

Thermodynamics: Entropy and Violation in George Martin's *A Game of Thrones*

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Abstract

This research applies an interdisciplinary method of discussion to read George Martin's *A Game of Thrones*, an epic fantasy, under the light of Nancy Katherine Hayles' theories concerning modern laws of physics and literature. The plot of the novel has prominent intricacy with vulnerability and flightiness of its storyline and characters which remains open to abundant literary interpretations. This article uses thermodynamics to refer to a type of physics concerned with temperature and heat, and their link to energy, entropy and the physical qualities of radiation and matter. The conduct of these quantities is ruled by thermodynamic laws that transfer a perceptible description utilizing quantifiable macroscopic physical features. This research traces them within the system of Westeros, a fictitious continent enduring countless tensions and wars, in which entropy is manifested metaphorically. Martin shows how thermodynamics and entropy function and bring chaos, and bases his fantasy on the violation of scientific laws to epitomize the ontology of physics and give meaning to his imaginary world. Regarding this, the researchers show and conclude how Martin interplays physics and literature to decipher the reality of this chaotic world and propose a realistic framework to see the mechanism of universe in fantasy and reality.

Keywords

Chaos; Energy; Entropy; Epic Fantasy; Tension; Thermodynamic laws.

1. Introduction

The world of science and physics with its fundamental principles provides all premises man knows about reality and offers a viable framework for this modern life. Although the two realms of science and literary studies have been considered too far apart since their commonalities were meditated insignificant, the emergence of modern physics unquestionably alters this separation and interacts these two fields of study in a new way. Literary discourse and theories of physics both offer creative visions of reality of the world.

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Among the postmodern novelists who intersect science and literature are American novelists, such as John Updike (1932-2009), and Thomas Pynchon (1937-), a Canadian novelist, Margaret Atwood (1939-), English novelists, such as Ian McEwan (1948-), and Jeanette Winterson (1959-). These novelists interweave the scientific knowledge of world to offer creative interpretation of reality. In the present research, the researchers explore how Martin in his well-known epic fantasy, *A Game of Thrones*, decodes such scientific realities.

George Raymond Richard Martin (1948-) is considered as a prosperous American writer whose outstanding works in the field of science fiction genre and fantasy have brought him fame and reputation. The beginning of his literary career was set in 1977 and *A Song of Ice and Fire* (1966) could be considered as his most notable work. This novel made of different volumes has been published since then; *A Game of Thrones* came as the first one and in 2011 was adapted into a successful series. Martins' works could get the attention of different generations from different cultures, and like J. R. R. Tolkien (1892-1973) he is regarded as a skillful writer. Martin has created the patterns of Westeros, his fictitious world, replete with strong characters who view the world through different and sometimes magical eyes. Throughout his writings, the reader is able to identify himself with the characters, who travel adventurously in a labyrinthine fantasy world and live with the most adventurous beings. Martin uses historical and literary references and resonances, with a deceptively open use of genre traditions, to activate the reader's anticipations.

His works can be pondered as the "secondary world fantasy", a genre of fiction in which "the writer textually constructs another world which is implicitly and sometimes explicitly a comment on the writer's own society" (Mains 77). Although Martin's fantasies come from the post-Tolkien convention filled with magic, knights, and dragons, it goes to our own planet, immediately getting from "European history such as the War of the Roses" (Tegelman 2). In fact, he has created "a reactive undertow to the fantasy" (Hayles, "Postmodern Parataxis" 395), while putting emphasis on social dynamics and realism more than over-reliance on magic. Martin goes beyond the oversimplification of Tolkien's devices and themes; he delves into ambiguities, and complexities of real-life while grounding his world on history to discover important social and political issues featured with complex relations and events. *A Game of Thrones* reveals the significance of science of physics and thermodynamics by which Martin builds the backbone of his novel through considering his fictional world as a complex system governed by laws of physics. A critical understanding of the work can be acquired to see how Martin offers a new imaginative framework to meet the real universe even in fantasy.

