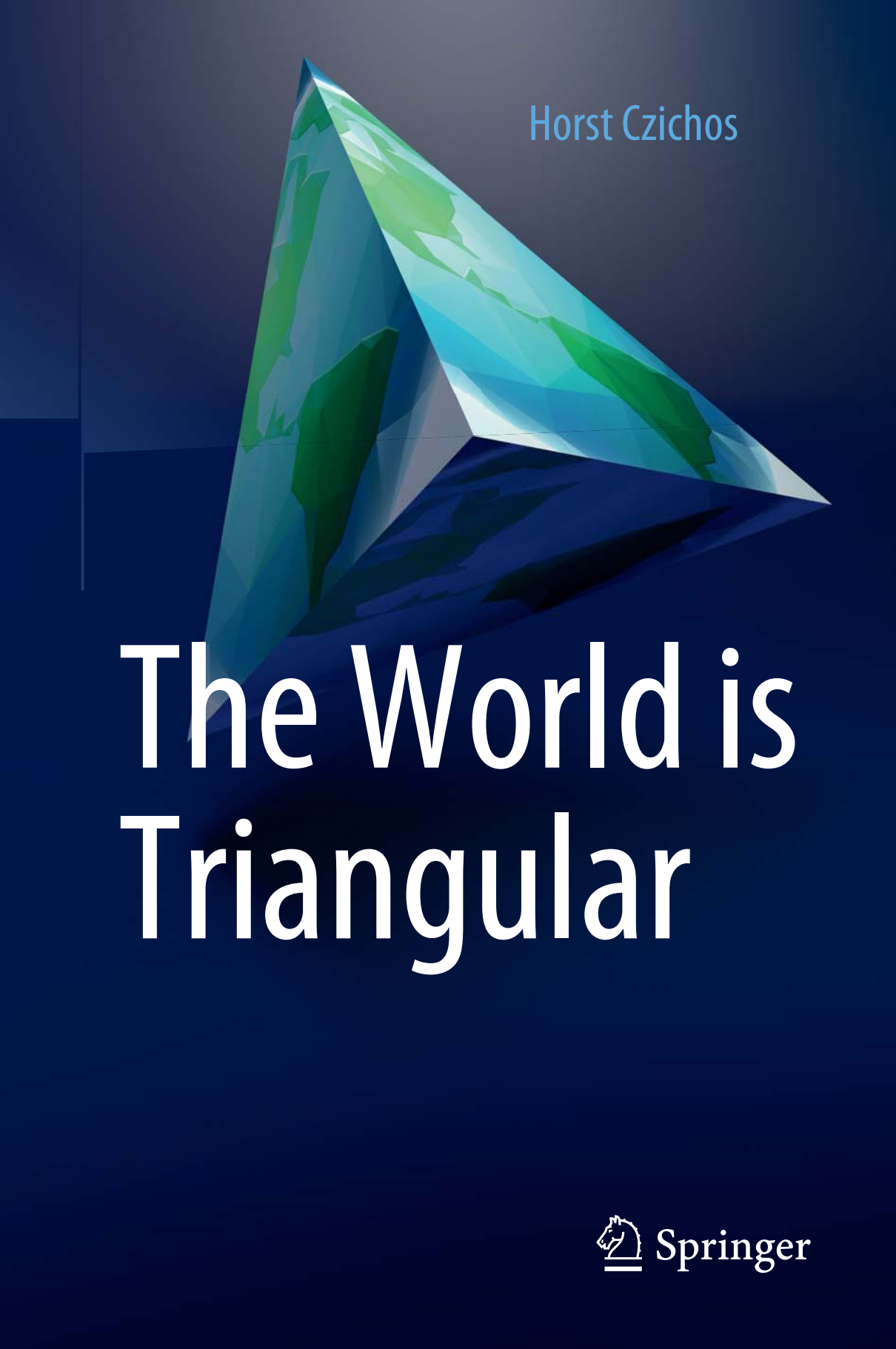
Horst Czichos
The World is Triangular
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Foreword of the 1st Edition

I got my first impressions of technology and philosophy during the engineer-internship in a company for counting and calculating machines. *The first adding machine the philosopher Leibniz built,* the trainer explained to us. *Philosophers are concerned actually not with technical things* said my friend Jürgen and described with Plato's theory of ideas an example of philosophical thought:

> *… according to Plato, the objects perceived by our senses are only images of "Ideas", the archetypal patterns of all objects ...*

The conversation about Leibniz's calculating machine and Plato's theory of ideas—and the discussions about *Marxism* and *Existentialism* in Berlin in the 1960s—were the beginning of an intensive occupation with philosophical questions.

