Extended Abstract for the First Hermann Minkowski Meeting on the Foundations of Spacetime Physics

# Gravitational Waves Propagation through the Stochastic Background of Gravitational Waves

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With the recent claim that gravitational waves were finally detected [1 and 2] and with other efforts around the world for GWs detection [3, 4, 5 and 6], its is reasonable to imagine that the relic gravitational wave background could be detected in some time in the future and with such information gather some hints about the origin of the universe. But, it´s also be considered that gravity has self-interaction, with such assumption it´s reasonable to expect that these gravitatinal wave will interact with the relic or non-relic GW background by scattering, for example. Such interaction should decresase the distance which such propagating waves could be detected The propagation of gravitational waves (GWs) is analysed in an asymptotically de Sitter space by the perturbation expansion around Minkowski. The stochastic relic GW background is given by a dimensionless function of the frequency [7 and 8]. Another way to characterize such background could be seem in [9 and 10]. Using the case of de Sitter inflationary phase scenario [7, 8 and 10], the perturbation propagates through a FRW background with a metric

$$ds^2 = a^2(\eta)(-d\eta^2 + dx^2)\,,$$

where the negative term is the conformal time.

The GW is represented by

$$h_{\mu\nu} = e_{\mu\nu}\phi(\eta)e^{\mathbf{ik\cdot x}}$$

The perturbation propagation metric could be expressed as

$$g_{\mu\nu} = a^2(\eta)(-d\eta^2 + dx^2 + h_{\mu\nu}\,dx^\mu\,dx^\nu)\,.$$

The amplitude of the GW must satisfy the following equation:

$$\left(\frac{d^2}{d\eta^2} + \frac{2}{a}\frac{da}{d\eta}\frac{d}{d\eta} + |\mathbf{k}|^2\right)\phi = 0\,,$$

the relevant result is the one corresponding to the de Sitter inflationary phase, where the scale factor behaves as

$$a \propto e^{H_{ds}t}$$

in terms of the phsical time *t.* In this scenario the solution becomes

$$\phi(\eta) = \frac{a(\eta_1)}{a(\eta)}(1 + iH_{ds}\omega^{-1})e^{-ik(\eta-\eta_1)}$$

here $H_{ds}$ is the Hubble factor during the de Sitter phase.

It shows that the amplitude has a damping effect that goes with

$$\phi \propto e^{-H_{ds}t}.$$

This shows that the GW, using the actual value for the Hubble scale $H_0$ , has a damping factor with a very small valor for the size of the observational universe. In this work we analize this same damping including the gravitational wave background due to astrophysical sources. Such background is 3 orders of magnitude bigger in some frequencies and produces a considerable damping at shorter distances.

The results presented in [11] gave the authors te ideia of developing this work, nevertheless it was done using the cosmological constant and not the GW background.

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