Therefore, the researchers' aim is to indicate how Martin intersects literature and physics to create his epic fantasy. The way Martin interprets physical reality in a world of fantasy, or constructs the plot of the novel scientifically, or violates the scientific rules of thermodynamics in *A Game of Thrones* can be considered as the central contention of the present research. For this purpose, Katherine Hayles' arguments about modern physics along with a particular plotline of *A Game of Thrones*, through descriptive narration, are traced to reveal the scientific bases of entropy and thermodynamic laws and their relation to literature, particularly in Martin's novel.

2. Theoretical Approach: Entropy and Laws of Thermodynamics

Thermodynamics, as a comprehensive science, studies the relations between energy, heat, temperature and work in small and large entities, such as solids, electron gas, living organisms, and other systems. It examines kinetic energy and shows how this energy is transferred in motion. Thermodynamic laws explain how in a system energy changes and perform useful work; the laws describe the states of matter using observable variables such as temperature, entropy, pressure and internal energy as well as the relation among them.

The first law explains that in a system that has done heat exchange with the surrounding environment, and mechanical work has been done on it, the increase in energy corresponds with the total sum of heat added to it and the work done on it. Based on this fact, two new properties of internal energy and temperature can be defined for a thermodynamic system. The relation between these two parameters creates a new property called entropy. In other words, there is a close relation between thermodynamic and disorder in a system. Alan J. Friedman mentions that "for the universe as a whole, or an isolated part of it, processes forward in time tend to increase disorder" (84), and adds that this maximal degree of disorder is entropy. The system, therefore, needs to have equilibrium to function properly, and this equilibrium is obtained through moving energy from warmer areas to the colder ones which is the main principle of thermodynamics.

The second law has only one sentence: the entropy of the universe is increasing. This law, with all its brevity, has a profound meaning and greatly contributes to our understanding of how processes work in the universe and states that energy in the material world, in any form, will either dissipate or expand. Therefore, entropy quantitatively measures the degree of spontaneity of processes and determines how much energy has been released at a particular temperature. In other words, it states that every process proceeds in a direction along which randomness increases. Entropy is a concept that gives meaning to energy since energy can be used when it is distributed. Entropy is not energy; it is an indicator for measuring the tendency of energy to spread, and the random activity in a system. This randomness is meant the wildness of energy that is not spontaneously contained and transformed into work. In fact, it is a measure of wasted energy that is not converted into function.

Notably in nineteenth century, the laws of thermodynamics and its physical quantity like entropy, moved from science into art, humanities and literary criticism to describe social, cultural and communicational states and disorder. Since then, authors, artists and critics use them in a fascinating variety of ways. Some apply entropy to refer to depletion of energy and cessation of work; others equalize it as lack of information. According to Debora Shaw and Charles H. Davis, entropy can either be realized “as a measure of the amount of energy available to do useful work in a system,” or it “has been recognized as a measure of disorder in, or lack of information about, any system” (135).

Jeremy Campbell, in *Grammatical Man*, notes that entropy is not just related to the domain of physics and scientific fields. He traces the concept of increasing entropy as the states of diversity and disorder which is essential for the progress of more ordered and highly complex systems, even in fictional world. In fact, entropy is a more comprehensive phenomenon that drifts in biology, information theory, psychology, linguistics, and even literature. Some authors express that entropy is needed for the system to go through more evolution and complexity, and to some it is the contradiction of perfection. Moreover, the ever-increasing amount of entropy and the idea of heat-death of the universe clearly bring apocalyptic interpretations appear in works of art. Literary critics have also traced the implications of decadence, physical and mental deterioration, restlessness, moral and spiritual perversity in entropy and laws of thermodynamics. Shaw and Davis bring some examples from “Samuel Beckett’s plays, especially ‘Waiting for Godot’, in which the characters deteriorate physically and mentally while waiting for something which never happens” (141). They assert that decadence symbolizes increasing entropy.