The engineering education provoked a strong interest in the physical basics of technology, so that besides freelance engineering development work in the optical industry, I studied physics at the Free University of Berlin. Thereby I also learned the analytical philosophy of Wittgenstein. After my doctorate, I worked in research, teaching and technical management.

From the long occupation with technological, physical and philosophical topics—and the experience that things today are mostly "complex" and not "mono-causal" understandable—the idea arose to combine the elementary knowledge from the different areas in a book. Mr. Thomas Zipsner, Springer Vieweg, I thank you for the stimulating and constructive discussions for the realization of this interdisciplinary project and Ms. Imke Zander for the careful editorial support.

The book takes a brief look at the development and the state of knowledge of the three fields and thus wants to contribute to a multidisciplinary understanding of the world.

Berlin, Germany — Horst Czichos
May 2013

Preface

The book gives a short presentation of the triad *philosophy—physics—technology* against the background of the common origin in ancient times.

The emergence of the book has been described in the foreword of the first German edition. The present second edition of the book is updated and extended, whereby new physical research results and technological innovations were included:

- The physics of space and time after the experimental detection of gravitational waves (Nobel Prize for Physics 2017).
- The New *International System of Units* (SI) for Physics and Technology which is completely based on natural constants and entered into force on World Metrology Day, 20 May 2019.
- Actual overview of basic technologies: Material, Energy, Information.
- Technologies for the "Digital World" of information and communication.
- Mechatronic and Cyber-physical systems for Industry 4.0.

The significance of technology for the world in the twenty-first century is discussed in the final section of the book.

Berlin, Germany
July 2020

Horst Czichos

Contents

Chapter 1
The World of Antiquity

The origins of philosophy, physics and technology are embedded in the world of antiquity, which is considered with its facets in the first part of the book.

In the cultural *Axial Age* (Karl Jaspers), in the period from 800 to 200 B.C., in several cultural areas the philosophical and technological developments evolved, which still form the basis of all civilizations today, Fig. 1.1. Even before that, about the 2nd millennium B.C., the "religions of revelation" (Judaism, Christianity, Islam) originated, who refer to Abraham as their progenitor. At the same time, the Phoenicians (Lebanon, Syria) developed the easily learnable alphabetical script, from which the European writings (Greek, Latin, Cyrillic) descendants.

1.1 Ethics—Religion—Natural Philosophy

In Persia, Zarathustra (ca. 630–550 B.C.) taught that people could choose between have good or evil. Good virtues are good disposition, truthfulness, wisdom, dominion, health, longevity. Evil is deceit and anger. A principle of life is the Triad: *good thoughts—good words—good deeds*. The world is the place of struggle between the good and the bad, in the end the spirit of good will prevail.

In China, Lao-tse (604–520 B.C.) cites the term *Tao* as the origin of the world, which embodies the unity and harmony of all things. Man should recognize this principle of originality, naturalness and simplicity as "way" and orient thinking and acting align with it.

The hallmark of the perfect human is silence, a philosophical non-action, the refusal to intervene in the natural course of things. State and rule should be kept to a minimum. The more laws and regulations, the more lawbreakers there are.

Confucius (551–478 B.C.) developed the principles of humanity and reciprocity, which should have a balancing and harmonizing effect in society in order to prevent injustice. The central concern is the embedding of the individual in family, State and morality. The five relationships, Prince ↔ Civil servant, father ↔ son, man

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Fig. 1.1 Cultural areas in which the foundations of civilizations arose

↔ woman, older brother ↔ younger brother, friend ↔ friend, must be determined through humanity, right action, custom, knowledge, truthfulness.

In India, the historical Buddha, Siddhartha Gautama (560–480 B.C.) founded the teaching of Buddhism. The teaching is based on the four noble truths: (1) everything life is full of suffering; (2) the cause of suffering is "thirst", desire; (3) suffering can be overcome by the suppression of desires and passions; (4) the path to this is the *noble eightfold path* with the steps of wisdom, morality, deepening. The goal is healing, the suspension of the ego-centered existence, the extinction of the life illusions, the nirvana.

Symbols of eastern cultures are shown in Fig. 1.2.

All cultures emphasize the importance of Ethics.

