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## HERACLITUS THEORY OF “ΕΚΠΥΡΩΣΕΙΣ” (EKPYROSEIS) AND MODERN VIEWS ABOUT THE END OF THE UNIVERSE

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**ABSTRACT:** A key element of Heraclitus cosmology is its reference to fire as the principle and substrate of all natural processes. But apart from the material element of the fire, Heraclitus also mentions another kind of fire, the thunderbolt, which is characterized by the existence of intellect. His cosmology, however, is characterized by the *ekpyroseis*, that comes from the advancing of fire which is called in Greek *κόρος* (= saturation) and is related to the phenomenon of *ekpyroseis* where everything is destroyed in the fire from which comes life and death in the Universe. The theory of *ekpyroseis* which refers to the constant alternation between the birth and the death of the Universe is analogous to the theory of Big Crunch.

**KEY-WORDS:** fire, Heraclitus, Universe, ekpyrosis, big crunch

Heraclitus (535-475 B.C.) from Ephesus of Minor Asia was one of the most significant thinkers of the Presocratic period of philosophy. His work is said to be divided into three parts cosmology (*περί τοῦ παντός*), politics (*πολιτικόν*) and theology (*θεολογικόν*)<sup>1</sup>. Heraclitus is considered as an independent philosopher rather than a member of other philosophical schools and is often described as an “obscure or dark” philosopher because his work was unclear and difficult to be understood. His philosophy is opposed to that of Parmenides, believing that reality is not motionless but is governed by eternal motion and change. Heraclitus is best known for his cosmology and especially for this theory about fire as the initial element of the Universe and also about the conflict of the opposites. Although an interesting point of his views is the alternation between birth and death in the Universe which takes place through periodic destructions of the cosmos called *ekpyroseis* (conflagrations). This view is analogous to the theory of Big Crunch and Oscillating Universe in modern Cosmology. In this paper will be initially presented the theory of Heraclitus about fire as the initial element of the Universe and his views about the *ekpyroseis*. Then will be studied the common points between the theory of *ekpyroseis* and modern cosmological models that speak of death and rebirth of the Universe

The cosmology of Heraclitus is characterized by constant motion and change (*πάντα χωρεῖ καὶ οὐδὲν μένει* - *Everything changes and nothing remains still*). Heraclitus also uses the example of the river to symbolize the continuous change that rules our cosmos, saying that you can't get into the same river twice<sup>2</sup>. This dynamic view of nature is also expressed in fragment 53 where he states that *war is the father of all and king of all, who manifested some as gods and some as men, who made some slaves and some free men*<sup>3</sup>. In spite of the fact that the Universe is subsequent to the laws of change, there is still a search for a factor that maintains the world harmony. According to Heraclitus this factor is named *Logos* and is considered as the regulator of the universe, exists in all things and people are not able to understand or experience it<sup>4</sup>.

Apart from the existence of *Logos* Heraclitus' main cosmological view was that everything emerges from the element of fire. Aristotle claims that Heraclitus

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<sup>1</sup> Diogenes Laertius *Vitae*, IX, 5-6.

<sup>2</sup> Plato (1900) 402a

<sup>3</sup> DK22 B53

<sup>4</sup> Sextus Empiricus (1914) VIII, 132.

and Hippasus of Metapontion accept the existence of a moving and finite element. This principle is fire and all beings are made through the process of thickening and diluting of the initial element and finally they disintegrate into fire. So this is the underlying nature, because everything is a change of fire<sup>5</sup>. Moreover the philosopher claims that there is also a superior kind of fire called *keraunos* (thunderbolt) that *steers everything* (B 64).

Keraunos has also the following attributes (B 64)<sup>6</sup>:

- *want and surfeit*
- *will judge and convict all things*

It is obvious that the element of fire therefore acts as a substrate in which the various changes take place including the birth and the perishing of beings. Also Heraclitus claims that the world, *no one of gods or men has made. But it always was, is, and will be: an ever-living Fire, with measures of it kindling, and measures going out* (B 30). Heraclitus, therefore, considers that the world has no beginning, and is characterized as a fire that lights up and goes out at regular intervals. This view is not far from reality, as from our personal experience we see that even on our planet the temperature rises or falls during the seasonal changing. Obviously Heraclitus was aware of the role of fire in natural processes