Since the second half of the 20th century, critical consideration on the literary studies revealed how creative written discourse intertwined physics and literature. This relationship lies in metaphoric perception “fundamental to all science and involves bringing together previously incompatible ideas in radically new ways” (Bohm and Peat 35). In fact, “the most important aspect of linking literature and physics is the imaginative process” (Vanderbeke 200) and both physicists and literary scholars apply metaphors to interpret reality. Metaphors as precious domain of imagination “have an extraordinary power, not only to extend the thought processes of science, but also to penetrate into as yet unknown domains of reality, which are in some sense implicit in the metaphor” (Bohm and Peat 41). In fact, scientists attempt to verify the predictions that the novelists make in the world of fiction.

Among the postmodern and interdisciplinary critics, Nancy Katherine Hayles asserts that scientific theories “display the passageways that enabled stories coming out of

narrowly focused scientific theories to circulate more widely through the body politic” (*How We Became Posthuman* 21). It means that literary discourse has the potentiality of activating scientific theories. Hayles professes that both fields affect each other, and states that literature can be considered as “an imaginative response to complexities and ambiguities”; and hence “a comprehensive picture of the field concept is more likely to emerge from the literature and from science viewed together than from either one alone” (*The Cosmic Web* 10). On the one hand, literature can influence scientific models, and on the other hand science has an impact on literature. Simultaneously both can affect our understanding of the world; i.e. both science and literature are at the converging point to shape the new contexts and make the impossibility of describing the invisible principles of the world possible.

Hayles born on 16 December 1943 is known for her notable publications in the fields of science and literature, and in particular electronic literature. She works at Duke University as the professor and Director of Graduate Studies in Literature. In her books, Hayles concentrated on applying information theory, cybernetics, statistical mechanics, dissipative structure theory, and chaos theory in literature. She offers theoretical discussions of similarities between science and human sciences, and explores the relationships among literary theory, modern literature and theories of 20th century physics, and acknowledges that scientific discourse can help to reinterpret self, language, text, and society. In *Chaos and Order Complex Dynamics in Science and Literature*, she acknowledges that, “One way to understand the connection between literature and science is to see science as a repository of tropes that can be used to illuminate literary texts” (20). Hayles believes that the cutoff points and applying science in literature were definitive, for they managed a final knockout to the developments of foundationalism in material science, and arithmetic. In *Chaos Bound*, she states that “[t]he essential change is to see chaos as that which makes order possible. Life arises not in spite but because of dissipative processes that are rich in entropy production” (100).

Thermodynamics and entropy have been studied in different literary works which depict the role and importance of science in the structure and formation of work of art for acquiring a better comprehension and recognition of real life. Concerning this purpose, the present research, is based on library study, reads *A Game of Thrones*, the epic fantasy of Martin through an interdisciplinary method of discussion engaging physics and literature and applies Katherine Hayles’ scientific interpretation of literary texts. Note taking and electronic sources are used to assert that Martin structures the novel scientifically grounded on the laws of thermodynamics to decipher the ontological significance of life.

3. Literature Review

Adapted into HBO series (2011-19), *A Game of Thrones* depicts an unpredictable chaotic universe with complex networking structures and random formations of the stories within stories which easily lead to amazing and new possibilities. The fictitious world of Martin viewed as a fusion of order and disorder and tension between the political poles. A vast number of academic literary studies and articles written on *A Game of Thrones* reveal that the narrative structure and measures of realistic social complexity along with wide scope of characterization which explore human psyche from different aspects encompass the potential of the novel in engaging literary critics to scrutinize it from many sides.

James Lowder in his book, *Beyond the Wall* (2012), collected a number of articles with extensive range of themes and elements in Martin's world of fantasy. Lowder, in this anthology, provides an excellent avenue to the multi-faceted world of Westeros. In "An Unreliable World," Adam Whitehead investigates the role of history in Westeros and of myths and tradition into "accepted fact"; and he states that the role of the Seven Kingdoms is "based on myths and legends much more than on hard historical facts even the recorded historical accounts of the Andals are prone to creative flourishes and outright errors" (64). He gives the series a postmodern level of uncertainty.

Remy J. Verhoeve, in *Re-Reading A Game of Thrones: a Critical Response to George R.R. Martin's Fantasy Classic*, studies Martin's first volume of the series. He discusses several themes and characters from his own perspective, which makes this work, more of a fan-publication. It mostly includes ideas, criticism, personal impressions, and his enthusiasm for the upcoming volumes of *A Song of Ice and Fire*.

