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ESTIMATION OF A POSSIBLE TIME VARIATION OF THE ELECTRON MASS FROM CMB OBSERVATIONS

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We study the effects of a possible joint variation of the electron mass and the fine structure constant on the CMBR temperature fluctuation spectrum. We use the first-year WMAP (Bennet et al. 2003) data to estimate the values of the fine structure constant and of the electron mass at the decoupling time.

1. GENERAL

The study of the cosmic microwave background radiation (CMBR) is not only one of the most important tests of the Big Bang theory, but it is also useful to obtain stringent constraints on deviations from standard cosmology and on alternative theories to the Standard Model of fundamental interactions (SM). Among these theories, there are some in which the fundamental constants may vary over cosmological time scales such as superstrings and Kaluza-Klein models. In this work, we study the joint effect of a variation of the electron mass (m_e) and the fine structure constant (α) on the CMBR fluctuation spectrum. Any variation of m_e or α alters the physical conditions at recombination and therefore changes the CMBR fluctuation spectrum (Kaplinghat et al. 1999; Hannestad 1999; Kujat & Scherrer 2000; Yoo & Scherrer 2003). Rocha et al. 2004 have put a constraint on α variation using the WMAP first-year data. In this work, we fix the cosmological parameters such as baryon and dark matter density, hubble constant, reionization optical depth and spectral scalar index to the WMAP best fit values (Spergel et al. 2003). We compute the CMB power spectrum using a modified version of CMBFAST(Seljak & Zaldarriaga 1996). We allow variations of α, m_e and the normalization factor (A). The χ^2 is computed for the TT and TE data set by the likelihood-code supplied by the WMAP team (Verde et al 2003). Our best fit values within 2 σ are: $\frac{m_e}{m_{e0}} = 0.978^{+0.024}_{-0.004}$, $\frac{\alpha}{\alpha_0} = 1.01^{+0.022}_{-0.017}$, $A = 0.88^{+0.034}_{-0.025}$, where m_{e0} and α_0 are the present-day values of the m_e and α respectively.

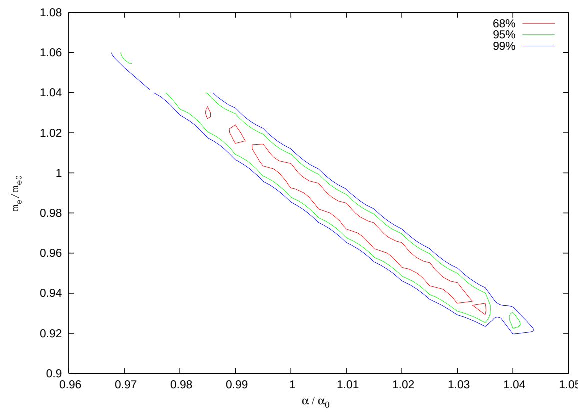

Fig. 1. 1-σ, 2-σ and 3σ likelihood contours for the fine structure and electron mass variation.

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