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Symmetry and Katachi in the Works of Aristotle

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Abstract. We study the structure of the world sketched by ARISTOTLE of Stageira where we find a gradually increasing KATACHI opposite to the gradually decreasing SYMMETRY when we approach from the ordered symmetric heavenly world toward the center of the gravity in Earth.

1. SYMMETRY and KATACHI for Ancient Greek Science

Ancient Greek natural science and philosophy were performed by many schools, but one of the most important schools, with strongest ties to medieval European natural sciences, was the Lykeon in Athens, founded by ARISTOTLE of Stageira (384–322 BC) in 335. He was the greatest scientist of natural sciences in ancient ages and his construction about physical (in Greek: natural) laws and the structure of the Universe was dominant until GALILEO. While his Kosmos is now a Chapter of History of Science for physicists, it is still the way of thinking about Nature for European laymen, and as far as physicists can guess, for many scholars too.

In the Stagirite's thinking Symmetry had a central role, as it can be expected from Greeks, who developed the symmetry concept. In Greek in early times symmetry meant proportionality, commensurability (commensurability is a good Latin mirror translation for the original Greek meaning of syn-metry): it had spatial meaning. The fact that repeated motions, repeated proportionality produces patterns with regularity did not contain the time factor in the concept. Only when symmetry became a more abstract concept in the western world then appeared that invariance through time is also part of the symmetry concept. If something preserves its form through time, in that case not the time invariance, but the form is important in the western thinking.

If a pattern is very symmetric, then, clearly, something is contained in less extent. For example, a mirror-symmetric pattern can be described by half of information than the non-symmetric (+ some bits for the mirror plane &c.). We try to formulate the opposed quality, growing when symmetry is decreasing and vice versa. Obviously it is a close relative to—or one of the meaning of—Forma. If the form or shape or some such is more and more

complicated or rich, then the symmetry is weaker or poorer. On the other hand, if the symmetry is large, then the form or shape is unsophisticated at best. E.g. an SO(3) symmetry would mean a perfect sphere with no outward pattern at all, although a simple zonal structure inside would still be permitted. (True, Forma is originally Latin and Symmetria is originally Greek; but perfect mirror translations between Latin and Classical Greek were in use in the time of the Roman Empire, and the two languages were in close kinship with very similar internal logics.)

Now, clearly, ARISTOTLE could not know the term Katachi, the first half of the title of the conferences Katachi U Symmetry, held in 1994 and 1999 in Tsukuba, because the term is Japanese. He used some Greek words meaning Forma. The successor of Forma is Form in English. However in the Volume of the first Katachi U Symmetry conference (OGAWA *et al*., 1996) OGAWA, NAGY and YANABU equally emphasized that Katachi is not equivalent to Form, albeit something similar.

The relation between English "form" and Japanese "katachi" was discussed linguistically and historically by YANABU (1996) and we accept his statement that the meanings of the two terms are not identical. Maybe the two most important differences were that i) "form" implies a Western, "analytic" viewpoint while the idea behind "katachi" is holistic, and ii) that "form" is definitely an "outside" property while "katachi" originates from inside. (As he tells: "...KATACHI, which often meant as human face, expressed its inner feelings directly".) It is true that in Modern English the external and adventitious character in "form" is strong. However in Aristotle's works the idea which is often translated as "form" is not always as "external" as modern "form".

The question touched here is quite complex and in itself would require an interdisciplinary research. Now we cannot go into details and want only to show some arguments that it is not absurd to look for Katachi versus Symmetry at ARISTOTLE. However we note that a true Japanese approach to "form" and "shape" in Aristotle's works would seem to have possibilities.

It is easy to treat the first difference observed by YANABU. "Form" is an idea of people for whom systems can be taken apart, study, and then again put together while "katachi" is holistically interpreted. However Ancient Greek scientists, while not as holistic as Easterners now, were definitely not so analytic as those of the last centuries of the West. We think that no detailed proof is needed at this point.

However the second point is not trivial and needs arguments. So: "form" is an external property but "katachi", while can be seen from outward, is determined from inside.

Now, ARISTOTLE uses two words which are sometimes synonymes but sometimes not. One of them is "$\varepsilon\iota\delta o\sigma$", the other is "$\mu o\rho\phi\eta$". While "eidos" is as external as English "form", "morphe" *is not* (and therefore sometimes is translated as not form but shape; see e.g. ROSS' translations). We do not want to stop here just now and therefore the further argumentation is relegated to the Appendix. Here we only note that when ARISTOTLE gives arguments that the stars are spherical, then their *shape* is spherical, not their *form* (so not their eidos but morpheé proper reference will come later).