Heraclitus also refers to the advancing of fire which is called in Greek *κόρος* (= saturation) and is related to the phenomenon of *ekpyrosis* where everything is destroyed in the fire. This process clearly defines the fate of the Universe which is born out of fire and then perishes into the fire. But in order to understand this view of Heraclitus it should be mentioned that the element of fire performs mechanical motions. It is a common point in Presocratic cosmology that the initial elements of the Universe appear to be in constant motion thus causing the creation of beings. Especially Anaximander speaks about *apeiron*, Anaxagoras about *homeomerias* and Leucippus and Democritus about atoms refer to mechanical processes and particularly about the motion of vortex that plays a significant role in the creation of beings<sup>7</sup>.

Heraclitus also assumes that the thickest part of fire is shrinking turning into earth, then water, and finally through vaporization air is created. Then everything will

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<sup>5</sup> Aristotle (1924) 984a

<sup>6</sup> Hippolytus (1986) IX, 10, 7

<sup>7</sup> Kalachanis (2016) 1-6

be destroyed from fire during the *ekpyrosis*<sup>8</sup>. Since the element of earth is the thickest (*παχυμερέστατον*) it appears that the initial material (fire) has undergone great compression. On the other hand, when it is exhausted in air the compression declines and the initial element becomes air which is the lightest element.

FIRE → EARTH → WATER → AIR

From the transformation of elements it is obvious that:

- a. Permanent and circular changes of fire are the essential elements of reality.
- b. The energy that exists in the Universe assumes all possible forms.
- c. The birth of the beings is constantly changing with their perishing.

This eternal process where death and the birth of an element alternate is an indication of the continuous conflict between the opposites which nevertheless maintains life.

The significant point in the cosmological model of Heraclitus is the perishing of the Universe in fire. We can find in modern cosmological views a similar situation within the concept of "Big crunch", a process inverse to "Big bang" when conditions as well as the temperature will be like in the epoch of "Big bang") But in order to understand how the Universe could end up in a Big Crunch we have to study the role of gravity which could possibly cause the "crunch" of the Universe. Einstein in order to overcome this obstacle added in his equations the "cosmological constant  $\Lambda$ " that acts counterbalance to gravity<sup>9</sup>. Einstein was convinced that the Universe should be static though he was not familiar with the idea of expansion thus considering the cosmological constant as the greatest mistake of his life. Alexander Friedmann (1888-1925) introduced in 1922 (and G.E. Lemaitre (1894-1966) independently in 1927) the idea that the Universe is expanding and also formulated the three scenarios about its fate including the factor of "critical density" ( $\Omega$ ) (figure 1):

A. The Universe starts at zero radius at  $t = 0$ , with  $\Omega < 1$ , expands slowly to a bend point  $t_f$  where the expansion is then accelerated (open universe).

<sup>8</sup> Aetius (1879) I, 11 (A 5)

<sup>9</sup> Einstein, (1915)

B. Self-accelerating dilation with a non-zero radius for  $t = 0$  and  $\Omega=0$  (flat universe). Observational data have revealed that due to the phenomenon of Inflation our Universe was dilated so fast that the space-time became flat.

C. The third scenario, also called the “Oscillating Universe”, describes an oscillating universe between zero radius and a critical value of density with  $\Omega>1$ . Until the critical value, the Universe expands in a slowing down, and then begins to contract, resulting in the Great Crushing (closed Universe).

