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Slow-wave amplifiers and oscillators: A unified study

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In an idealized model of a traveling-wave amplifier operating in the linear regime it is assumed that all the transients have decayed. This implies that the electromagnetic wave has an amplitude which is constant in time but may vary in space according to the interaction process. In an idealized model of an oscillator, the situation is reversed. The amplitude of the electromagnetic wave is constant in space and it may vary in time. We present a generalized formulation of the interaction in a traveling-wave tube which includes reflections and spatial and temporal transients. Within this framework it is shown that, in an amplifier, the reflections cause time variations of the amplitude that are ultimately revealed as a broadening of the spectrum. The "transition" to an oscillator is also investigated. In the case of an oscillator, it is shown that in addition to the well-known temporal transient (lethargy) there is a spatial transient. This is due to the fact that it takes part of the system length for the "fresh" electrons entering the oscillator to get bunched. Beyond this transient the amplitude is constant in space, as anticipated by the idealized theory.

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