Golden rules of practical ethics

- What should not be done or forced to me I will also not do to other humans (Confucius)
- What is unwelcome and awkward to me how could I do it to others (Buddha)
- Nothing doing to other humans which is not good to myself (Zarathustra)

The golden rules of ethics are comparable with the biblical commandment of charity, which according to the Luther Bible of 1545 as a Christian rule of life is expressed in this way:

- **What you don't want done to you, don't do to others.**

Under the term **Religion**, a multiplicity of different cultural phenomena that are related to elementary realities of life (birth, body, soul, death) are summarized. T*heism* is the conviction of the existence of a (personal) God, which is in distinction to the counter-concepts of *atheism* or *pantheism* (God and nature are one).

However, science can neither prove nor disprove the existence of God. *We do not know what the meaning of life is and what the right moral values are. A discussion*

Fig. 1.2 Symbols of Eastern Philosophy: Tori (left), symbol of Japanese Shintoism and Buddha statue

of this necessarily leads to the broad source of attempts at interpretation and moral teachings and these fall within the realm of religion, says the Nobel Prize winner Richard P. Feynman in his book *The Meaning of it All* (Feynman 1999), and named three basic aspects of religious belief:

- the metaphysical aspect, which tries to explain what things are and from where they come, what man is, what God is and what qualities he has,
- the ethical aspect, which gives instructions on how to behave in general and especially in the moral sense,
- the inspiring power of religion for art and other human activities.

Today, there are more than 2 billion Christians, 1.2 billion Muslims, 810 million Hindus, 380 million Taoists, 360 million Buddhists, 12 million Jews and 6 million Confucians on earth, as well as millions of believers who subscribe to other theories and teachings (Anke Fischer in: The seven world religions).

– *Judaism, Christianity, Islam* have their roots in the “Abrahamic model of divine revelation”, according to which the world was created by a benevolent God. The realities created by God in the physical world are worth less than the humans they are subject to. Man should therefore not be guided by reality of this world, but must seek his model of behavior in God himself. God reveals himself less through his creation than through his “revelation". He can proclaim a “law” to the world via “prophets” or “angels”, as in Judaism (Torah) and in Islam (Koran), or through

the incarnation as "Son of God" to enter the world as in Christianity. Christianity emphasizes the principle of charity and proclaims that the soul is considered a personal attribute of every human it is immortal, but indissoluble with a single individual connected.

- *Buddhism* is a non-theistic religion that is directed at all people. It does not understand itself as a revelation, but as a discovery of the world connections with the four noble truths and the noble eightfold path.
- *Hinduism* knows no founder of religion and no dogma, thinks cyclically (birth, death, rebirth) and is based on the religious-philosophical System of Sanatana Dharma (eternal law) with different concepts of God and the principle of karma (transmigration of souls).
- *Confucianism* developed out of the teachings of Confucius and was still in use until at the end of the Chinese Empire as temporarily Chinese state religion. It is based on the principles of humanity and reciprocity.
- *Taoism* (also known as Daoism) is based on the teachings of Lao-tse and is concerned with the harmony of man and nature. At the center of the religious Taoism stands above all the search for immortality.

The **Natural Philosophy** of the ancient world embraced—with a pantheism view—nature and the soul and actions of mankind. It has its origins on the west coast of Asia Minor (Ionia, today Turkey), on Sicily, in Lower Italy and in Athens, Fig. 1.3. "We are attracted to Greek philosophy *because nowhere else in the world, neither in before and after, such an advanced, well-structured building of knowledge and thought has been established*," emphasizes the physics Nobel laureate and co-founder quantum physics Erwin Schrödinger in his book *Nature and the Greek* (Schrödinger 1958).

Thales of Miletus (ca. 625–547 B.C.) is considered the first philosopher ever. As a mathematician, he discovered the theorem of Thales (every triangle enrolled in a hemicycle is right-angled) and is said to have calculated the height of Egyptian pyramids with the mathematical theorem of rays. As a philosopher he took a universal invigorating principle, literally translated "water", as symbol for the diversity of

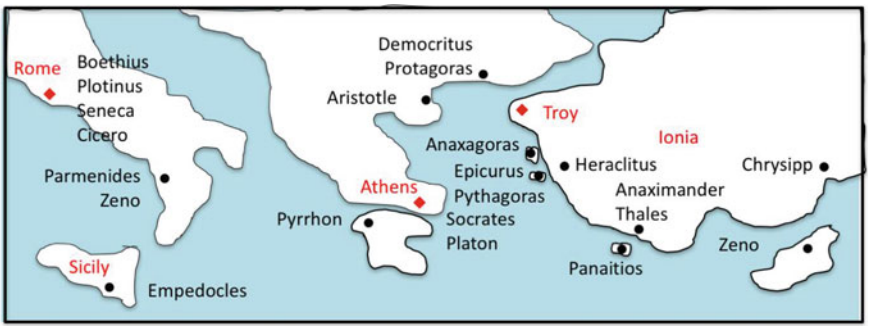
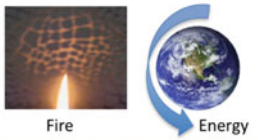


