Astrophys Space Sci (2013) 346:237–244
DOI 10.1007/s10509-013-1421-6

ORIGINAL ARTICLE

Self-creation theory of gravitation. A self-similar approach

J.A. Belinchón

Received: 5 February 2013 / Accepted: 10 March 2013 / Published online: 20 March 2013

Abstract In order to study how the gravitational constant, G, varies within the Barber's second self-creation theory of gravitation we find exact solutions for Bianchi type I, VII_0, IX and Kantowski-Sach (KS) under the self-similar hypothesis. Some physical and geometrical properties of the models are also discussed and compare the obtained results with the current observations. We also compare our results with the obtained ones in the Brans-Dicke theory.

Keywords Exact self-similar Bianchi types · Barber theory of gravitation · Time-varying constants

1 Introduction

Current observations suggest us that the Newton gravitational constant, G, varies with the time. We obtain the following estimation from observations of Hulse-Taylor binary pulsar B1913 + 16, $G'/G \sim 2 \pm 4 \times 10^{-12}$ yr^{-1} (Damour et al. 1988; Bisnovatyi-Kogan 2006). Helio-seismological data provide the bound -1.6×10^{-12} yr$^{-1} < G'/G < 0$ (Guenther 1998). Type Ia supernova observations (Perlmutter et al. 1997, 1998, 1999) give a upper bound of the variation of G as -10^{-11} yr$^{-1} \leq G'/G < 0$ at redshifts $z \simeq 0.5$. Astereoseismological data from the pulsating white dwarf star G117-B15A lead to $|G'/G| \leq 4.10 \times 10^{-11}$ yr^{-1} (Biesiada and Malec 2004). In order to accommodate such variation into the models we need to modify the field equations of the general relativity (GR) or to create another gravitational models such as the scalar-tensor theories. One of these scalar-tensor theories is the formulated by Brans and Dicke (BD) which incorporates Mach's principle in a relativistic frame work by assuming interaction of inertial masses of fundamental particles with some cosmic scalar field coupled with the large scale distribution matter in motion. In this theory the scalar field has the dimensions of inverse of the gravitational constant and its role is confined to its effects on gravitational field equations. Several modifications of the BD theory have been formulated in order to incorporate a dynamical cosmological constant as well as other fields (see for instance Faraoni 2004; Fujii and Maeda 2003 and Will 1993 for a review of these theories).

Another approaches have been formulated by Barber (1982, 2002, 2004, 2006, 2010). In an attempt to produce a continuous creation theory, Barber (1982) has proposed two theories. The first is a modified Brans-Dicke theory that, as it has been pointed out by Brans (1987), is unsatisfactory since, it is not only in disagreement with experiment, but is actually inconsistent since the equivalence principle is violated. The second is a modification of general relativity to include continuous creation of matter and is within the limits of observation. In this theory, the scalar field acts as a reciprocal gravitational constant, $G \sim \phi^{-1}$. It is postulated that this scalar field couples with the trace of energy-momentum tensor. For a review of these theories see for instance (Barber 2010). Several authors have worked in these theories, for example, Venkateswarlu and Reddy (1990) have obtained exact solutions for Bianchi I type while vacuum solution, by using this metric, have been studied by Reddy (1987). Pradhan and Vishwakarma have studied perfect and viscous inhomogeneous LRS Bianchi I, i.e. $\phi = \phi(t, x)$, (Pradhan and Vishwakarma 2002; Pradhan et al. 2009; Pradhan and

J.A. Belinchón (✉)
Departamento de Física Atómica, Molecular y Nuclear,
Universidad Complutense de Madrid, 28040 Madrid, España
e-mail: abelcal@ciccp.es