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Baryon overproduction constraints on the lepton flavor asymmetry in the early Universe

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Anomalous transport phenomena, such as the chiral magnetic effect, are originated from the chiral anomaly of gauge theories and recently developed in hadron and condensed matter physics. They can also cause interesting phenomena in the early Universe when the chirality is a good conserved quantity at the temperature much higher than 100 TeV. An example is the chiral plasma instability, where helical hypermagnetic fields are amplified from chiral asymmetry, which will be the source of the baryon asymmetry through the hypermagnetic helicity decay. In particular, we point out that a large lepton flavor asymmetry before the electroweak symmetry breaking with satisfying total B-L to be zero, which has been thought not to be strongly constrained, generally corresponds to a large chiral asymmetry. This causes an amplification of a strong helical magnetic field, which leads to baryon overproduction. We find that this gives a stronger constraint on the lepton flavor asymmetry than the one given weakly from the BBN. In a similar way that a large lepton asymmetry before the electroweak symmetry breaking is constrained by the SU(2) electroweak sphalerons/chiral anomaly to avoid the baryon overproduction, we conclude that a large lepton flavor asymmetry is constrained by the U(1) hypergauge chiral anomaly.

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