Fig. 1.3 Philosophers of Western Antiquity and their birthplace or location of activity

dynamic, life-sustaining functions. Anaximander (611–545 B.C). and Anaximenes (585–525 B.C.) from Miletus tried to trace the "All of Being" back to a first principle (ark). For Anaximander it was the principle "infinity" (wherefrom things arise and where they go). For Anaximenes the first principle was "air" because "air carries the world".

Heraclitus of Ephesus (544–483 B.C.) developed the concept of *Logos* as cosmological, all-founding and determining principle and raised the "fire" to its symbol and first principle (arche). The "embeddedness" of physics in the philo-sophia of antiquity was revealed by the physicist Heisenberg in his book Physics and Philosophy (Heisenberg 2011) with the following comparison:

If one replaces the word "fire" with the word "energy", one can call Heraclitus' statements as an expression of our modern physics. The energy is actually the substance from which all elementary particles, all atoms and all things in general are made, and at the same time, the energy is also the moving thing.



Heraclitus assumed that everything is determined by "change" as a structural principle. He illustrates the constant change through the image of the river, whose water is constantly changing and yet remains the same. (You can't go down the same river twice). Heraclitus' principle of constant change was later expressed by the aphorism "everything flows". Figure 1.4 shows analogies between eastern and western symbols.

Parmenides of Elea (515–445 B.C.) developed the basic features of a "doctrine of the knowledge of being". The being is un-become and imperishable. It is an "indecomposable Whole" and must be regarded as uniform and dormant: "The same thing namely is knowledge and being". The followers of the doctrine of Parmenides are called eleates. Zenon of Elea (490–430 BC) defended the doctrine of Parmenides by perceptive and convincing (dialectical) evidence:

Anaxagoras of Klazomenai (ca. 500–428 BC) was one of the first philosophers in Athens. He started from the principle that "nothing can be created from nothing" and that there is an infinite variety of material qualities in small units. According to today's interpretation, his considerations can be understood as anticipation of the principle of self-organization of matter. Anaxagoras saw—in contrast to the mythical-magical thinking of his time – e.g. in the stars no divine beings, but celestial bodies similar of the earth. The views of Anaxagoras gave natural philosophy expanded dimensions.

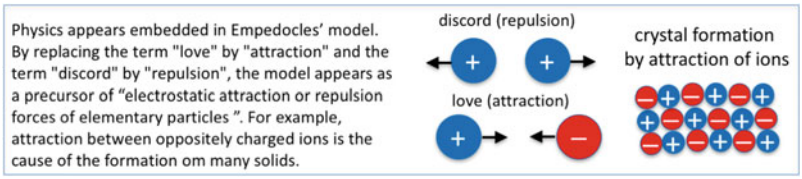
Tao is the origin of the world, which embodies the unity and harmony of all things, symbolized by Yin (white, cold, negative) and Yang (black, warm, positive).
The S-shaped curve symbolizes the dynamic character of dichotomy.
Lao-tse

Everything is governed by Logos, the law of the unity of thesis and antithesis. Nothing is imaginable without its antipode: day and night, vigil and sleep, life and death. All events result from contradictions. Change is the general structural principle. Heraclitus

Fig. 1.4 Symbols of Eastern Philosophy (Lao-tse) and Western Philosophy (Heraclitus (

1.2 Primordial Elements and Atomism

After Thales had declared "water" the very first beginning (ark), Anaximenes the "air" and Heraclitus the "fire", Empedocles (495–435 B.C.) was first thinker of antiquity to extended this "monism" to a "pluralism". He designated the four elements *fire, earth, air, water* as the "roots of things". Empedocles supposed in mythological language, that through "love" and "discord" between basic elements the variety of things comes into being.



