All the relevant physical processes take place essentially in the range from a few MeV ~ 0.1 sec down to $60 - 70$ KeV $\sim 10^3$ sec. During this period only photons, $e^{\pm}$ pairs, and the three neutrino flavors contribute significantly to the energy density. Any additional energy density may be parameterized in terms of the effective number of light neutrino species N_ν, so that

$$g_* = 10.75 + \frac{7}{4}(N_\nu - 3)\,. \tag{78}$$

BBN constraints the number of light neutrino species by $N_\nu \leq 4$ [28, 30]. The four LEP experiments combined give the best fit as $N_\nu = 2.994 \pm 0.12$ [319]. The likelihood analysis which includes all the three elements (D,^4He, and ^7Li) yields the baryon to photon ratio [320]

$$4.7 \times 10^{-10} < \eta < 6.2 \times 10^{-10}\,, \qquad 0.017 < \Omega_b h^2 < 0.023\,. \tag{79}$$

Despite the uncertainties there appears to be a general concordance between theoretical BBN predictions and observations, which is now being bolstered by the CMB data $\Omega_b h^2 = 0.02229 \pm 0.00073$ [258].

2. Baryogenesis

The baryon asymmetry of the universe (BAU) parameterized as $\eta_{\rm B} \equiv (n_{\rm B} - n_{\bar{\rm B}})/s \approx \eta$ is determined to be 0.9×10^{-10} by the recent analysis of WMAP data [13]. As pointed out by Sakharov [321], baryogenesis requires three ingredients: (1) baryon number non-conservation, (2) C and CP violation, and (3) out-of-equilibrium condition.

All these three conditions are believed to be met in the very early universe. Baryogenesis during the electroweak phase transition [322] has been studied widely, see [323]. Another mechanism known as Affleck-Dine baryogenesis, which happens due to the non-trivial dynamics of a light scalar condensate is a natural outcome of inflation [324–326]. It is also possible to convert leptonic asymmetry into baryonic asymmetry, $B = a(B - L)$ [327–330], for a review see [331], where $a = 28/79$ in the case of SM and $a = 8/23$ for the MSSM [332].

A lepton asymmetry can be generated from the out-of-equilibrium decay of the right handed (RH) neutrinos into Higgs bosons and light leptons, provided $CP-$violating phases exist in the neutrino Yukawa couplings. The created lepton asymmetry will be converted into a baryonic asymmetry via sphaleron processes. This scenario works most comfortably