The free parameters of a flat accelerating model without dark energy are constrained by using Supernovae type Ia and observational H(z) data. Instead of the vacuum dominance, the present accelerating stage in this modified Einstein-de Sitter cosmology is a consequence of the gravitationally-induced particle production of cold dark matter. The model present a transition from a decelerating to an accelerating regime at low redshifts, and is also able to harmonize a cold dark matter picture with the latest measurements of the Hubble constant $H_0$, the Supernovae observations (Constitution sample), and the H(z) data.

**Keywords**: Accelerating Universe, Cold Dark Matter, Gravitational Particle Production

**1. Introduction**

A growing body of complementary cosmological data are suggesting that the Universe underwent a late time transition from a decelerating to an accelerating expansion. Current data are accurately fitted by a flat FRW type cosmology containing nonrelativistic matter plus some sort of dark energy. The simplest and by far the most popular dark energy candidate is represented by a cosmological constant. In the so-called $\Lambda$CDM model, the cosmic fluid contains radiation, baryons, cold dark matter plus a vacuum energy. Nevertheless, this $\Lambda$CDM model is plagued with some difficulties like the cosmological constant and coincidence problems.

On the other hand, the presence of a negative pressure is the key ingredient required to accelerate the expansion. This kind of stress occurs naturally in many different contexts when the physical systems depart from thermodynamic equilibrium states. In this connection, as pointed out by some authors, the process of cosmological particle creation at the expense of the gravitational field can phenomenologically be described by a negative pressure, and, more interestingly, can accelerate the Universe.

In this context, we constrain the free parameters of a flat accelerating CDM cosmology recently proposed in the literature. As we shall see, this extended...
CDM model is consistent with the SNe Ia (Constitution sample) and H(z) data. In addition, there is a transition from a decelerating to an accelerating regime at redshift of the order of a few, and the Hubble constant does not need to be small in order to solve the age problem. Such a transition happens even if the matter creation is negligible during the radiation and considerable part of the matter dominated phase. In certain sense, the coincidence problem of ΛCDM model is replaced here by a gravitational particle creation process at low redshifts.

2. Decelerating Parameter, Supernova and H(z) Bounds

For simplicity, let us consider that the spacetime is filled only by a cold dark matter component. In this case, the Hubble and the decelerating parameters are given by

\[ H(z) = H_0 \left[ \frac{\gamma + (1 - \gamma - \beta)(1 + z)^{\frac{1}{2}(1 - \beta)}}{1 - \beta} \right], \]

\[ q(z) = \frac{1}{2} \left[ \frac{(1 - 3\beta)(1 - \gamma - \beta)(1 + z)^{\frac{1}{2}(1 - \beta) - 2\gamma}}{(1 - \gamma - \beta)(1 + z)^{\frac{1}{2}(1 - \beta)} + \gamma} \right]. \]

Note that if \( \gamma = 0 \) there is no transition from a decelerating to an accelerating regime. The Universe is always decelerating or accelerating depending on the value of the \( \beta \) parameter. The existence of a transition redshift depends exclusively on the \( \gamma \) parameter. However, this fact does not remain true when baryons are included.

In Figure 1a, we display the effect of the free parameters \((\gamma, \beta)\) in the reduced Hubble-Sandage diagram for the Constitution sample. The lowest (yellow) curve is the prediction of the Einstein-de Sitter model.

In Figure 1b, we show the contours of constant likelihood (68.3%, 95.4%, and 99.7% C.L.) in the \((\gamma, \beta)\) plane from a \(\chi^2\) statistics based on the Constitution set. Following standard lines, we have marginalized our likelihood function over the nuisance parameter \( h \) \((H_0 = 100hKm.s^{-1}.Mpc^{-1})\). It is found that the free parameters fall on the intervals \(0.22 \leq \gamma \leq 0.67\) and \(0 \leq \beta \leq 0.38\) at 68.3% of confidence level. The best fit occurs for values of \(\gamma = 0.64\) and \(\beta = 0\) with \(\chi^2_{\text{min}} = 466.97\) and \(\nu = 395\) degrees of freedom. The reduced \(\chi^2 = 1.18\) where \((\chi^2 = \chi^2_{\text{min}}/\nu)\), thereby showing that the model provides a very good fit to these data.

In Figure 1c, we show the contours on the \((\gamma, h)\) plane using the H(z) data from Stern et al. The free parameters are constrained by \(0.61 \leq h \leq 0.86\) and \(0.38 \leq \gamma \leq 0.76\) (at 2\(\sigma\) C. L.). Note that the constraints on the \(\gamma\) parameter are consistent with each other for these two different classes of data.

3. Conclusion

By using SNe Ia and \(H(z)\) data, we have discussed some constraints on a flat accelerating cold dark matter cosmology without dark energy. The accelerating
regime is powered by a negative pressure associated to the gravitationally-induced creation of CDM particles. The transition from a decelerating to an accelerating regime at late times happens even if the matter creation is negligible during the radiation and considerable part of the matter dominated phase (this is equivalent to take $\beta = 0$ in all the expressions). In this case, like in the flat $\Lambda$CDM, there is just one free parameter, and the resulting model provides an excellent fit to the observed dimming of distant SNe Ia data. More important, such constraints are compatible with the latest determinations of the Hubble constant $H_0$ (see Figure 1c). Naturally, complementary tests must still be investigated to see whether the present scenario may provide a realistic description of the observed Universe.

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