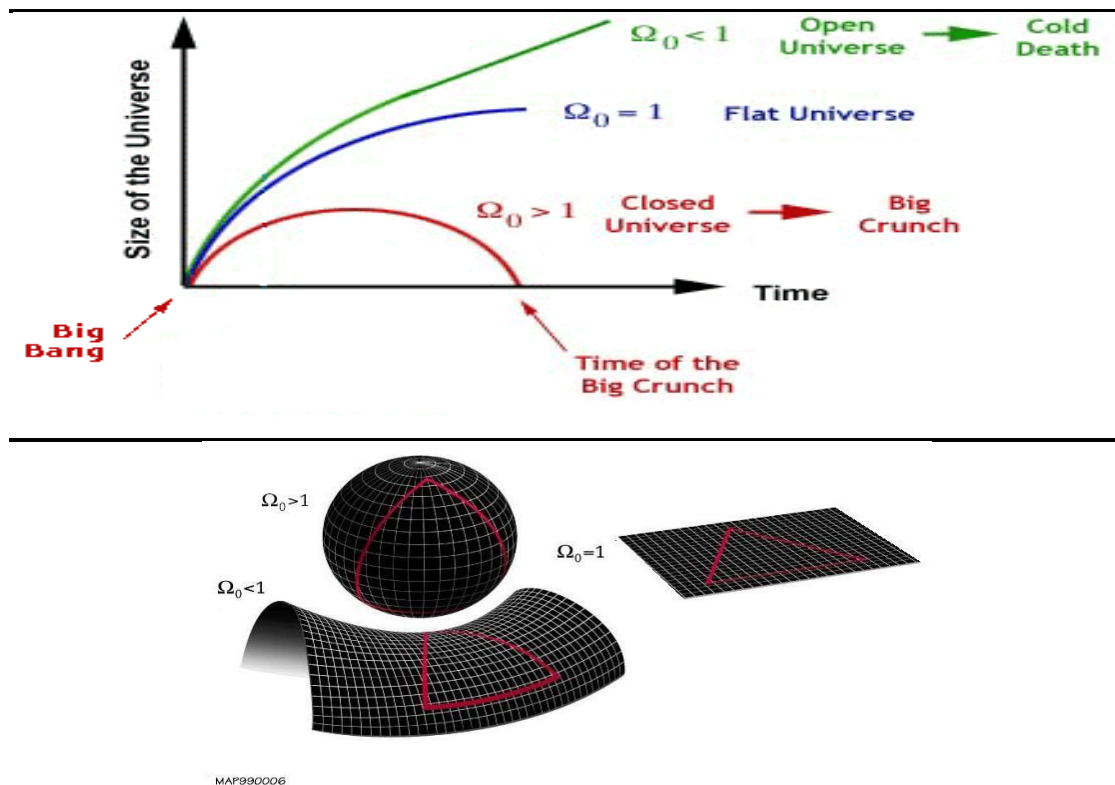


Figure 1: Upper: The three scenarios about the fate of the Universe which come out of Friedmann's equations. Down: the three types of Universe that are based to the value of critical density.

Critical density is correlated to the term “escape velocity” where a body in order to overcome a gravitational field should develop a certain velocity. In this case, a rocket launched from Earth should acquire sufficient kinetic energy that exceeds its dynamic energy under the influence of the gravity of the celestial body. In the case of Earth the escape velocity ( $V_{esc}$ ) of a body from its surface is  $V_{esc} = 11,2 \text{ km/s}$  and is calculated by the following formula:

$$v_{\text{esc}} = \sqrt{\frac{2GM}{R}}$$

$G$  = the universal gravitational constant ( $G \approx 6.67 \times 10^{-11} \text{ m}^3 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$ )

$M$  = the mass of the body to be escaped

$R$  = the distance from the center of mass

It is obvious, therefore, that the evolution of the Universe is in some respects analogous to the fate of a body trying to escape from a field of gravity, such as a rocket (figure 2).



Figure 2: A Saturn V launch vehicle sends Apollo 15 on its way to the Moon in 26/7/1971

An interesting point is that Heraclitus' cosmology had a major impact on the Stoics who believed that the Universe would suffer a death in fire by saying that the cosmos perishes though *ekpysorseis* and then rebirths. Chrysippus claims that Zeus who symbolizes fire, increases (*τὸν Δία φησὶν αὐξέσθαι*), until he reaches a point where he consumes all the other elements (*μέχρις ἂν εἰς αὐτὸν ἅπαντα καταναλώσῃ*)<sup>10</sup>. According to this point the element of fire seems to increase until it reaches a point of saturation that results in the death of the Universe. But this death is not irreversible since the cosmos revives, a process that is eternal<sup>11</sup>. This constant

<sup>10</sup> SVF 604, 3

<sup>11</sup> SVF 611, 1

change between life and death in the Universe is obvious in nature since according to Heraclitus all elements “live” each other’s death (B 76). So

Summarizing it is obvious that the cosmology of Heraclitus clearly refers to a Universe that is not static, but is characterized by constant changes, like in modern cosmological theories. His view of oscillating Universe includes a phase analogous to the Big Crunch, an option for the fate of Universe which possibility depends on the nature of dark energy and the critical mass in Universe.

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