Gessey-Jones and others, in their article, show that Martin organizes a world of fantasy in a way not to surpass the regular mental limits of a wide readership. Rather the construction of its social world reflects the normal interpersonal organizations in manners liable to limit the psychic burden on the reader. The narrator has controlled the course of events of the novel in such a way as to make it more engaging by making huge occasions appear to be arbitrary to elevate the reader's commitment. The distinguishing proof of examples of cognizance, possibility and, unusualness via computational techniques can motivate more extensive quantitative ways to deal with different spheres of abstract world of art, "including drama, Television, film, periodicity, genre, canonicity, literature, history, and fantasy" (28588).

B. Kozinsky investigates the way Martin "resists the long tradition of using injury as a mark of moral corruption" which is typically the demonstration of incapacitation in literature (170). He traces the characters who lost their limbs, and states that Martin "den[ies] the body's role as moral sign" and instead "invites new interpretations on the malleable form and substance of his characters" (174). Focusing on loss of limbs to mark

changing identity and character metamorphosis, Kozinsky praises Martin by focusing on physical disability to represent the relationship between the body and identity. He denies using disability or “injury” to display “moral corruption,” and argues that Martin turns the realization of disability by not characterizing it through a solitary identity.

Peggy Zawadil, in “Antihero” Defying Clichés: A Study of a Character in George R.R. Martin’s *A Song of Ice and Fire*,” highlights the role of several characters, and a great range of literary issues. She analyzes characterization from different points of view and traces the traits of some major heroes appearing in the novel series from *A Game of Thrones*, the first volume, to the last one. Moreover, Zawadil embraces a broad domain of linguistic, literary, and cultural features of the series of the novel.

On the other hand, the meaningful prevailing convergence, between literature and physics, leads to the creative academic publications by scholars to annihilate the fracture between the two realms. A significant number of studies have focused on the impact of physics on literary discourses by many authors. Among them are Palgrave Macmillan’s *Representations of Science in Twenty-First-Century Fiction: Human and Temporal Connectivities*, John Canaday’s *The Nuclear Muse: Literature, Physics, and the First Atomic Bombs*, and Peter Pesic’s *Seeing Double: Shared Identities in Physics, Philosophy, and Literature*. Considering the major written works on Martin’s novel, it can be realized that different works have been conducted on *A Game of Thrones* to analyze and interpret it from various standpoints. However, there is no a single work on this epic fantasy from the scientific perspective. With the wide scope of reality that Martin brings in plot of the novel, the researchers explore how Martin links physics in his fabricated fiction to verify the life of this chaotic real world.

4. Ever-Increasing Entropy in *A Game of Thrones*

In *A Game of Thrones*, Martin introduced an epic fantasy filled with adventure, mystery, romance and intrigue. In a long past forgotten time, an unnatural phenomenon made the seasons out of balance. In this land with lasting winters and summers of several decades, wars were started among different Houses over Iron Throne, the seat of king in King’s Landing. The freezing cold is coming back to the north of Winterfell, and the evil forces of White Walkers are grouping beyond the structure of Wall as the protection of the kingdoms. The king’s power in the south is breaking down, his most loyal counselors are killed under unknown conditions and the king’s enemies are appearing from everywhere. At the core of the chaos stands the family Starks of Winterfell, an unyielding, harsh House similar to the toughness of freezing land where they were born. Lord Eddard Stark (Ned) is unwillingly requested to be the new “Hand of the King,” a position that not only threatens to separate his family but also the entire kingdom.

A Game of Thrones tells the story of nobles, soldiers, lords and ladies, bastards, sorcerers, and assassins. They all gather in chaosmos, a time of ominous and fateful omens. There is a mysterious tribe of fighters not similar to other warriors; a fierce clan of Wildlings that draw men into insanity; there comes a merciless prince who exchanges his sister to take back his usurped position and throne; a young child drifts between life and death and his decided mother takes a treasonous adventure to protect all she holds dear. Among conspiracy, schemes, terror and betrayal, allies and enemies, tragedy and victory, amidst this chaos the fate of various Houses falls into danger, and each strives to win that fatalist fights: the game of thrones.