But if so, then indeed what is opposed to Symmetry in Aristotle's cosmology, is not Form or richness of Form, but that of something in between Form and Katachi, not necessarily halfway, and it would be the topics of another paper to see, exactly where in between. But then we have the right to discuss Katachi versus Symmetry in Aristotle's

works; and now we are going to do this.

In the next Chapter the statements of ARISTOTLE and his followers are in normal fonts, *"moderns" in italics*. Parts of the Aristotlean canon (first published by Andronicus of Rhodes) are referred in { } brackets, other works with author and year, notes in [ ]. Small parts of the canon are referred by page (number and a for front, b for back) + line.

2. The Cosmos of Aristotle

The World of ARISTOTLE is the inside and boundary of a finite sphere. His opinion is that this shape is necessary because of the diurnal rotation of the shell of fixed stars, the boundary of the Universe. Later commentators, especially ALEXANDER OF APHRODISIAS and SIMPLICIUS argumented about the possibility of shapes symmetric around the axis {De Caelo}, but generally accepted the sphere as the most symmetric choice. ARISTOTLE explicitly states that "the universe is spherical" {287^b 15}.

A perfect sphere can be i) homogeneous (when its symmetry is SO(3,1), E(3) or SO(4), each having an SO(3) subgroup (ROBERTSON and NOONAN, 1969)*, or can be ii) a Kantowski geometry SO(3)*E(1)* (KANTOWSKI, 1966) *or iii) simply SO(3). Case ii) was completely out of the scope of the geometers of Aristotle's age firmly believing in (proto) Euclidean geometry. In Case iii) there is again an alternative: the symmetry motions may act a) in 3 dimensions or b) on 2-dimensional spherical surfaces. Case a) is not compatible with Euclidean geometry. Cases i) (the E(3)) and iiib) seemed the only possibilities.*

By a priori laws the Universe of the Stagirite is inhomogeneous.
The only large-scale inhomogeneity compatible to SO(3) symmetry with 2 dimensional transitivity is isotropy around a single center (HAWKING and ELLIS, 1974).

ARISTOTLE's spheric World has one special point, the center {296^b}, which is the center of gravity too {De Caelo, De Mundo, Physica}. In a world spherical for whole and having a centerpoint only for organisation one expects zonal structure, and on the whole this is the situation {Meteorologica}.

ARISTOTLE's world is eternal and ungenerated {279–280}. Therefore there is no evolution in the overall structure. He distinguishes 5 elements, of which 4 are subjects of gravity. Their natural (so: free) motions are therefore radial: down to the center (EARTH, WATER) or up from the center (AIR, FIRE). The fifth element (QUINTA ESSENTIA) is untouched by the phenomenon of Gravity, and therefore its natural motion is circles around the center {De Caelo, Physica}. The first 4 elements are subjects of change {De Generatione et Corruptione, Meteorologica}, the fifth is not {De Caelo}.

Then structure formation can be expected for the first 4 elements (but not for the fifth; celestial bodies are strictly spherical for shape ($\mu o \rho \phi \eta$) {291^b}, confirmed by direct observation of Moon). However it is an observed fact that the spherical symmetry is not valid for matter, especially in the neighbourhood of the center of the world.

In Aristotle's physics matter does not re-act on the structure and especially on geometry of space. In General Relativity it does, and then the geometric symmetry almost imply symmetry of material structures too; however observe counterexamples (LUKÁCS and PERJÉS, 1977).

The zonal structure is the natural position of elements. In the sublunar world the 4 changing elements are zoned. EARTH the innermost, less heavy WATER on top. Gravity

is pushing the other 2, so they are light; AIR is less light and so it comes after WATER, and FIRE is more light, so it is outside {Meteorologica, Physics}. QUINTA ESSENTIA is outside from Moon. Being light is not the lack but the opposite of being heavy (heavy matter goes down, light up).

2.1. Aristotle's Gravity is more similar to our Coulomb force; it has a +/– sign

Heavy matter (mainly EARTH) is accumulated around the center which is also center of Gravity because there is only one center in a spherical world. However, the first 4 elements can form complicated structures which are then subjects of change. Experience shows that forms are best preserved for solid EARTHS, less for liquid WATERS, even less for dilute AIR and FIRE. So near the center the shape or permanent form (≅ katachi) is strongly represented, at the periphery symmetry reigns.

