THE PLASMA FREQUENCY: RADAR APPLICATIONS

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An analysis now exists to indicate that one of the primary applications of the aerosol operations is likely to involve the advanced use of radar technology for military purposes. Citizens may recall that this application was brought forth several months ago from unnamed sources; this current study substantiates that earlier disclosure through the processes of observation, analysis and deduction. Enhanced electromagnetic propagation of various energy forms, previously undefined as to specific wavelengths or frequencies employed, has been at the forefront of research by this author for some time now.

Although I do not, in any fashion, claim to be highly versed in plasma physics, this field has been an important topic of research for the past

year in conjunction with the analysis of the aerosol operations. A plasma is an ionized gas consisting of ions and free electrons distributed over a region in space. The effect of the aerosol operations can lead to no other logical conclusion except that the lower atmosphere itself has been altered to a plasma state. Previous research over a substantial period of time within this site will support this finding. An alternative interpretation of a plasma is that of an electrically conductive gas. In this case, the 'gas' employed is the atmosphere. An artificial ionosphere has been, in effect, created within the lower atmosphere. It may also help to mention that a neon, or fluorescent light, is a familiar visual example of plasma physics.

Within the field of plasma physics, concentrated attention must be devoted to what is known as the 'plasma frequency'. The plasma frequency can be considered as a *resonant* frequency of the ionized gas. The magnitude of this frequency

has highly significant ramifications with respect to the propagation of electromagnetic energy through the ionized gas. Take, for instance, the following elaboration by Richard Feynman, within Lectures of Physics, Vol II:

"This natural resonance of a plasma has some interesting effects. For example, if one tries to propagate a radiowave through the ionosphere, one finds that it can penetrate only if its frequency is higher than the plasma frequency. Otherwise the signal is reflected back. We must use high frequencies if we wish to communicate with a satellite in space. On the other hand, if we wish to communicate with a radio station beyond the horizon, we must use frequencies lower than the plasma frequency, so that the signal will be reflected back to the earth."

A difficult problem facing this researcher is how to arrive at the specific frequencies that are expected to be employed when provided with remote and limited data. Formal

authorities and agents of the public welfare, including the national media and environmental organizations, have demonstrated a complete and total refusal to confront the numerous demands by the public for an accounting of, and an informed consent to, the affairs overhead.

In order to arrive at the plasma frequency for the current state of the atmosphere, it is essential to determine an estimate for the electron density of the atmosphere under its current and altered state. The plasma frequency is intimately dependent upon the electron density; it is, in fact, proportional to the square root of this electron density. Determination of the electron density of the lower atmosphere(altered) has been a relatively difficult problem to approach with limited resources and the methods of analysis alone. It is thought that a satisfactory estimate of that electron density level can now be achieved. This work will show itself to be dependent upon earlier sustained research on

the subject of particle density estimates within the atmosphere. This work is presented on the page entitled Air Data Scrutiny Now Required presented elsewhere on this site.

As an opening example, let us consider an estimate of the plasma frequency for the ionosphere. The ionosphere is a rather classic example of a plasma state, and is of tremendous importance to radio communications because of the properties of reflection of waves as has been mentioned earlier. There are several forms of equations available that involve plasma frequency determination, e.g., see Introduction to Modern Optics by G. Fowles 1975, Theoretical Physics by G. Joos, 1986, Lectures of Physics, Feynman 1964, Theory of Electromagnetic Wave Propagation by Papas 1988, Optical Physics by S.G. Lipson 1995, The Electromagnetic Field by A. Shadowitz 1975, Physics of Waves by W. E. Elmore 1969 and others.

The form which is most

The form which is most convenient and simple to use at this point is:

$$w_p^2 = N (q_e)^2 / (E_o m)$$

where w_p is the plasma frequency in radians, N is the number of electrons per unit volume, E_o is the permittivity of free space, q_e is the charge of an electron and m is the mass of the electron. The following values are available:

q_e = 1.6E-19 coulomb

E_o = 8.85E-12 farad-meter^{-1}

m = 9.11E-31 kgm

A value for N, the number of electrons per unit volume for the ionosphere is available from the University of Leicester, on a web page entitled Ionospheric Physics (valid 08/19/01). It will be seen that representative values for the electron density of the ionosphere range from approximately 1E2 to 1E6 electrons per cubic centimeter. For this example, let us use a rather representative value of 1E5 electrons / cm3.

Using these values in the above equation,

w_p^2 = (1E11 (e-/m^3) * (1.6 E-19coulomb)^2) / ((8.85E-12 farad-meter^{-1}) * (9.11E-31kg))

or

w_p = 1.78E7radians

and dividing by 2 * pi for cycles/sec

w_p = 2.83Mhz.

This value is quite realistic and representative of what is known as a critical frequency (peak plasma frequency) of shortwave (high frequency) radio communications. Ionosonde measurements (measurements of ionization levels of the atmosphere) typically depict a value as has been determined above; please refer to Basic Ionosonde Theory (valid 07/28/01) for additional information.

The plasma frequency of solid metals can also be determined by these same principles. Electron density within metals is also known, and the plasma frequency of solid metals can also be determined. It is of more than passing interest that the plasma frequency of a solid metal is also related directly to its 'transparency' with respect to the electromagnetic frequencies to which it is subjected.

The problem of estimating the electron density of the altered atmosphere poses several difficulties, as some estimate of the concentration and type of the aerosols which have been injected into the atmosphere will be required.

Readers may now wish to refer to an earlier presentation, where such estimates of particulate concentration levels have been presented. It may be recalled that an extremely conservative approach to this problem was taken, with an end result of approximately 60 micrograms / cubic meter (EPA limit 50 : PM<10) being

arrived at through a reasoned analysis and synthesis of observations. In addition, assume a baseline value of 39 micrograms cubic meter from the reference data of the interval 1996 - 1998; this value is taken from an [additional study] of particulate matter. Assume, therefore, a difference of particulate matter on the order of 21 micrograms / cubic meter from the reference value. Assume for the present example that we are using magnesium as a primary constituent of the aerosol particulate matter.

In a manner similiar to R. Feynman, within Lectures on Physics Vol II, subsection entitled, *Low Frequency and high-frequency approximation; the skin depth and the plasma frequency*, let us assume that there is one free electron per atom within the particulate material under analysis. This now leads to an estimate for N as:

N = ((60E-6 gms / m^3) - (39E-6 gms / m^3) * 6.02E23

(Avogadros No.)) / (24.3 gms / mole of Mg)

N(estimate) = 5.20E17 electrons / m^3

Notice that this estimate is significantly higher than the magnitudes expected within the ionosphere itself.

Determining the plasma frequency for this electron density, we have:

w_p^2 = ((5.20E17 e- / m^3) * $(1.6E-19)^2$) / ((8.85E-12) * (9.11E-31))

which leads to an estimate of the plasma frequency of the altered atmosphere of:

w_p = 4.06E10radians

or

w_p = (6.46E9)Hz

The significance of this frequency value is that it represents the upper end of radio waves, i.e., radar waves within the electromagnetic spectrum. Based upon the earlier discussion. it is

therefore expected that the altered atmosphere medium is conducive and beneficial to the reflection, propagation and/or the ducting of radar waves(as well as lower frequencies) over long distances. This strongly suggests that a significant application of the aerosol operations may well involve that same enterprise, i.e, the propagation of radar waves (as well as lower frequencies) over extended distances. There are numerous military and electromagnetic propagation applications that become evident from this finding. Any modifications to this presentation will be made as is appropriate.

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