

# Field of a charged particle in a scalar-tensor theory of gravitation

D.R.K. Reddy · T. Vidyasagar · B. Satyanarayana

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**Abstract** Field equations in the scalar-tensor theory of gravitation, proposed by Saez and Ballester (Phys. Lett. A 113: 467, 1986), are obtained for a static charged point mass with the aid of a spherically symmetric metric. A closed form exact solution of the field equations is presented and may be considered as describing the field due to a charged mass point at the origin surrounded by a scalar-tensor field.

**Keywords** Charged particle · Scalar-tensor theory

## 1 Introduction

In recent years there has been an immense interest in alternative theories of gravitation. Among them scalar-tensor theories of gravitation proposed by Brans and Dicke (1961) and Saez and Ballester (1986) are considered to be viable alternatives to general relativity. Brans-Dicke theory introduces an additional scalar field  $\phi$  besides the metric tensor  $g_{ij}$  and a dimensionless coupling constant  $\omega$  while in Saez-Ballester scalar-tensor theory the metric is coupled with a

dimensionless scalar field  $\phi$  in a simple manner. This coupling gives a satisfactory description of the weak fields. In spite of the dimensionless character of the scalar field an antigravity regime appears. This theory also suggests a possible way to solve missing matter problem in non-flat FRW cosmologies.

Extensive work is present in the literature on the exact solutions and cosmological models of alternative theories of gravitation. Saez (1985), Shri Ram and Singh (1995), Singh and Agrawal (1991) and Reddy and Rao (2001) have investigated several aspects of this theory. Reddy and Rao (1981) have discussed the field of a charged particle in Brans-Dicke theory of gravitation in a conformally flat space-time while Reddy and Rao (1983) presented the same in the presence of scalar-meson fields in general relativity. However, to our knowledge, the field of a charged particle in Saez-Ballester scalar-tensor theory has not been discussed till date.

Here we have considered the energy-momentum tensor due to a source free electromagnetic field and have obtained an exact solution of the Saez-Ballester-Maxwell field equations with the aid of a spherically symmetric metric. We have obtained an exact solution of Saez-Ballester-Maxwell equations which represents field of charged mass point in Saez-Ballester scalar-tensor theory.

## 2 Metric and field equations

We consider the spherically symmetric static metric in the form

$$ds^2 = -e^\lambda dr^2 - r^2 d\theta^2 - r^2 (d\phi^2 + \sin^2 \theta d\phi^2) + e^\nu dt^2 \quad (1)$$

where  $\lambda$  and  $\nu$  are functions of  $r$  only.

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D.R.K. Reddy (✉)  
Department of Science and Humanities, M. V. G. R. College  
of Engineering, Vizianagaram, Andhra Pradesh, India  
e-mail: [reddy\\_einstein@yahoo.com](mailto:reddy_einstein@yahoo.com)

T. Vidyasagar  
Department of Science and Humanities, Miracle Educational  
Society Group of Institutions, Vizianagaram, Andhra Pradesh,  
India

B. Satyanarayana  
Department of Basic Science and Humanities, GMR Institute  
of Technology, Rajam 532127, Andhra Pradesh, India  
e-mail: [satyam22us@gmail.com](mailto:satyam22us@gmail.com)