2.2. Katachi weakens when going outside and in exchange Symmetry takes over

The theory excellently agreed with known facts *then*. It is natural that it agreed with terrestrial facts; but it explained several facts of upper regions too, and we briefly list such ones. Heavenly bodies are the planets (including Moon and Sun) + fixed stars. They do not have individual motions (being spherical), not even rotation {290^a} [1] and are unchanged. *This explains that the 1006 and 1054 supernovae were not mentioned in European sources. Astronomers were uninterested They belonged to transient meteorology.*

In the sublunar worlds transitional phenomena are treated by meteorology {Meteorologica}. Maybe the uppermost (and fairly stationary) is Milky Way. This is an agitation of the FIRE zone by the light of some stars above {345^b}. Comets are similar but quite transient {343}. Proof: there is a star with a faint tail at the thigh of the constellation Dog; it shows the minimum degree of the "Milky Way" phenomenon {343^b 12} [2]. Going down, more and more "heavy" meteorological phenomena appear ("meteor" is cca. "mid-AIR"). A lot of those are called simply "meteors" and are guessed to happen at the border of FIRE and AIR zones {Meteorologica, De Mundo}. Deep in the AIR zone winds &c. are generated and in the WATER and EARTH zones other transient changes.

Now let us concentrate on meteors, because there the construction meets one of its most serious challenge. Meteorologica states that "shooting stars" appear not among the stars but below (albeit somewhere high) {341^a 33} [3]. Meteorologica generally states that the cause of such phenomena are AIR, FIRE and especially some combustible matter. However De Mundo takes slightly different standpoint when states that "If the flashing body...be only half of FIRE, but violent also and massive, it is called a meteor" {395^a 22}. It implies that a "meteor" should contain some massive "EARTH" too.

Our guess is that this contradiction between Meteorologica and De Mundo was caused by the great challenge of the Aigospotamoi meteorite. According to the report of PLUTARCHOS, the devastating Spartan victory (the end of the Pelloponesian War) at Aigospotamoi in 404 BC was predicted "by the fall of the stone". Strabon in Geographika also mentions the fall, and the stone was preserved, maybe for centuries (LUKÁCS, 1995).

PLUTARKHOS (1892) preserved some reports of DAIMAKHOS (De Religione; lost) that there had been light phenomena prevously for 75 "days" (rather nights). Then it must have been a complicated and persistent "meteor", as persistent as a comet; but it contained an EARTH-type "core", the big stone.

3. Summary

ARISTOTLE takes the challenge in Meteorologica and concludes that the stone "had been carried up by a wind [at night?] and fell down in the daytime" {344^{b} 32} and in the same time there was a comet (causing or indicating windy weather) on the western sky (Daimakhos' light?). Until the case is exceptional, the principle of approaching the problem is correct; but this was enough for the Stagirite to have doubts and may have well caused the difference between Meteorologica and De Mundo. (De Mundo is later, one of the last writings of the canon, maybe compiled by disciples in 322 when ARISTOTLE went to Khalkhis to avoid the asebeia trial; or even later. But both the next heads of Lykeion, THEOPHRASTOS OF ERESSOS, and the second, STRATON OF LAMPSAKOS were raised quite near to Aigospotamoi to be familiar with the stone.)

> *Aristotle's world model was the best available. However this rigid, one-centered Universe model seriously slowed down the development of meteoritics at least until 1807 AD [4], which was an accidental, but sad consequence, because thus collecting of extraterrestrial matter was regarded as superstition, or at best religious piety.*

Appendix: Eidolon vs. Psyche vs. Thymos

As YANABU (1996) has shown, "katachi" was originally a human face whose appearance or expression is determined from inside. True, now there is no single word with such a meaning in Western languages. However in older times Westerners were less Western. Ancient Greek texts are available for us from cca. the VIIIth century BC, namely the Iliad and Odyssey, and there we can detect "anomalies".

Maybe "katachi" was originally connected with some "essence" or "soul" of humans; at least YANABU's example in Modern Japanese "Kakko ii" ~ "His katachi is good" suggests such an interpretation. Now in Iliad and Odyssei there are at least 3 words which have some meaning of "soul". One is "psyche", meaning solely "soul" from classical times upward. But the two Homeric epics are old enough to use two other words too. (And they are the oldest long and continuous Indo-Germanic texts except for the oldest parts of Vedas of the Old Hindu.)

The most common term there also is "$\psi\upsilon\chi\eta$". Odysseus visits the Underworld (Od. XI.), and there he meets psyches. They have just the outward appearances of the persons just before dying. That is so, up to the extent that in the Iliad a killed Argive warrior goes to the Underworld with the (psyche of the?) piercing spear (Il. XIV, 457). But these psyches are extremely weak; as weak that they even cannot be seen normally. Odysseus pours them different drinks, finally sheep blood, and then they become transiently seen and can speak. What is more, they lack lust, initiative and such. So a psychê is similar to the outward appearance of a man. Modern English translations use "soul" or "spirit" for "psyche". Psyche probably meant originally cca. "breath".

