Teaching Wigner optics: what and how

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Abstract: We discuss how we introduce Wigner optics to students of different backgrounds, what sub-topics we find most appropriate, what difficulties we have encountered, and how we motivate an appreciation of the subject by means of suitable examples.

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In this paper we discuss how we introduce Wigner optics to students of different backgrounds, including electrical engineering, applied physics, and information technology; what sub-topics we find most appropriate (and inappropriate) for exposition, what difficulties we have encountered (and learned to avoid) in teaching the material, and how we motivate an appreciation of the subject by means of suitable examples. Issues addressed include the following (WDF = Wigner distribution function, WSBD = Wigner space-bandwidth diagram):

- How much of the mathematics of the WDF should be taught? How?
- Should the WDF, as used in wave optics, be said to provide a phase-space representation of the optical wave? (Intimately-related question: What *is* a phase-space representation?)
- How should the WSBD be constructed?
- What are some good examples of uses of the WSBD?
- Should the relationship between the WDF and the FRT be taught? (The real issue: Should the FRT be taught at all in an optics course?)
- How should the WDF be introduced? By way of a discussion of time-frequency representations of signals (e.g., short-time Fourier spectra, player-piano rolls, etc.)? Without any prelude?
- How should the teaching of Wigner optics change with the background of the students (e.g., students of electrical engineering and opto-electronics, applied physics, information technology)?
- How does one deal with the dimensionality-expanding nature of the WDF? When is it sufficient to work with a 1-D complex amplitude (and corresponding 2-D WDF)?
- What is the relationship between the WDF of wave optics and the WDF functions of quantum mechanics and coherence theory?

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