Spectroscopic Detection of Strong Langmuir Turbulence

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With a view toward modelling the ultimate stages of the strongly developed electromagnetic (Weibel) turbulence arising in the collective stopping of pw-laser produced relativistic electron with ultrahigh density and precompressed deuterium + tritium core, we consider a non interacting fluid of Langmuir cavitons. These latter could meaning fully mimicked filaments featuring a last Weibel stage. An interesting signature of the strongly developed Langmuir turbulence is the Gaussianlike behaviour of the low frequency microfield distribution arising from the background ions. Such a typical behaviour has been experimentally documented [1], A plausible and a anisotropic low frequency distribution may be written as :

$$W(E,\cos\theta)dEd\cos\theta = \int d\vec{E}_{//}\int d\vec{E}_{\perp} W_1(\vec{E}_{//})W_2(\vec{E}_{\perp})\delta(\vec{E}-\vec{E}_{//}-\vec{E}_{\perp})dEd\cos\theta$$

$$=\left(\frac{2}{\pi\langle E_{//}^2\rangle}\right)^{\frac{1}{2}}\frac{E^2}{\langle E_{\perp}^2\rangle}\exp\left[-\frac{E^2}{E_{\perp}^2}-\cos^2\theta\left(\frac{E^2}{\langle 2E_{//}^2\rangle}-\frac{E^2}{\langle E_{\perp}^2\rangle}\right)\right]dEd\cos\theta, \qquad (1)$$

Then, convoluting as in the standard impact line broadering theory (Baranger-Griem) the short range collisions contribution in the line center with the microfied [Eq. (1)] effect on the static Stark pattern, one can obtain analytically for the Lyα line of hydrogen, significant line profiles. Figs. 1 display wing behaviours for two values of the anisotropy parameter $\eta^2=\langle 2E_{//}^2\rangle/\langle E_{\perp}^2\rangle$.

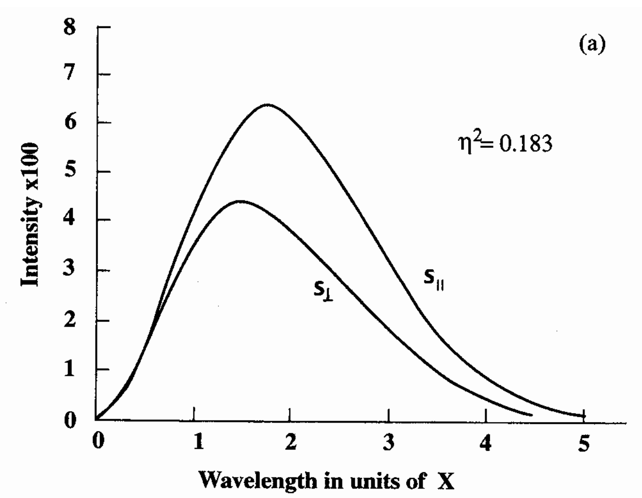

Figure 1(a) : Wing contribution to the normalized line-intensity profile $S_{//}$ is the intensity viewed along the axis of symmetry z, and $S_{\perp}$ is the intensity perpendicular to it.

The anisotropy parameter is $\eta^2=\langle 2E_{//}^2\rangle/\langle E_{\perp}^2\rangle=0.183$.

To obtain the full line profile one must superimpose contributions from the line center.

$X=0.1106\Delta\lambda/(E_o d)$ and $2d=\frac{1.5\lambda_0^2}{\pi m_e c}$ for Lyα.

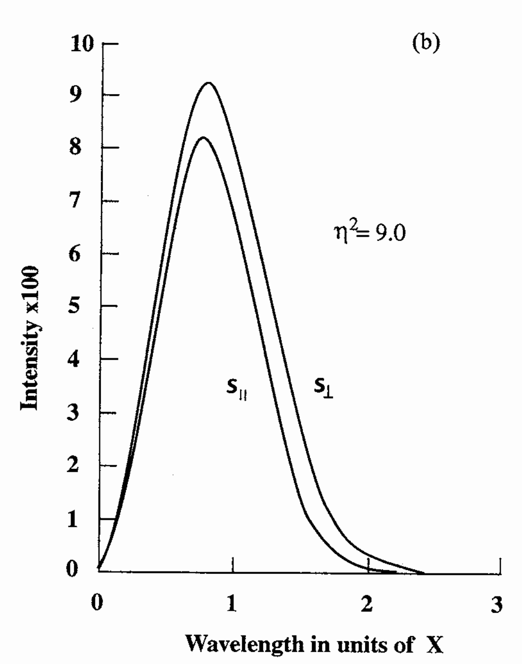

Figure 1(b) : Same as (a), except that the anisotropy parameter is $\eta^2 = 9.0$.

It is also instructive to consider ratios of intensity $\frac{S_{//}}{S_{\perp}}$ around line center, where the collisions contribution has been included. Here this ratio is wavelength independent.

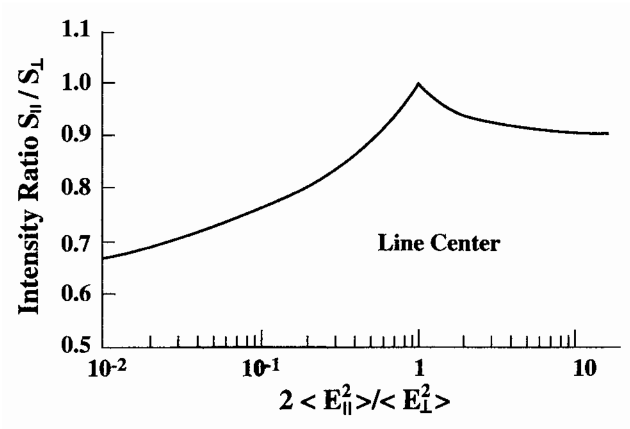

Figure 2 : Ratio of intensities $S_{//}/S_{\perp}$ at and near the line center, as a function of the anisotropy parameter $\eta^2=\langle 2E_{//}^2\rangle/\langle E_{\perp}^2\rangle$. Note that at the line center this ratio is independent of the wavelength.

References

[1] D. Levron, G. Benford and D. Tzach, Phys. Rev. Lett., **58**, 1336 (1987)