However in Od. XI there is something even weaker than psyche; this is "$\varepsilon\iota\delta\omega\lambda o\nu$ = eidolon". Odysseus meets the hero Hêraklês; more definitely his eidôlon, since Hêraklês has become a god, so his psychê is with his body in Heavens. So an eidôlon has the outward

appearance of a psychê, which in turn has the outward appearance of the body. But even the great Homer is not too consequent. Odysseus meets first the psychê of Elpênôr (Od. XI, 51), an old comrade and fresh dead. But when they part (Od. XI, 83), went away "eidôlon d' heterôthen hetairou poll' agoreuen", azaz Elpênôr's eidolon went away. For him an eidôlon and a psychê are rather similar; but an eidôlon is even slightly emptier than a psychê. ROSE (1953) guesses that the spirits of the Underworld (Hades) are the eidola of the dead; this is possible, so let us continue.

Now the original meaning of "$\varepsilon\iota\delta\omega\lambda o\nu$" is clear enough. The word "eidon" is the 1st Sg. Aorist of the strong verb "horaô" = "see", meaning cca. "was seen, has been seen". So again something which seems just the same (but only seems; inside it is different, or has it no inside at all?). Eidon seems to be the regular counterpart of Latin "video" (BRUGMANN, 1904), and indeed, "visus" in Latin may mean some supernatural, which we see. Going back to YANABU (1996) then eidolon, eidon or eidos is the extreme Western "form" (since it is only the outward appearance, and separable from the "whole"). And "eidos" is one of Aristotle's terms, and when he uses it, he generally means outer appearance or layer.

However there is a third term for soul or spirit, "$\theta\upsilon\mu o\sigma$ = thymos". It is connected with internal attributes, so it is usual to translate it as "heart" or something similar for modern languages, but it is not a definite human internal organ. Its original meaning is hard to reconstruct. Regular Indo-German forms from exactly the same ancient root are well known (BRUGMANN, 1904), but the actual meanings in the languages of common origin have already diverged too much when the written documents appear. The Greek thymos seems to mean "courage, temper, passion, emotional fluctuation", but the exact Latin counterpart "fumus" means already only "smoke", as "dym" in various Slavic languages. (The reconstructed Old Indo-German form is "dhumos".)

Now, Il. V, 643 tells that the hero Sarpedon's thymos is bad ("soi de kakos men thymos"), but from the text it is clear that the even bigger hero Tleptolemos wants to state by this that Sarpedon is a coward. Then let us be polite, unlike to Tleptolemos, and let us tell: "$\Theta\upsilon\mu o\sigma\ \varepsilon\sigma\tau\iota\ \alpha\gamma\alpha\theta o\sigma$", i.e. "Thymos ii". (The verb "to be" must always be used in such Indo-Germanic sentences.) Is it not similar to YANABU's example "Kakko ii" (where, he states, kakko = katachi)?

But if so, we think we showed arguments that at least preclassic Greeks were able to formulate statements about something not unsimilar to katachi. Thymos is "inside", but its state was directly reflected on the faces of Old Greeks. In the IV-th century BC language (and thinking) has changed, but was still not in the present, "analytic" and "external" stage of modern West.

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Notes

1. See the observation of Moon. *We would tell that Moon makes one rotation by one revolution.* However if we accept Moon fixed to the rotation of the spherical shell of fixed stars, then lunar observations disprove individual rotation.
2. For us that is M41 in Canis Maioris (Big Dog), an open stellar cluster, with the apparent diameter of the Moon (30′), and brightness $m = 5.0$. That 2000 years ago it was a fair model to the Milky Way structure, can be demonstrated by the fact that the Andromeda galaxy (galactica (Greek)-> Via Lacta (Latin) = Milky Way), a quite sister of our Milky Way galaxy is M31, 160 by 35 arc minutes for size and $m = 4.8$.
3. For us shooting star phenomena are caused by micrometeorites glowing by air friction and finally burning cca. at 60–120 km height; then they evaporate. Indeed it is the highest air region.
4. At a report on a meteorite fall, THOMAS JEFFERSON, 3rd President of USA, still kept the opinion “rather believe that two Yankee scientists lied than that stones fell from the heavens” (SAGAN C.: Broca’s Brain, Ballantine, New York, 1980); it is a good Aristotelian standpoint, and JEFFERSON was Virginian, not Yankee. One of the Yankee scientists was BENJAMIN SILLIMAN of Yale (Asimov I.: The Obvious Factor. The Best Mysteries of ISAAC ASIMOV, Fawcett, New York, 1987).