“I (CRITICALLY) THINK, THEREFORE I AM”: THOMSON’S ATOMIC MODEL AND THE INEFFECTIVENESS OF PHYSICS EDUCATION

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INTRODUCTION

In 1904, Thomson proposed an accurate atomic model (Thomson, 1904), with a precise geometrical structure, intended as a heuristic device and aimed to explain the stability and unity of atomic phenomena, both from a chemical and electrical point of view. Therefore, the plum pudding image - commonly used in textbooks (Walker, 2017; Amaldi, 2020; Halliday, 2021; Cutnell, 2022) and familiar to teachers and students, but never used by Thomson - is due to a deep conceptual misunderstanding or perhaps to a teasing of the model.

A WIDESPREAD LACK OF CRITICAL THINKING

In physics courses, Thomson’s model is presented after electrostatic issues and described as a spherical distribution of positive charge with electrons randomly arranged in it (as the plums in an alleged “plum pudding”); nevertheless, the awareness that such a configuration cannot be in stable conditions unexpectedly does not arise, showing a widespread failure in using electrostatic knowledge previously acquired in a different context. Moreover, it is known that accelerated charges emit and therefore a stable planetary model cannot be possible. Thomson's model - which supposes electrons in motion, to obtain stable configurations - clearly shows the inaccuracy of this absolute statement: the problem is not the emission, but rather its amount (since collisions can provide a way to regain small energy losses). It is therefore necessary to become aware that, without calculations, the merely qualitative aspects can be misleading.

Students and teachers do not usually question themselves how a model proposed by a great physicist - as Thomson was, having won the Nobel Prize in 1906 - could only be an inconsistent qualitative pattern, rather than a rigorous mathematical structure, capable of both explaining phenomena and making predictions. This lack of critical thinking compromises the foundations of physics education, and asks for careful considerations about the real effectiveness of actual physics courses in schools and universities.

In this work that we are presenting, we will deal with this theme, which is not an isolated case, since also in other situations (like while dealing with the photoelectric effect and the Compton effect) coherency problems at an elementary level appear, showing the inefficacy of physics education in creating the mental conceptual structures required to critically analyse what is usually taught and learned.

REFERENCES

Amaldi, U. (2020). *Il nuovo Amaldi per i licei scientifici blu (Vol.3)*. Bologna: Zanichelli.
Cutnell, J. D., Johnson, K. W., & Young, D. (2022). *Physics: International Adaptation (12th ed.)*. Hoboken, NJ: Wiley.
Halliday, D., & Resnick, R. (2021). *Fundamentals of Physics (12th ed.)*. Hoboken, NJ: Wiley.
Thomson, J. J. (1904) On the Structure of the Atom. *Philosophical Magazine*, 7(39), 237-265.
Walker, J. S. (2017). *Physics (5th ed.)*. Bellingham, WA: Western Washington University.

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