Electron self-injection and trapping into an evolving plasma bubble\textsuperscript{1} S. KALMYKOV, S.A. YI, V.N. KHUDIK, G. SHVETS, Institute for Fusion Studies, The University of Texas at Austin — In the blowout regime of laser wakefield acceleration (LWFA), radiation pressure creates a co-moving bubble of electron density behind the driving laser pulse. Self-injection of initially quiescent electrons into the bubble and their subsequent acceleration are studied both analytically and by particle-in-cell (PIC) simulations. Semi-analytic model treats the bubble as a spherical cavity of electron density moving with a relativistic velocity over an immobile ion background. The non-evolving bubble must be unrealistically large to self-inject quiescent electrons, whereas its slow expansion significantly relaxes this requirement. PIC modeling shows that a defocusing laser may cause self-injection into the expanding bubble, even when a non-evolving pulse would not. This effect is explained in terms of non-stationary Hamiltonian theory. Temporal expansion of the bubble appears to be the dominant mechanism of electron self-injection in rarefied plasmas ($n_0 \sim 10^{17}$ cm$^{-3}$) relevant to the LWFA with petawatt-class lasers. Combination of bubble expansion and contraction results in monoenergetic electron beams due to the termination of self-injection process and phase space rotation.

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