Electroweak baryogenesis in a cold universe

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Abstract

We discuss the possibility of generating the baryon asymmetry of the Universe when the temperature of the Universe is much below the electroweak scale. As discussed by Nagatani recently the evaporation of primordial black holes may re-heat the surrounding plasma to temperatures above the electroweak transition temperature leading to the restoration of electroweak symmetry locally. The symmetry is broken again spontaneously as the plasma cools and a baryon asymmetry is generated during the phase transition. We re-analyse the transfer of heat in the plasma surrounding the black hole and point out that the diffusion approximation used earlier is not valid due to the breakdown of hydrostatic equilibrium. We then provide an estimate of the temperature profile of the plasma outside the black hole after including outward motion of the plasma due to the presence of a pressure gradient and an estimate of the baryon asymmetry that may be generated in the plasma. Simple estimates for a second order electroweak phase transition imply that this scenario may generate sufficient asymmetry. For a first order phase transition, sufficient asymmetry may be generated if viscous effects slow down the heated plasma as it moves away from the black hole. In this scenario there is no wash-out of the asymmetry after the phase transition as the plasma rapidly cools to lower temperatures thereby shutting off the sphaleron processes. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Baryogenesis; Black holes; Electroweak theory; Phase transitions

1. Introduction

In recent years much effort has been devoted to formulating a mechanism for baryogenesis at the electroweak phase transition (For a review see Ref. [1]. For more recent developments see Ref. [2]). Electroweak baryogenesis is indeed a very exciting possibility as here one is working within the framework of a theory (or its extensions) which is reasonably well understood and the energy scale involved is accessible in laboratory experiments. However the requirement of a strong first order phase transition, large CP violation and a small Higgs mass to ensure that the created baryon asymmetry is not washed away after the phase transition places stringent constraints on these models and practically rules out electroweak baryogenesis in the context of the standard model. In

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