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Course Number?
Symmetry:

Cultural-historical and ontological aspects of science – arts relations:
The natural and man-made world in an interdisciplinary approach

Annotated lecture contents
The aim of the course
is to present the role of interdisciplinary connections among different scientific disciplines, as well as arts, and technological applications, and
to present also their roles in scientific thinking, in shaping a holistic world view.
In the course of the lectures, symmetry is a working concept that assists us to go through the creative application of interdisciplinary approach in the history of scientific thought.

INTRODUCTORY LECTURES

1. The concept of symmetry, invariance, harmony.
Interpretation of symmetry as a phenomenon. The geometric meaning of the concept, its generalisations, relation to synonymous expressions. Changes in the meaning of symmetry in different ages. Basic notions. The mathematical description of symmetry: groups. Symmetric and asymmetric phenomena in our environment.

2. Historic background.
Appearance of the phenomenon of symmetry. The substantial enrichment of the notion of symmetry from the Bible, through the ancient science, architecture and arts, as well as through the Renaissance until the interweaving of contemporary arts and sciences.

3. Frieze patterns (groups), wallpaper patterns (groups), crystallographic groups. Symmetry in decorative art, space groups, crystal structures.
Repetitions, rotations, reflections in one-, two-, and three dimensions. Their artistic appearance and mathematical description.

4. Golden section. Fibonacci sequences.
The golden section: its concept, and comparison of its algebraic and geometric interpretations. Artistic beauty and golden section. Interrelation between golden section and the Fibonacci numbers.

LECTURES ON INTERDISCIPLINARY EXAMPLES

5. The harmony of the built environment. Phillotaxis in the organic world.
Golden section in architecture. Fibonacci numbers and geometric formations. Their appearance in the organic nature (e.g., patterns of sunflower seeds, scales of a pine-cone or a pine-apple). Arrangement of leaves and flower petals.

6. The perfect solids: from Plato to the crystals.

Perfectness and beauty. The properties of the 5 regular polyhaedra. Music of the spheres and the planets' orbits by Kepler. Tessellation in the plane, in the space, and on the surface of a sphere. Applications. Semi-regular polyhaedra. Cellular automata.

7. That mysterious fivefold symmetry: from Dürer to the quasicrystals.
Why is it impossible to cover the plane with regular pentagons without gaps and overlapping? Attempts to find a solution, from Dürer to Penrose. What are those quasicrystals? Fivefold symmetry in the inanimate and the organic nature, in our built environment and technological applications.

8. From the structure of viruses, through stability of built structures, to the Fullerene molecules.
What is common in the surface structure of viruses, morphology of radiolaria, the patterns of golf balls, basket weaving , the dome-console-structure by Buckminster Fuller, the sewing pattern of soccer balls, and in the C60 Fullerene molecule?

APPLICATIONS IN THE PHYSICAL NATURE

9. Cosmological symmetries.
Periodic phenomena and symmetries. Motion of the Earth around the Sun, the axial rotation of the Earth and calendar making.

10. Seeing and hearing: the harmony and physics of the world of colours and tones.
Common properties of periodic oscillations. Visual and acoustic perception. Physics of colours and colours in the arts. Physics of sounds and the world of music.

11. Generalisation of the concept of symmetry in physics. Symmetry breaking in the inanimate nature.
Laws of nature and variational principles. Variational principles and symmetries. Symmetry principles and conservation laws. Noether theorems. How physics extended the notion of symmetry to non-geometric invariances. Discoveries in microphysics and symmetry breaking. Evolution of matter starting from a supposed Big Bang, through the development of elementary particles, atoms, molecules, and solid states, appearance and evolution of life, up to the human brain and its functions – as a series of symmetry breaking.

BRIDGES TO THE MAN

12. Chirality. Morphological and functional symmetry breaking along the evolution of the organic matter.
Right- and left-handed molecules? Why don't they appear in equal rates in the inanimate, than in the organic nature? Two types of sugar molecule. Asymmetries in nourishment. What direction does the DNA molecule, the bean- or grape- trailer helix wind? Asymmetries in our body.

13. Asymmetries of the human brain and its consequences. Symmetry in mathematical and logical thinking.

Differences in functioning of the two hemispheres of the human brain. Why are we left- or right-handed? The place of the speech centre and the motoric centre in the brain. The mechanism of our thinking and the two brain hemispheres. Reading, the number perception, space- and time perception as well as the brain lateralisation. Scientific and artistic perception, knowledge, and consequences for the teaching process.

BRIDGES TO THE HUMANITIES

14. The beauty and the truth. The emotional and rational functions of the human brain: arts, techné, science.
The hemispheric dependence of the emotional and rational human activities. Arts – searching for the beauty; sciences – searching for the truth. The techné. Scientific achievements and aesthetic functions in the products of technology. Symmetry in the different branches of arts.

15. Rationality and impression: function and art in the works of art and technology in the 20th century.
A few significant art movements in the 20th century, and the connection of art and science education. Interaction and interrelation of achievements of technology, arts and sciences.