The Zeroth Law of Thermodynamics Revisited, in Light of Euclid's First Axiom

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Abstract- This article makes an attempt to establish a direct link between the Zeroth Law of Thermodynamics and Euclid's first axiom.   The foundational premise of the Zeroth Law appears to be intimately linked to the ancient Greek mathematician Euclid's axiom, and due credit should be given to him by the technical and scientific community.

Keywords – Zeroth Law of Thermodynamics, Euclid's First Axiom, Thermal Equilibrium

I. INTRODUCTION

The branch of Thermodynamics is relatively new, around 200 years old or so, arising mostly out of the explanations given for the workings of a steam engine and improving its efficiency. The formalism was put into place by pioneering scientists like Rudolf Clausius, Lord Kelvin and J. Willard Gibbs.

  The Zeroth Law is one of the very fundamental laws of Thermodynamics, and the basis for temperature measurement. The objective of revisiting this Zeroth Law of Thermodynamics is not necessarily to add or refute, but to possibly ascertain its lineage and give credit where it's due. An attempt is made to establish a direct link between Euclid's first axiom and the Zeroth Law;   in the plethora of textbooks that exist on Engineering Thermodynamics - and they all give similar examples when introducing the Zeroth law - none of them ever mention Euclid (circa 300 BC), the ancient Greek mathematician.

  A somewhat similar scenario to the one explained in this article about Thermodynamics, exists in Mechanics; it is the theorem of Pappus and Guldinus which relates areas and volumes of solid bodies to movements of its centroid. In this case however, due homage is paid to Pappus of Alexandria, circa 300 AD; Paul Guldin was a relatively contemporary Swiss Mathematician, circa 1600 AD.   The pertinent contributions of ancient scientists should never be diminished.

II. THE LINK BETWEEN THE ZEROTH LAW AND EUCLID'S AXIOM

The Zeroth law of thermodynamics states that if two systems are in thermal equilibrium respectively with a third system, they must be in thermal equilibrium with each other [1,2]. This law helps define the notion of temperature. It is the last one in chronological order of the four Thermodynamics Laws to be postulated, done so in the 1930s. Since temperature is a more fundamental property than internal energy or entropy, the law was named the Zeroth Law instead of the Fourth Law.

  To establish the link between this law and Euclid's First Axiom, let's examine both. Euclid's five Axioms are presented below [3]. Of particular note is the First Axiom, which states that 'Things which are equal to the same thing are also equal to one another'.

First Axiom: Things which are equal to the same thing are also equal to one another.
Second Axiom: If equals are added to equals, the whole are equal.
Third Axiom: If equals be subtracted from equals, the remainders are equal.
Fourth Axiom: Things which coincide with one another are equal to one another.
Fifth Axiom: The whole is greater than the part

As shown in Fig 1,   the striking similarity that exists between that the Zeroth Law of Thermodynamics and Euclid's First Axiom cannot be overlooked.   Replacing 'Things' by 'Thermal Equilibrium' basically elicits the exact same result.   Euclid never mentioned temperature or thermal equilibrium, but logically, 'things' encompass both those quantities. So, why should Euclid not get any credit for this Law? This similarity has been observed by other researchers in the past, notably Pogliani and Berberan-Santos [4] who effectively state that the Zeroth Law strongly resembles the first axiom of Euclidean Geometry.
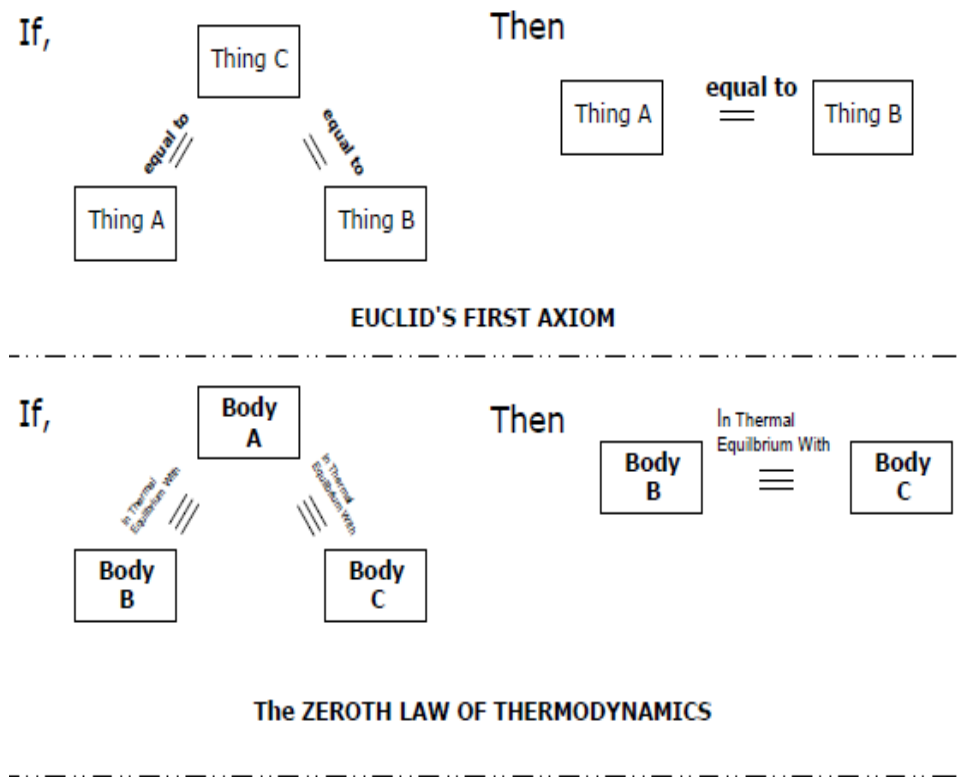

Figure 1.   Similarity between Euclid's First Axiom and the Zeroth Law of Thermodynamics

III.CONCLUSIONS

The work of ancient scientists cannot be undermined just because our timeline is set primarily for 'modern day' activities - the past few hundred years or so.   Works of great significance, such as Euclid's axioms, must be acknowledged in whatever science or engineering discipline they appear it.   That is the only way to respect and exemplify their original contributions. In the author's opinion, the Zeroth Law of Thermodynamics should be reworded henceforth as " The Zeroth Law of Thermodynamics, based on Euclid's First Axiom, states that if two systems are in thermal equilibrium respectively with a third system, they must be in thermal equilibrium with each other".

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