

Macroscopic electromagnetism via complex quaternions

Mustafa Emre KANSU

(Dumlupınar University, Department of Physics, Kütahya, Turkey)

E-mail: memre.kansu@dpu.edu.tr

Quaternions, which are non-commutative but associative, have a great importance in terms of representation of physical systems and mathematical problems in a different way [1, 2]. Many subfields of physics such as electromagnetism, gravitation, magnetohydrodynamics, plasma physics, acoustic, quantum mechanics can be dealt with quaternions. In this work, electromagnetic equations have been studied for macroscopic environments with quaternions forming the generalization of complex numbers in four dimensions. Polarized and magnetized media are great importance for these environments, and there are linearities both electric and magnetic induction fields, respectively [3, 4]. Here, as shown in the notation of tensor, the relation between field and source expressions has been written in a short, different and simple form [5] by defining quaternion induction fields. In addition, electromagnetic energy conservation with induction fields [6] has been derived for the first time by using quaternion algebra under some approaches.

Acknowledgement: This work has been supported by Dumlupınar University Scientific Research Project, which has Project number DPU-SRP 2017-39.

REFERENCES

- [1] William Rowan Hamilton. *Elements of Quaternions*. New York : Chelsea Publishing, 1969.
- [2] Klaus Gürlebeck and Wolfgang Sprossig. *Quaternionic and Clifford Calculus for Physicists and Engineers*. Chichester : Wiley - Sons, 1997.
- [3] John David Jackson. *Classical Electrodynamics*. USA : Wiley - Sons, 1999.
- [4] David J. Griffiths. *Introduction to Electrodynamics*. New Jersey : Prentice Hall, 1999.
- [5] Mustafa Emre Kansu. An analogy between macroscopic and microscopic systems for Maxwell's equations in higher dimensions. *The European Physical Journal Plus*, 128(12) : 149, 2013.
- [6] P. Kinsler, A. Favaro and M.W. McCall. Four Poynting Theorems. *European Journal of Physics*, 30(5) : 983, 2009.