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Primordial magnetogenesis from electroweak dumbbells

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The "electroweak dumbbell"consists of a magnetic monopole and an antimonopole of the standard electroweak model connected by a string made of Z–magnetic field. We have scrutinized the structure of static electroweak dumbbells using "constrained relaxation"for a range of separations and twists, and find that dumbbells with a twist have a novel magnetic field structure. Using the relaxed field configurations, we simulated the annihilation of dumbbells, studying their lifetimes and relics. In particular, we find that the relic magnetic field in the twisted case is helical. The topology of electroweak theory gives rise to monopole pairs that are confined by strings, whose distribution we have determined by an extension of the Kibble mechanism. These monopole-antimonopole pairs would undergo annihilation and leave behind cosmological relic magnetic fields during the epoch of electroweak symmetry breaking (EWSB) in the early Universe. For a general pair of monopole and antimonopole, the twist angle will be non-zero and the magnetic field lines emanating from a monopole will terminate on an antimonopole of some other dumbbell. This is likely to have consequences for the correlation length of magnetic fields leftover from the electroweak epoch. We conduct EWSB simulations to examine the generated primordial magnetic field. This could carry important implications for the cosmological magnetic field properties in the present Universe and provide a new avenue to constraint electroweak phenomena.

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