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# General theory of the bubble regime

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We present the energy-conserving theory of plasma wakefields in the strongly nonlinear "bubble" or "blowout" regime. In this theory, we derive an equation for the bubble boundary based on the energy conservation law. Compared to previous models, this equation precisely characterizes the bubble boundary and the accelerating field across a broad spectrum of driver parameters, including those with small transverse bubble sizes, without relying on fitting parameters. Additionally, our model converges with existing models in cases where the bubble size is sufficiently large. We establish a self-consistent method for describing bubble excitation by both electron drivers and laser drivers based on setting the initial conditions from the analytically calculated quasi-linear solution at the front of the driver. The model's predictions are validated through 3D PIC simulations, showing excellent agreement.

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