, where\ \omega_b = \frac{eB}{m}$$

$$J_c = e \cdot n \cdot v = \frac{jne^2}{m(\omega \pm \omega_b)} E = \sigma \cdot E$$

$$\sigma = \frac{jne^2}{m(\omega \pm \omega_b)}$$

$$rot\overline{H} = -j\omega \cdot \varepsilon \cdot E + \frac{jne^2}{m(\omega \pm \omega_b)} E = -j\varepsilon\omega \left(1 - \frac{\omega_p^2}{\omega(\omega \pm \omega_b)}\right) \cdot E$$

$$\overline{J}_d = -\overline{J}_c \Rightarrow rot\overline{H} = 0 \Rightarrow \omega^2 \pm \omega \cdot \omega_b - \omega_p^2 = 0$$

$$\omega_b = \omega_p \Rightarrow \frac{e \cdot B}{m} = \sqrt{\frac{n \cdot e^2}{m \cdot \varepsilon}} \Rightarrow \frac{e^2 B^2}{m^2} = \frac{ne^2}{m\varepsilon} \Rightarrow B^2 = \frac{n \cdot m}{\varepsilon}$$

If $B = \frac{E}{c} \Rightarrow \varepsilon \cdot E^2 = n \cdot m \cdot c^2$, the whole wave energy is transferred to particles.

In this case electrons are like photons, traveling with the speed of light and having no resting mass m_0.

$$\omega_{1,2} = \frac{-\omega_b \pm \sqrt{\omega_b^2 + 4\omega_p^2}}{2}, \omega_{3,4} = \frac{+\omega_b \pm \sqrt{\omega_b^2 + 4\omega_p^2}}{2}$$

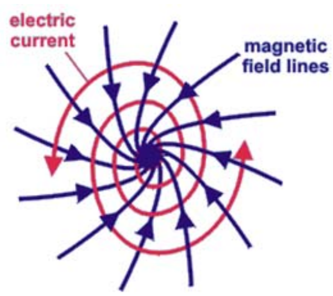
We can’t have negative solutions for frequencies, so only the positive solutions will remain:

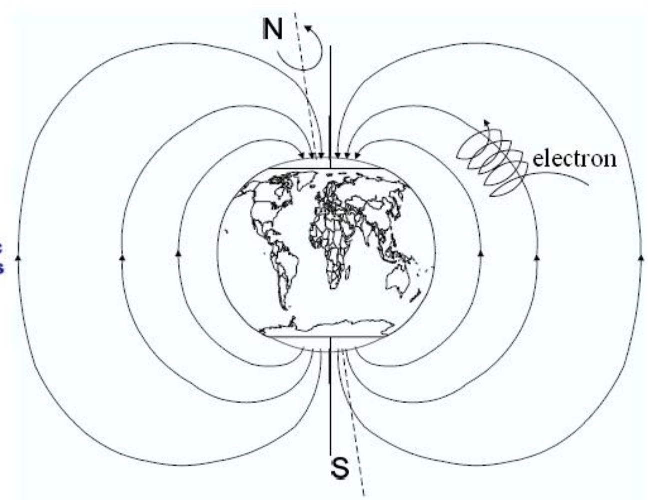
$$\omega_{1,2} = \frac{\mp \omega_b + \sqrt{\omega_b^2 + 4\omega_p^2}}{2}$$

If $\omega_b = \omega_p$ then we will obtain interesting values:

$$\omega_{1,2} = \left(\frac{\mp 1 + \sqrt{5}}{2} \right) \cdot \omega_p$$

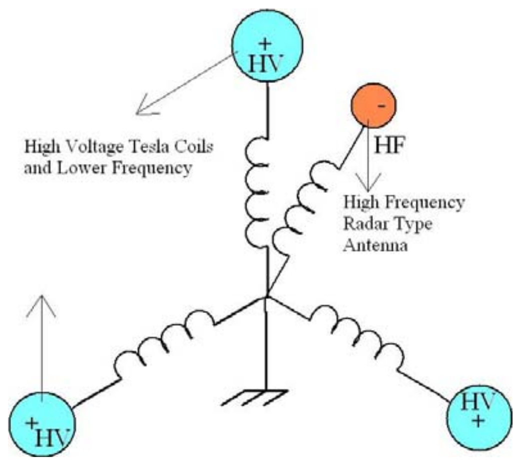
$$\Phi = \frac{1+\sqrt{5}}{2} \quad \omega_1 = \Phi \cdot \omega_p \quad \omega_2 = (\Phi - 1) \cdot \omega_p$$