Aristotle (384–322 B.C.) supplemented the model of Empedocles with a fifth primordial element (quintessence) as a symbol of heaven (sun, moon, stars). The five elements were symbolized by perfectly regular polyhedrons, Fig. 1.5. The symbolic bodies can be disassembled and new "model building blocks of matter" can be built from them. For example, a tetrahedron (symbol fire) and two octahedrons (symbol air) can be disassembled into twenty equilateral triangles and from these an icosahedron (symbol water) can be built up.

In other cultures, similar models of the "elements of nature" were developed—in the Buddhism the four-element doctrine and in Taoism the five-element doctrine, Fig. 1.6. The idea that nature in all its manifestations is made of a special mixture of the four basic elements was explainable until the beginning of the nineteenth century, i.e. until the discovery of oxygen and its subsequent formation of today's chemistry, scientific claim.

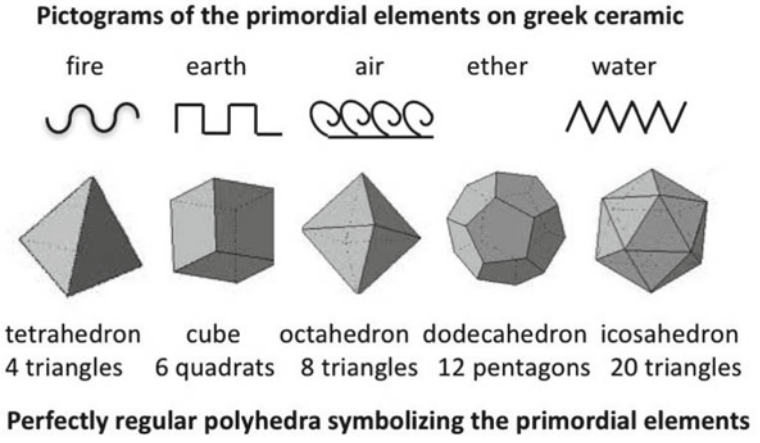


Fig. 1.5 The primordial elements of antiquity and their symbols

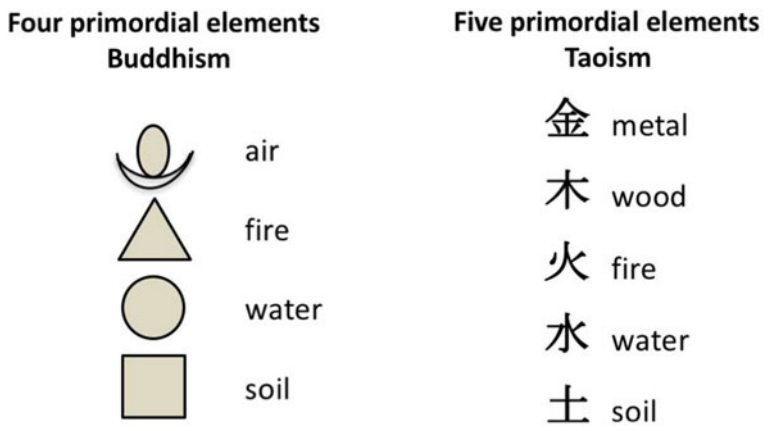


Fig. 1.6 The primordial elements in Eastern cultures

1.2.1 Atomism

Ancient atomism—founded by Leucippus of Miletus (460–370 B.C.) and Democritus of Abdera (460–371 B.C.)—postulates the existence of smallest (even indivisible) particles (atoms), which in different combinations determine the type, shape and change of things. All atoms have their own original capacity to move. Between the atoms there is the "void", the space between them. The whole reality can be completely defined in its structures and processes by the different types of movement, the connection or dissolution of atomic groups in the void. Atomism established a completely new understanding as illustrated in a comparison with the earlier "Natural Philosophy", see Fig. 1.7.

- The philosophy of nature of Thales is looking for a uniform "primordial substance" and takes archetypal "water" as the primordial element.
- In contrast, ancient atomism postulates that all things—including the primordial element "water" of Thales—consists of smallest particles, the atoms.
- The atomic structure of matter postulated by Democritus around 400 BC could be made "visible" experimentally in 1951 with field ion microscopy, see Sect. 3.1.

Using the model of atomism, Democritus explains with the formal characteristics of atoms the differences between the four elements postulated by Empedocles (earth, air, water, fire) and the fifth element, the ether, that substance that according to Aristotle forms the celestial world, thinking and intelligence.

Also the spirit is made of atoms, it is a "psychic matter". This statement is the first philosophical representation of "materialism", according to which everything that exists can be explained without exception as a combination of basic atomic types.

