Research & Reviews: Journal of Pure and Applied Physics ISSN: 2320-2459

Exploring Notable Solutions of Einstein's Field Equations: A Survey of Exact Models for Gravitating Systems

Patricio Corbalan Campos*

Department of Mechanical & Metallurgical Engineering, Pontifical Catholic University of Chile, Santiago, Chile

Short Communication

Received: 08- Nov-2022, Manuscript No. JPAP-22-63918; **Editor assigned:** 11-Nov-2022, Pre QC No. JPAP-22-63918(PQ); **Reviewed:** 25-Nov-2022, QC No. JPAP-22-63918; **Revised:** 02-Dec-2022, Manuscript No. JPAP-22-63918(A) **Published:** 09-Dec-2022, DOI:10.4172/2320-2459.10.4.005

***For Correspondence:**

Patricio Corbalan Campos, Department of Mechanical & Metallurgical Engineering, Pontifical Catholic University of Chile, Santiago, Chile

E-mail: pacorbal@uc.cl

Keywords: Objects; Radius; Black Hole; Space-time; Gravity

ABSTRACT

In general relativity, the effects of gravitation are ascribed to space-time curvature instead of to a force[1]. The starting point for general relativity is the equivalence principle, which equates free fall with inertial motion. The issue that this creates is that free-falling objects can accelerate with respect to each other[2]. To deal with this difficulty, Einstein proposed that space-time is curved by matter, and that free-falling objects are moving along locally straight paths in curved space-time. More specifically, Einstein and David Hilbert discovered the field equations of general relativity, which relate the presence of matter and the curvature of space-time. These field equations are a set of 10 simultaneous, non-linear, differential equations. The solutions of the field equations are the components of the metric tensor of space-time, which describes its geometry. The geodesic paths of space-time are calculated from the metric tensor[3].

Notable solutions of the Einstein field equations include;

The Schwarzschild solution, which describes space-time surrounding a spherically symmetrical non-rotating uncharged massive object. For objects with radii smaller than the Schwarzschild radius, this solution generates a black hole with a central singularity. The Reissner–Nordström solution, in which the central object has an electrical charge. For charges with a geometrized length less than the geometrized length of the mass of the object, this solution produces black holes with an event horizon surrounding a Cauchy horizon[4]. The Kerr solution for rotating massive objects. This solution also produces black holes with multiple horizons[5]. The cosmological Robertson–Walker solution, which predicts the expansion of the universe. General relativity has enjoyed much success because its predictions not called for by older theories of gravity have been regularly confirmed[6]. General relativity accounts for the anomalous perihelion precession of Mercury. Gravitational lensing was first confirmed in 1919, and has more recently been strongly confirmed through the use of a quasar which passes behind the Sun as seen from the Earth. The expansion of the universe predicted by the Robertson–Walker metric was confirmed by Edwin Hubble in 1929[7]. The prediction that time runs slower at lower potentials has been confirmed by the Pound–Rebka experiment, the Hafele–Keating experiment, and the GPS[8]. The time delay of light passing close to a massive object was first identified by Irwin Shapiro in 1964 in interplanetary spacecraft signals. Gravitational radiation has been indirectly confirmed through studies of binary pulsars such as PSR 1913+16[9]. In 2015, the LIGO experiments directly detected gravitational radiation from two colliding black holes, making this the first direct observation of both gravitational waves and black holes. It is believed that neutron star mergers and black hole formation may also create detectable amounts of gravitational radiation[10].

CONCLUSION

Several decades after the discovery of general relativity, it was realized that it cannot be the complete theory of gravity because it is incompatible with quantum mechanics. Later it was understood that it is possible to describe gravity in the framework of quantum field theory like the other fundamental forces. In this framework, the attractive force of gravity arises due to exchange of virtual gravitons, in the same way as the electromagnetic force arises from exchange of virtual photons. This reproduces general relativity in the classical limit, but only at the linearized level and postulating that the conditions for the applicability of Ehrenfest theorem holds, which is not always the case. Moreover, this approach fails at short distances of the order of the Planck length. Theoretical models such as string theory and loop quantum gravity are current candidates for a possible 'theory of everything'.

REFERENCES

1. McGowan JG, et al. Windpower: A turn of the century review. Annu Rev Energy Environ 25; 2000: 147-197.
2. Ben-Daya MS, et al. Handbook of maintenance management and engineering. Springer Verlag London Limited 2009.
3. Marquez FPG, et al. Condition monitoring of wind turbines: Techniques and methods. Renew Energy 46; 2012: 169-178.
4. Tyminski NC, et al. Bayesian Inference applied to journal bearing parameter identification. J Braz Soc Mech Sci Eng 39; 2017: 2983-3004.
5. Taherkhani Z, et al. Stochastic model updating of rotor support parameters using Bayesian approach. MSSP 158; 1978: 107702.
6. Lawrence HJ, et al. Using markov chain montecarlo to estimate bearing condition. 21st Electronics New Zeland Conference. 21 st Electronics New Zealand Conference. 2014: 83-88.
7. Faiz J, et al. Eccentricity fault detection-From induction machines to DFIG: A review. Renew Sustain Energy Rev 55; 2016: 169-179.
8. Ebrahimi BM, et al. Magnetic field and vibration monitoring in permanent magnet synchronous motors under eccentricity fault. IET Digital Library 6; 2012: 35-45.

9. Abu-Elhaija WS, et al. Analytical prediction of instantaneous torque and speed for induction motors with mixed-eccentricity fault using magnetic-field equations. Electromagnetics. 30; 2010: 525-540.
10. Torkaman H. Determining degrees of freedom for eccentricity fault in SRM based on nonlinear static torque function. Int J Comput Math Electr Electron Eng 30; 2011: 671-685.