The spot to start investigating the structure of world of Martin is the laws of thermodynamics and the concept of entropy. According to Hayles in *Chaos Bound*, “Thermodynamic quantities such as temperature and entropy are macrostate properties; [...] statistical averages that represent the collective actions of millions of molecules [...] [hence,] we have no way to know how a single particle behaves” (53). This means that the movements of energy and entropy in the system of Westeros represent the collective actions of all characters from different Houses who struggle to win the Iron Throne and increase the entropy. As Milivoje M. Kostic remarks “thermodynamic entropy [...] is generated always and everywhere”; he adds that it “cannot overall decrease, but only overall increase” (1).

Hence, all living natural systems keep on existing based on energy and the fact that there is a propensity in nature to move in a direction that increases the entropy and randomness of a system. Hayles writes, “[e]ntropy represented the tendency of the universe to run down” (*Chaos Bound* 40). Showing the increase of entropy, the researcher displays movements of different armies in King’s Landing which end in the violation of the second law of thermodynamics.

4.1. Energy and Motion in ‘King’s Landing’

The ‘King’s Landing’, as the heart and the most important region of the ‘Six Kingdoms’, becomes the ideal system of energy absorption in which different movements of armies produce mass of energy along with its unpredictability. It is situated on the east part of Westeros in the Crownlands, only north of where the Blackwater Rush streams into Blackwater Bay and above it. It is the place of Red Keep which holds the Iron Throne, the seat of the Andals King and the First Men. This zone partakes of a thermal environment, as a metaphor for the ideal system. The city is overpopulated under the most favorable circumstances. The second thermodynamic law is perceived well in this site based on which whenever the energy rises up, the system absorbs it. The motions of particles create thermal energy and the faster the particles move, the higher or greater is the quantity of thermal energy they transfer. The whole system of King’s Landing shows uncertainty. It has experienced incidental assaults during different era, remarkably during the major battle known as Robert’s Rebellion, when Lord Tywin Lannister deceived King Aerys II Targaryen and requested the military to loot the city prior to surrendering it to Robert Baratheon as a token of fidelity.

Logistically, the two continents of Westeros and Essos in the novel present two contradictory poles. The Narrow Sea is the sea that divides the east of Westeros and isolates it from the bigger landmass of Essos toward the east. The abrogating awkwardness of this world has all the earmarks of the call to war of Starks of Winterfell. As Lord Mormont mentions in *A Game of Thrones*, “Winter is coming, and when the Long Night falls, only the Night’s Watch will stand between the realm and the darkness that sweeps from the north. The gods help us all if we are not ready” (247). Surely Westeros is by all accounts getting colder, while Essos appears to appreciate extensive warmth. Hotness and cold section the world and produce the occupants’ personalities. Despite anything occurring in cosmological terms, the ‘World of Ice and Fire’ is suspected to be swinging between limits of ice and fire as the two deadly components of archaic conviction: “ice leading to frozen extinction and fire leading to flaming destruction” (Monk 8). The interaction between the cold and the hot place becomes the main principle of the thermodynamic law within this chaotic system of Westeros.

In fact, this contrast between two poles of the system in Westeros is both instructive and destructive: the Starks and Others of Westeros are given to cold and unyieldingness, the Lannisters of Casterly Rock and others are given the temperature and fierceness. The two sides are politically secured in a structure of inflexible progressive feudalism which behaves like a source of heat escalating both the components.

