Summer School on *Waves and fusion plasmas*, Paris, July 3rd-7th, 2017.

Semiclassical methods for waves in hot magnetized plasmas

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This lecture addresses computational methods used to model electromagnetic wave beams in fusion plasmas. Due to the large scale separation between the beam wave length and the typical plasma scale length, such methods are based upon improved variants of WKB asymptotics and are generally referred to as semiclassical methods.

In fusion experiments wave beams are used either for heating plasmas at the high temperatures required by fusion reactions, or in plasma diagnostics. This lecture will be biased on the side of plasma heating applications, and thus we shall pay particular attention to the energy transported by the wave, rather than to the wave field itself.

The lecture comprises two parts.

- Part 1. After a brief overview of the key concepts, we address the methods routinely employed in fusion plasma physics, paraxial methods [1-3] in particular.
- Part 2. Recently, the effect of plasma turbulence on wave beams has been intensely investigated as it might lead to degraded beam quality in large machines such as ITER. Within some limitations, turbulence effects can be studied by means of statistically averaged Wigner measures [4] as implemented in the code WKBeam [5]. We address the theory basis of such an approach.

Selected references

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5. H. Weber, IPP report, Max-Planck Institute for Plasma Physics, 2013.