In the theory of atomism, a certain analogy to graphic texture can be seen because atoms combine with each other to matter like alphabetic characters combine to words. So, the things and beings of the world are dependent on:

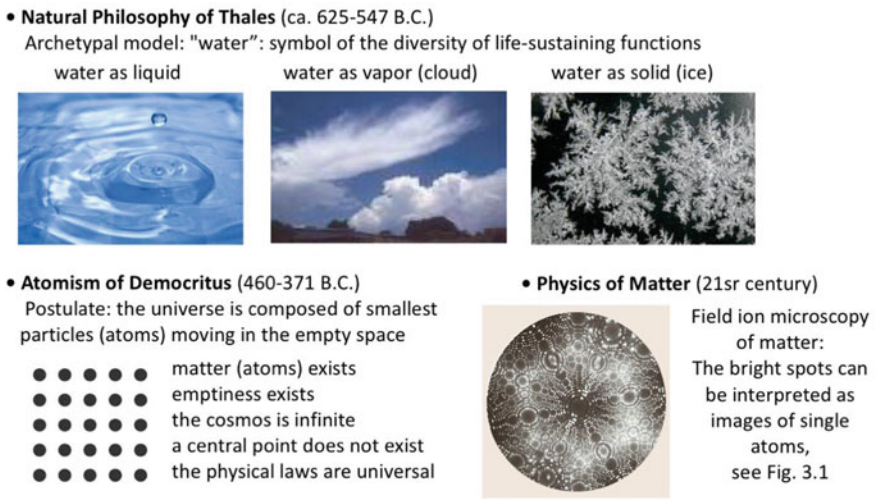


Fig. 1.7 Models of Natural Philosophy, Atomism and the real physics of matter

– the shape of atoms from which things are formed differ, like the shape of letters from which words are formed differ, e.g. letter A has a different shape than letter N,
– the position of atoms in a "composite" (substance) or of the position of letters in a "phrase",
– the order of atomistic or letter combinations. A limited number of atoms explain the complexity of the world, similar to twenty-six letters of the alphabet are sufficient to form all words.

1.2.2 Determinism

The philosophical and scientific determinism established by Democritus claimed that there is a necessary relationship between all natural phenomena which is based on the principle of cause and effect.

A system is described as deterministic if by its "state" at an arbitrary date and applicable "laws of nature" the state of the system to any future date is completely determined. If the laws of nature assumed here are thought to be "causal laws", one speaks of *causal determinism,* or with respect to the world of a *cosmological determinism.* A special case of the causal determinism is "theological determinism" with the "doctrine of predestination", that all events in the world are predestined by God's (inexplorable) fact and will.

1.3 Measure and Number

For the philosophers of classical antiquity, **measure** is a basic concept that defines the "coherent". A life lived in harmony can be described as something that is "ordered by measure".

1.3.1 Rules of Governance

Nothing in excess is a well-known aphorism ascribed to Solon (640–560 B.C.), the first historically proven creator of the law of the Athenian city-state. The wording of Solon's laws, in the first "Athenian Constitution" is not preserved. To the question of the best state, Solon should have answered (conveyed by Plutarch's document *The Banquet of the Seven Wise Men)*: "The state, in whom a criminal is accused and punished in the same way by all those he has not harmed and the one he has harmed".

The Greek philosopher and politician Demetrios of Phaleron (350–280 B.C.) ascribes the following aphorisms to Solon:

- Do not advise the citizens what is most pleasant, but what is best.
- If you demand accountability from others, give it yourself.
- Be more faithful to decency than to your oath.
- Do not sit in judgment, or you will be an enemy to the condemned.
- Learn to be ruled, and you will know how to rule.
- Lie not, but speak the truth.
- Seal your words with silence, your silence with the right moment.
- Unlock the invisible from the visible.

The saying "the measure is the best thing", which comes from classical antiquity can be seen as a feature of Greek thinking as a whole. Aristotle put it this way:

> *The true man chooses the medium and distances himself from the extremes, the excess and the too little.*

1.3.2 Number Symbolism

Number is an abstract functional unit of account in mathematics and should not be confused with the character that symbolizes a number, e.g. "4" and "IV" are different symbols for a single number.

Pythagoras of Samos (around 580–496 B.C.) founded the religious-philosophical movement of Pythagoreism, a movement based on numbers teaching. Since Pythagoras, the natural (integers) numbers are in the center of occidental interpretation of nature. "*I don't know any other person who has had such an influence on human thinking like Pythagoras*," says the philosopher Bertrand Russel (1872–1970).