

RETRACTIONS OF MCVITTIE SPACE-TIME

NASR AHMED¹ AND H. RAFAT²

ABSTRACT. In this article we introduce some types of the deformation retracts of the McVittie space-time making use of Lagrangian equations. The retraction of this space-time into itself and into geodesics has been presented. The relation between folding and deformation retract of this space has been achieved.

REFERENCES

- [1] H. Eschrig, *Topology and Geometry for Physics* (Lecture Notes in Physics, Vol. 822). Springer; 1st edition 2011.
- [2] E. Bick F.D. Steffen (Eds.), *Topology and Geometry in Physics*, (Lecture Notes in Physics). Springer; 2005.
- [3] Rafael D. Sorkin, *Consequences of spacetime topology*, 1989 (SYRACUSE).
- [4] Arvind Borde, *Topology Change in Classical General Relativity*, arXiv:gr-qc/9406053.
- [5] Andrew Chamblin, *Some Applications of Differential Topology in General Relativity*, J.Geom.Phys. 13 (1994) 357-377.
- [6] K. Borsuk, *Sur les rétractes*, Fund. Math. 17 (1931) 2–20.
- [7] S. A. Robertson, *Isometric folding of Riemannian manifolds*, Proc. Roy. Soc. Edinburgh, 77, (1977) , 275-284.
- [8] A. E. El-Ahmady, and H. Rafat, *A calculation of geodesics in chaotic flat space and its folding*, *Chaos, Solitons and fractals*, 30 (2006), 836-844.
- [9] M. El-Ghoul, A. E. El-Ahmady and H. Rafat, *Folding-Retraction of chaotic dynamical manifold and the VAK of vacuum fluctuation*, *Chaos, Solutions and Fractals*, 20 , (2004), 209-217.
- [10] A. E. El-Ahmady, H. Rafat, *Retraction of chaotic Ricci space*, *Chaos, Solutions and Fractals*, 41 , (2009), 394-400.
- [11] M. El-Ghoul, *The deformation retract of the complex projective space and its topological folding*, J.Mat. Sc., Vol.30 (1995) 4145-4148.
- [12] H.Rafat and Nasr Ahmed, *On the deformation retract of Eguchi-Hanson space and its folding*, *Advances in Mathematical Physics*, Vol 2015 (2015), Article ID 301928, 9 pages.
- [13] P. DI-Francesco, *Folding and coloring problem in Mathematics and Physics*, Bull. Amer. Math. Soc. 37, (3), (2002), 251-307.
- [14] J.Nesetril and P.O. de Mendez, *Folding*, *Journal of Combinatorial Theory, Series B*, 96, (2006), 730-739.
- [15] W. S. Massey, *Algebraic topology, An introduction*, Harcourt Brace and World, New York (1967).
- [16] Helmut A. Hamm, Nicolae Mihalache, *Deformation retracts of Stein spaces*, *Math. Ann.* 308,(1997), 333-345.
- [17] H. Rafat, *A Spacetime Geodesics of the Schwarzschild Space and Its Deformation Retract*, *Int.J.Math.Combin.* Vol.3 (2009), 23-31.
- [18] G.C. McVittie, *Mon.Not.R.Astron.Soc.* 933, 325 (1933).

Received 24 April 2015

2010 *Mathematics Subject Classification.* 54E35; 54C15; 58H15; 32G10; 14B12.
Key words and phrases. Space-time Geodesics, McVittie space-time, retractions.

¹ ASTRONOMY DEPARTMENT, NATIONAL RESEARCH INSTITUTE OF ASTRONOMY AND GEOPHYSICS, HELWAN, CAIRO, EGYPT, ² DEPARTMENT OF MATHEMATICS, FACULTY OF SCIENCE, TANTA UNIVERSITY, TANTA, EGYPT, ^{1,2} MATHEMATICS DEPARTMENT, FACULTY OF SCIENCE, TAIBAH UNIVERSITY, SAUDI ARABIA.

E-mail address: ¹ abualansar@gmail.com, ² hishamrafat2000@yahoo.com