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Magnetic field production in an expanding plasma: Biermann or Weibel? KEVIN SCHOEFFLER, NUNO LOUREIRO, LUIS SILVA, RICARDO FONSECA, IPFN, Instituto Superior Técnico — Recent laboratory experiments focusing intense lasers ($\sim kJ$) at solid targets show the production of strong magnetic fields (of order a megaGauss). It is conjectured that these fields arise via the Biermann battery mechanism, due to non-aligned electron density and temperature gradients. We investigate the generation and amplification of such magnetic fields in a kinetic particle-in-cell model, and its dependence on system size, L. For moderate system sizes ($L \gtrsim d_i$), we find that the strength of the magnetic fields scales as $1/L$, consistent with their origin being due to the Biermann effect. However, for large L/d_i, we discover that the Weibel instability (due to electron temperature anisotropy) supersedes the Biermann battery effect as the main mechanism behind the production of magnetic fields. The Weibel-produced fields, unlike the ones due to Biermann, saturate at a finite amplitude (plasma $\beta \sim 1$) for large L/d_i. These results have strong implications for the interpretation of laser-solid interaction experiments. They may also be important to the understanding of the origin of the observed magnetic fields in the universe.

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