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Simulations of Cold Electroweak Baryogenesis

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We perform numerical simulations of Cold Electroweak Baryogenesis, including for the first time in the Bosonic sector the full electroweak gauge group SU(2)×U(1) and CP-violation.
We investigate the dependence of the asymmetry on the speed at which electroweak symmetry breaking takes place.
Curiously, we find that the overall sign of the asymmetry depends on the quench time and the maximum asymmetry does not occur for arbitrarily fast quenches.
In addition, we compute the magnitude of the helical magnetic fields, and find that it is proportional to the strength of CP-violation and dependent on quench time, but is not proportional to the magnitude of the baryon asymmetry as proposed in the literature.
Astrophysical signatures of primordial magnetic helicity can therefore not in general be used as evidence that electroweak baryogenesis has taken place.
We also compute the baryon asymmetry generated from Cold Electroweak Baryogenesis, when a dynamical Beyond-the-Standard-Model scalar singlet field triggers the spinodal transition.
Using a simple potential for this additional field, we match the speed of the quench to earlier simulations with a "by-hand" mass flip.
We find that for the parameter subspace most similar to a by-hand transition, the final baryon asymmetry shows a similar dependence on quench time and is of the same magnitude.
For more general parameter choices the Higgs-singlet dynamics can be very complicated, resulting in an enhancement of the final baryon asymmetry.

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