No world comprises of just two components; between ice and fire, there should be a state of equilibrium to balance them out. There is a need for an element which can hold equilibrium between two inverse powers. Tyrion Lannister, the main and wise dwarf, metaphorically functions as an element that is able to hold the power between the Starks and the Lannisters. He preserves the balance between ice and fire which are in great motion and interact with each other since both are determined to destroy each other as they are part of the process in which the second law of thermodynamics takes place. The presence of Tyrion, as a balance point of ice and fire, depicts how the second law of thermodynamics is taking place smoothly in which heat is being absorbed into a cold place to create equilibrium or reduce the entropy. According to Kostic, “we could reduce the entropy of any system by transferring it out to other systems, but we cannot ‘completely reduce’ it, “entropy is always generated” (3). This means that Tyrion has “a much broader cognitive function depending for its specificities” (Hayles, *How We Became Posthuman* xiv); he cannot remove the whole entropy in Westeros, but he can reduce the entropy or tension as much as possible.

4.2. Temperature and Heat in Westeros

The whole system of Westeros goes through the process of getting heat and increasing of entropy. Based on thermodynamic rules, the heat moves from a warmer place to a colder one and this movement continues until the equilibrium is achieved. This is the same as

the movement of Lannister's army marches to the North to face Robb's rebellion. Such movements, in 'War of the Five Kings', the large conflict among the claimant to the Iron Throne, depict how Westeros goes through chaos before reaching equilibrium. Robb Stark faces the Westerlands troops in the Riverlands and alleviates the powers faithful to his ancestors enduring an onslaught for some time. Martin narrates:

Nodding, Robb had studied the map her uncle had drawn him. Ned had taught him to read maps. [...] Here was a hush in the night, moonlight and shadows, a thick carpet of dead leaves underfoot, densely wooded ridges sloping gently down to the streambed, the underbrush thinning as the ground fell away. [...] The whispering wood let out its breath all at once, as the bowmen Robb had hidden in the branches of the trees let fly their arrows and the night erupted with the screams of men and horses. (*A Game of Thrones* 830-31)

The 'wood' signifies an isolated system remaining intact; hence, the army has to cross through forest without making a contact. In physics, the thermodynamic system does not allow any energy or matter to pass through although matter and energy can move through the system, or it is quite far from other systems, has no interaction with them and can sense its own gravitational force. Isolated systems do not sense external forces. Robb and his mother Catelyn believe that this zone can act as an isolated system, and provide them with a field which is empty of any external interaction.

Catelyn makes a deal with Lord Walder Frey – the head of House Frey and the Lord of Crossing – to permit Robb's military safe entry across the Trident at the Twins, a strategic area in the Riverlands of the Seven Kingdoms. Walder gives the entry, and contributes his duties to Robb's military, consenting to wed one of his daughters. The Stark host parts into two powers: one, of 2,000 men, moves south to stand up to Tywin, while the other power moves south-west to go up against Jaime. Since the numbers increase and the movements rise up in the system, the isolated system heats up.

Based on thermodynamics, when a system loses or absorbs heat, the value of kinetic energy of the molecules will change. Heat transfer leads to a variation in the temperature of the system whose change depends on the number of molecules. This thermal mechanism is perceived in the confrontation between these two forces in the system. Tywin gets word that the Starks are moving against him. Accepting this is the full Stark host, in light of the information, the caught scout got back to him, he gets ready to stand up against it. In a fight – the Battle of the Green Fork – the Lannisters arise adequately successful because of overpowering predominance of numbers, yet very soon understand that they have been deluded. Regarding how energy functions, Martin describes:

You have never seen Riverrun, Ser Harys, or you would know that Jaime had little choice in the matter. The castle is situated at the end of the point of land where the Tumblestone flows into the Red Fork of the Trident. The rivers form two sides of a triangle, [...] turning Riverrun into an island. The walls rise sheer from the water, and from their towers the defenders have a commanding view of the opposite shores for many leagues around. To cut off all the approaches, a besieger must need place one camp north of the Tumblestone, one south of the Red Fork, and a third between the rivers, west of the moat. There is no other way, none. (*A Game of Thrones* 908)

This excerpt validates an isolated system in which entropy always increases. In addition, temperature has an intense property. It does not depend on the amount of matter and does not change throughout the system as long as it is the same throughout the system. At the atomic level, the molecules in every system are persistently moving and striking each other. In each collision of two molecules with each other, kinetic energy is transferred. According to the second law of thermodynamics, when two systems come in contact with each other, heat is transferred from the warmer to the colder one through molecular collisions until the two bodies become isothermal. When two systems with same temperature, are in contact with each other, they are in thermal equilibrium.

