USAGE OF PARAMETRICALLY INDUCED TRANSPARENCY IN OPAQUE TOROIDAL PLASMAS FOR DIAGNOSTICS BY BERNSTEIN WAVES RADIATION

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In [1-4] it was proposed to use the effect of electromagnetically induced transparency (EIT) for the transportation of radiation through "opaque" medium. Effect of EIT is the variant of nonlinear resonant 3-wave interaction. In this regime the signal wave (s-wave) is carried through the opaque plasma by the beating between drive wave (d-wave) and quasielectrostatic "transporting" wave (t-wave). And t-wave is excited by the beating between s-wave and d-wave at the boundary of opaque region. One of the most difficult tasks here is to provide the focused high-power drive wave over the whole distance of s-wave propagation.

However, the significant simplification is possible if t-wave is the electromagnetic wave with nonzero group velocity, which can propagate to the vacuum. In this case it is necessary to apply the drive only in the region of effective nonlinear interaction between s-wave and t-wave. Then exited t-radiation will go to the vacuum and the s-wave intensity can be determined via the appropriate postprocessing of received t-radiation (because the amplitude of s-wave unambiguously determines the amplitude of excited t-wave). We call this variant *parametrically induced transparency* (PIT).

We discuss the applications of PIT for getting the information about the intensity of spontaneous emission, "separated" from the vacuum by opaque region near the upper-hybrid resonanse (UHR) in dense toroidal plasma. The main idea of the diagnostic technique is the following. The plasma produces radiation at one of the EC harmonics, which is partially represented as electron Bernstein waves (we mainly discuss Bernstein wave at second cyclotron harmonics). These waves propagate to the UHR region and are transformed into extraordinary electromagnetic waves. An extraordinary wave is considered as the s-wave and during propagation from the UHR region toward the plasma center it is transformed into a t-wave by the means of PIT. For the high power drive wave, such an experiment could make use of existing high power gyrotrons that are being used for electron cyclotron resonance heating at second cyclotron harmonics. The general system of equations, describing the 3-wave interaction is derived. We investigate the nonlinear mode conversion in inhomogeneous medium, which significantly influences on the whole effectiveness of PIT scheme. The numerical calculations are provided for the parameters corresponding to the TEXTOR tokamak. We discuss the possibilities to observe this effect experimentally and provide the comparison between PIT regime and OXB scheme of radiation extraction.

References

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