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WMAP 5-year constraints on α and m_e

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Abstract. We have studied the role of fundamental constants in an updated recombination scenario. We focus on the time variation of the fine structure constant α, and the electron mass m_e in the early Universe. In the last years, helium recombination has been studied in great detail revealing the importance of taking new physical processes into account in the calculation of the recombination history. The equations to solve the detailed recombination scenario can be found for example in Wong *et al.* 2008. In the equation for helium recombination, a term which accounts for the semi-forbidden transition 2^3p–1^1s is added. Furthermore, the continuum opacity of HI is taken into account by a modification in the escape probability of the photons that excite helium atoms, with the fitting formulae proposed Kholupenko *et al* 2007. We have analized the dependences of the quantities involved in the detailed recombination scenario on α and m_e. We have performed a statistical analysis with COSMOMC to constrain the variation of α and m_e at the time of neutral hydrogen formation. The observational set used for the analysis was data from the WMAP 5-year temperature and temperature-polarization power spectrum and other CMB experiments such as CBI, ACBAR and BOOMERANG and the power spectrum of the 2dFGRS. Considering the joint variation of α and m_e we obtain the following bounds: $-0.011 < \frac{\Delta\alpha}{\alpha_0} < 0.019$ and $-0.068 < \frac{\Delta m_e}{(m_e)_0} < 0.030$ (68% c.l.). When considering only the variation of one fundamental constant we obtain: $-0.010 < \frac{\Delta\alpha}{\alpha_0} < 0.008$ and $-0.04 < \frac{\Delta m_e}{(m_e)_0} < 0.02$ (68% c.l.). We compare these results with the ones presented in Landau *et al* 2008, which were obtained in the standard recombination scenario and using WMAP 3 year release data. The constraints are tighter in the current analysis, which is an expectable fact since we are working with more accurate data from WMAP. The bounds obtained are consistent with null variation, for both α and m_e, but in the present analysis, the 68% confidence limits on the variation of both constants have changed. In the case of α, the present limit is more consistent with null variation than the previous one, while in the case of m_e the single parameters limits have moved toward lower values. To study the origin of this difference, we have performed another statistical analysis, namely the analysis of the standard recombination scenario together with WMAP5 data, the other CMB data sets and the 2dFGRS power spectrum. We see that the change in the obtained results is due to the new WMAP data set, and not to the new recombination scenario. The obtained results for the cosmological parameters are in agreement within 1σ with the ones obtained by the WMAP collaboration, without considering variation of fundamental constants.

Keywords. cosmic microwave background, early universe, cosmological parameters