The unnaturally hyper energy, vitalizing the armies as they struggle to rise up out of their territories, sorts out the power, for it returns them back to alive state; yet these selfsame efforts guarantee that their moving toward disintegration will be conclusive, accelerating Robb's death. The Lannisters' efforts resemble the stormy condition that animates the evil-smelling in the shadow of the forest. As their energy prompts the death of Robb so the army's consumption of energy is connected with the crumbling of the House of Starks and the annihilation of the family he protected. Such relationships infer that order and confusion are bound together in logic. According to Hayles, "the more energy expended, the more certain the collapse into fragmentation and chaos in the isolated and incestuously closed system formed by [the House of Lannister]" (*Chaos Bound* 22).

In War of Five Kings, Martin recounts that the number of Robb's forces plunge into Jaime's army and lead him into 'Whispering Forest' in northwest of Riverrun. In an ultimate battle, Robb's men from North achieve a decisive triumph by defeating the forces of Lannister and capturing Jaime himself. The 'Triumph of the Starks at the Battle of Whispering Wood' over the Lannisters' powers attacking Riverrun essentially annihilated half of Lannister's permanent force and eliminated their second group of forces in the river lands; left Tywin further east with only 30,000 troops under his own command. In this lost situation, Tywin withdraws his army further South in the Riverside to Harrenhal, the largest castle in the Seven Kingdoms, to use this palace as headquarters

for a protracted conflict. Tywin notes that the system is absorbing so much heat, and it functions like an isolated system; thus, entropy is constantly created in all cycles. Tywin has to function in order to preserve the balance of the system since the occurring changes have drastic actions.

Previously, Robb was defiant and strongly unaware of the battle. The fight not only strengthened Robb's position as a solid ruler, it also places him in command of two of the kingdoms and radically expanding the full size of his army. The Northern forces dispatched by Robb were not the only ones Tywin had to administer, as the Baratheon brothers presented their own cases to the privileged from the South. The Lannisters are in an open system under the great force of entropy, and they are unable to quench the existing entropy. Due to increasing number of movements, the entropy is increasing as well.

Since it is impossible to annihilate entropy at any scale, it cannot be obliterated locally; or for a brief time and afterward be remunerated somewhere else later. Kostic notes that “[n]on-thermal [...] processes are isentropic, but [...] always generating entropy” (5). This means that regardless of the condition, randomness is a permanent process in a system. This left the Lannisters trapped in the center and fought in a two-pronged condition. Consequently, Tywin's main force was basically stuck in the center of the kingdom in Harrenhal, unable to send an attack on Riverrun north, inspired by a paranoid fear of an attack from Storm's End South and vice versa. This led the Lannisters to scramble to find another field force of green recruits in their home domains in the Western Lands, and to wait for their chance until these new taxes could be passed on to the field.

5. Violation of the Second Law: 'Beyond the Wall'

'Beyond the Wall' is a term given for the northern-most piece of the mainland of Westeros. This zone is not constrained by the Iron Throne, rather being home to tribesmen and residents known as the 'Free Folk', called wildlings by people in south of the Wall. This area is lined toward the North by the unending frozen, known as 'Lands of Always Winter', toward the east by the Shivering Sea and toward the west by the Sunset Sea. The Wall and 'the Bay of Ice' structure the southern edge of this area. From the geographical positions of the Wall in the North, and King's Landing, in another direction, the move of armies and characters, from South to the North simulates a system in which the second thermodynamic law can take place in an irreversible manner.

The terrains past the Wall are isolated from a few lesser locales. North of the Wall lies the massive 'Haunted Forest'; this broadens northwards for a long distance. The backwoods is home to a few wildling towns, like Whitetree. In the north-east lies the landmass of Storrol's Point, at the tip of which lies Hardhome, the biggest wildling

settlement obliterated by fire a few centuries prior under baffling conditions. Toward the east of the Haunted Forest lies the Frostfangs, a generous mountain range stretching out from the 'Lands of Always Winter' in South into the North of the Seven Kingdoms. There are two significant routs through the mountains, the 'Skirling Pass' and the 'Giant's Stair'. The tallest top in the chain is the Forktop. The Milkwater River runs along the feet of the Frostfangs and is taken care of by streams running off the pinnacles. Past the mountains lies the Frozen Shore, a more open region lining 'the Bay of Ice' toward the South. Fisherfolk and thieves live around here, at times cruising south to assault Bear Island and the grounds around Deepwood Motte.

