

Determine the mode number and wave-number of plasma instability using harmonics in the spectrum

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Harmonic phenomenon occurs frequently in the plasma diagnostic signal spectrum and is often considered useless or even harmful. Because the harmonic of plasma modes may overlap with other modes making it difficult for experimenters to distinguish between these modes. But in some case harmonics of mode may carry important information that helps further study plasma instability modes.

Harmonic phenomenon may come from mode coupling with itself. By analyzing the different harmonic frequencies in the spectrum, the toroidal mode number of the mode be determined. For example, Harmonics are seen in the spectrum of laser interferometer. There are mode and its harmonics in the spectrum at around 345~350ms. According to the magnetic probes the toroidal mode number is $n=3$. After analyzing the harmonics in the spectrum, the toroidal mode number $n=3$ or 4 is obtained. This is generally consistent with the measurements obtained from the magnetic probes.

The Bragg condition shows that the most efficient reflection of microwave occurs at $kf=2k0$, where kf is the wavenumber of the perturbation spectrum, $k0$ is the wavenumber of incident wave. The wavenumber of harmonic increases with the order of harmonics. When the wavenumber of harmonics meets the Bragg condition, it will show a stronger reflect phenomena. This phenomenon has been observed on HL-3's microwave reflectometer signal. And after determining the wave number of the incident wave, the wave number range of the mode can be roughly determined.

Speaker's email address

huliwen@swip.ac.cn

Speaker's Affiliation

Southwestern Institute of Physics

Member State or International Organizations

China

Authors: HU, Liwen (核工业西南物理研究院); SHI, peiwan (Southwestern Institute of Physics); CHEN, Wei (Southwestern Institute of Physics, P.O. Box 432 Chengdu 610041, China); Mr FENG, xi (核工业西南物理研究院); YU, Liming (Southwestern Institute of Physics)

Presenter: HU, Liwen (核工业西南物理研究院)

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