Relation Between Electron Density and
Frequency of Large Amplitude Langmuir Oscillations

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Plasma physics may be considered to have begun in 1929 with the discovery by Tonks and Langmuir of the formula for the frequency of small amplitude oscillations in a cold neutral plasma:

$$\omega_{pe} = \sqrt{4\pi e^2 n_o / m_e} ,$$

where $n_p = n_o$ is the constant proton density, e is the electron charge and m_e is the electron mass. This formula has become the basis for the diagnostics for electron density in space plasmas, specifically in the Earth's ionosphere and magnetosphere and in the solar wind as well as the magnetospheres of other planets.

The validity of this formula for large amplitude Langmuir oscillations is the focus of this talk for plane, cylindrical and spherical modes. The deviation from quasi-neutrality (build-up of negative charge) by such oscillations in type III radio burst regions and for waves in the front of the Earth's bow shock will be discussed.