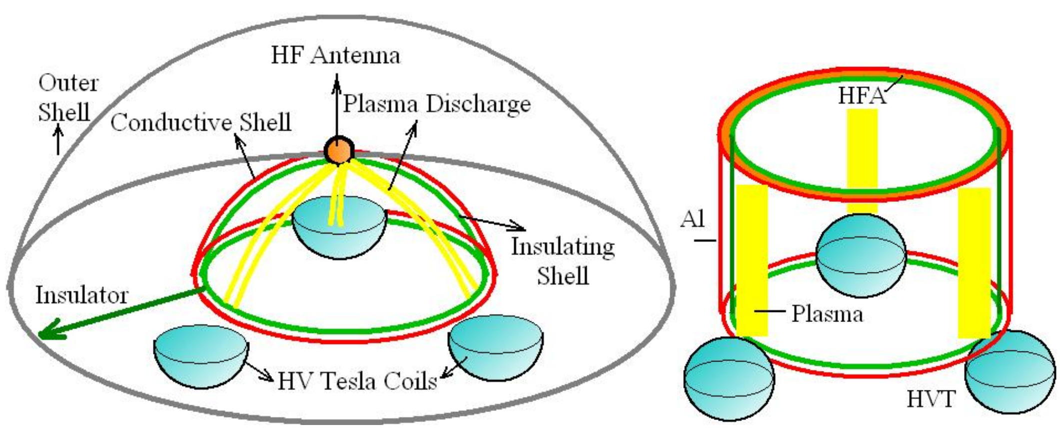




3. UFO propulsion system, UFO design

If we use only one Tesla coil we can't directly change the navigation path of the ship, instead if we use three Tesla coils we can obtain a major improvement in navigation system. For three Tesla coils we can have 6 horizontal propulsion directions and 2 (upwords and downwords) for a vertical path.





$$U_{ind} = -\frac{d\Phi}{dt} = -\frac{d\left(\mu_0 \cdot \omega_2 \cdot V_{1m} \cdot C_2 \cdot e^{-\omega_2 \cdot t} \cdot \frac{A}{k \cdot r}\right)}{dt} = -\mu_0 \cdot \omega_2^2 \cdot V_{1m} \cdot C_2 \cdot e^{-\omega_2 \cdot t} \frac{A}{k \cdot r} = \mu_0 \cdot \omega_2 \cdot I_p \cdot \frac{A}{k \cdot r}$$

$$I_{ind} = \frac{U_{ind}}{R}$$

The depth of penetration (in meters) of an electromagnetic wave into a conductor is:

$$\delta = \frac{1}{\sqrt{\pi f \mu \sigma}}$$

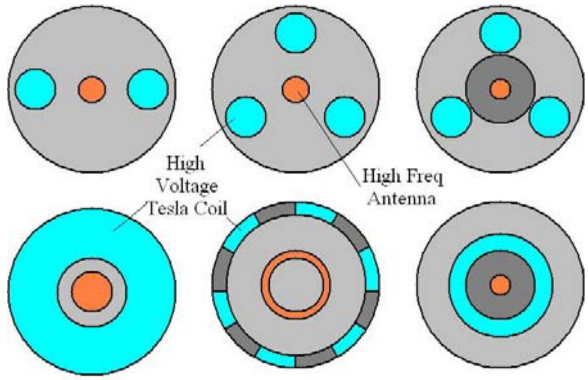
(depth of penetration in plasma)

$$\delta_p = \frac{c}{\sqrt{\omega_p^2 - \omega^2}} = \frac{c}{\omega_p} \text{ (for } \omega << \omega_p \text{)}$$

Tesla Coil Matlab Program:

```
miu0=4*pi*10^-7
Ut=30000
It=250*10^-3
Pt=Ut*It
f1=50
w1=2*pi*f1
f0=375000
w0=2*pi*f0

%secondary coil dimensions in centimeters
d0=0.82*Pt^0.4
%ideal aspect ratio
ar0=13.8*Pt^(-0.197)
h0=ar0*d0

Zt=Ut/It
Xc1=Zt
C1=1/(w1*Xc1)

%capacitatea distribuita a bobinei in [pF]
C0b=(0.1*ar0+0.32)*d0
```

```
%saucers capacity
da=1
ha=2
Cs=8.85*pi*da^2/(4*ha)
C0=(C0b+Cs)*10^-12

kt=sqrt(C1/C0)
U0=kt*Ut
I1=w0*C1*Ut
I0=w0*C0*U0
L1=1/(C1*w0^2)
L0=kt^2*L1

%densitatea cuprului in S/cm^2
Jcu=5814
dc0min=sqrt(4*I0/(Jcu*pi))
%a doua bobina e tip solenoid pe un singur rand
n0=1000*sqrt(L0*(45.72*d0+101.6*h0))/d0
dc0=h0/n0

%lungime conductor pt. bobina zero centrala in metri
lungc0=pi*n0*d0/100

%pentru prima bobina, este o spirala plata
Jcu=5814
dc1min=sqrt(4*I1/(Jcu*pi))
a1=10
din=d0+2
d1=din+a1
n1=1000*sqrt(L1*(40.64*d1+111.76*a1))/d1

df=6
g=0.02
Is=8000
Ifd=80000
Fprop=miu0*Ifd*Is*df/(4*pi*g)
```



Different circular craft configurations