The geographical structure of 'Beyond the Wall' and the Wall itself show that there would be no penetration from beyond the wall. This wall prevents progression of the 'Others' including 'the White Walkers' and 'the Wildings'. This means that the second law of thermodynamics cannot be violated; i.e., energy fails to move from a cold place to a hot place. Likewise, the whole world of Westeros tends to be destroyed due to the movement of energy. This preserved energy, depicted metaphorically in the form of political tensions and the battles between different groups, can be absorbed by the system or Westeros and it goes toward destruction. The 'Others' are limited by the entropy, and they are unable to break the wall.

According to Edward Lorenz, "[t]he laws of thermodynamics will tell us how the temperature will behave, and other laws will allow us to handle the remaining variables" (79). One of these variables, in the novel, is the structure of the Wall that several thousand years prior, after the 'War for the Dawn' was raised by Bran the Builder to forestall the arrival of White Walkers, the supernatural creatures, who are the thread to the existence of mankind. Notwithstanding, certain individuals would not forsake their homes North of the Wall and decided to keep residing there, regardless of the danger of White Walkers. As the centuries passed and they did not return and blurred to legend, the wildlings filled in number, fighting with each other and the Night's Watchers monitoring the Wall. These 'Others' function as the mass energy being accumulated and transferred to the colder places. The 'Dead' armed force begins to ascend in a freezing place where the entropy is at the most minimal level and energy is low. Their development begins to make energy which seems strange and indiscernible, and it would destroy the harmony of the world's system. This violation of the laws of thermodynamics is shown figuratively through raising the 'Dead' which is against the regulations and unimaginable. In fact, the penetration of these Others, the wildlings and White Walkers, from cold zone into Westeros shows violation of the second law of thermodynamics that cannot take place easily.

6. Conclusion

Physics and literature are places of intersection by which the novelists interpret the real world and discover scientific aspects of reality. The relationship between them and the vastness and complexity of issues that both realms attempt to interpret prepare the ground for constructing interdisciplinary researches for authors, artists and literary critics. Indeed, the interplay of literature and the laws of physics makes us face the reality of the world. A novelist like George R. R. Martin incorporates modern physics in imagination to represent perception of scientific exposition of the world in narration and passes the borders of disciplinary fields to present another way for the readers to experience the reality.

Martin demonstrates that the whole kingdom of Westeros, his fictitious universe which mirrors our real world, experiences the laws of thermodynamics and entropy. The movement of energy and violation of the balanced system have created chaos in the whole novel in the forms of tensions, political struggles, and wars. In Westeros, different elements are attracted to each other; as a result, a surge of energy from different parts raises and moves to increase the entropy within the system. Entropy is a measure of the unavailable energy and randomness in a closed system usually considered as the system's disorder which features its state. According to the second law of thermodynamics, energy never ceases to exist but it will be transformed from one to the next form. Based on this law, entropy increases in time until it reaches equilibrium. The whole structure of the novel centers on the second law of thermodynamics which dictates the dominant amount of energy throughout the Seven Kingdoms. As the narration progresses in time, the increase of entropy level is sensed accordingly. In the vastness of the Kingdom, the entropy reaches the highest point; however, that the armies move from the South to the North manifests the movement of energy in which it moves from the warmer objects to the colder ones. This violation of the law is shown metaphorically in the form of raising the dead which is beyond reasoning. Accordingly, Martin first bases the structure of the novel on the laws of thermodynamics to bring chaos; and then he violates the second law to bring fantasy out of reality. In this way, he differentiates himself from the other epic fantasy writers who use magic to advance the plot and empower the characters.

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