Linear analysis of active-medium two-beam accelerator

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We present detailed development of the linear theory of wakefield amplification by active medium and its possible application to a two-beam accelerator (TBA) is discussed. A relativistic train of triggering microbunches traveling along a vacuum channel in an active medium confined by a cylindrical waveguide excites Cherenkov wake in the medium. The wake is a superposition of azimuthally symmetric transverse magnetic modes propagating along a confining waveguide, with a phase velocity equal to the velocity of the triggering bunches. The structure may be designed in such a way that the frequency of one of the modes is close to active-medium resonant frequency, resulting in amplification of the former and domination of a single mode far behind the trigger bunches. Another electron bunch placed in proper phase with the amplified wakefield may be accelerated by the latter. Importantly, the energy for acceleration is provided by the active medium and not the drive bunch as in a traditional TBA. Based on a simplified model, we analyze extensively the impact of various parameters on the wakefield amplification process.

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