

Actor–Network Theory and Byzantine Interpretation of Aristotle's Theory of Action: Three Points of Possible Dialogue¹

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Abstract

The paper continues the study of the *implicit theory of action*, developed by Byzantine orthodox philosophy and based on Aristotle's ideas on human action. The claim is that because of developing Aristotle's ideas in a somewhat different direction compared with that taken in the Latin tradition modern philosophy and social science are heirs to, the achievements of Byzantine theory of action are in correspondence with some contemporary critiques of the social sciences' analyses of human actions, especially those of *actor-network theory* and *sociology of regimes of engagement*. The paper analyses three of these achievements: (1) *the 'double nature' of action*, according to which the courses of action of any agency, be it human or not, could in principle be divided into two large categories—'causal actions' and 'existential actions' (or in Aristotle's terms 'movements' (κίνησις) and *actions in the proper sense*, or *energies* (ἐνέργεια)); (2) the elaboration of original concepts, which allows us to grasp and trace the ways different acting agencies mutually influence each other—among them the most important are *hypostasis* (ὑπόστασις), *persona* (πρόσωπον) and *periboresis* (περιχώρησις, interpenetration, *Durchdringung*); (3) the elaboration of Aristotle's category of *hexis* (ἕξις), which accounts for the empirically observable differences between acting agencies (hypostases) and *defines the personal*, or rather, *the hypostatic factor in the direction and definiteness of an action*. Taken together, these achievements expand our resources in understanding human actions, especially when approaching some barely studied or neglected phenomena, such as *resistance*, *suffering* and *endurance* in laboratory life (and social life in general). These phenomena need to be considered *according to their own*, and not reduced to statements such as 'being enrolled', 'being translated', and other similar connotations or attributed to the solidity and robustness of the non-human agencies involved.

The paper continues the study of the *implicit theory of action*, which was developed by Byzantine orthodox philosophy in the framework of a thousand year old tradition (IV – XV century).² Our basic claim is that because of

developing Aristotle's ideas in a rather different direction than the Latin tradition modern philosophy and social science are heirs to, the achievements of the Byzantine theory of action are in striking correspondence with some contemporary critiques of the social sciences' analyses of human actions, especially those of *actor-network theory* and *sociology of regimes of engagement*. Three of these achievements are of particular interest:

- (1) *The 'double nature' of action*—in Byzantine philosophical reasoning, the vast realm of action was split, so that the courses of action of any agency, be it human or not, could in principle be divided into two large categories, which could be named 'causal actions' and 'existential actions' or, to use Aristotle's original terms, '*movements*' (κίνησις) and *actions in the proper sense*, or *energies* (ἐνέργεια). This distinction stems from the different way (in comparison with Latin tradition) Byzantine philosophers interpreted the Aristotelian concepts δύναμις and ἐνέργεια (translated in Latin as *potentia* and *actus* or, respectively, as *possibilitas* and *actualitas*). Applied to the contemporary critiques of traditional sociological notions of human action, this allows for example explaining what makes the success of actor-network theory (ANT) possible in introducing semiotic notions that symmetrically account for the activity of both or human and non-human agencies.
- (2) *An original language, which allows us to grasp and trace the ways different acting agencies mutually influence each other in the course of action*—influence manifested not only in the 'results' of the actions, but also in the direction and strength of the subsequent actions these agencies are involved in (and which have been interpreted by traditional sociology as changes in their 'capabilities' and 'competencies'). The most important concepts here are *hypostasis* (ὑπόστασις), *persona* (πρόσωπον) and *periboresis* (περιχώρησις, interpenetration, *Durchdringung*). In the Latin tradition, the first two concepts were commonly used as synonyms. However, recent studies have revealed that while *persona* denotes only rational beings³ (God, angels, men), the Byzantine concept of ὑπόστασις has a universal meaning—*every being has its hypostasis*, which approaches this concept to the ANT notions of *actant* and *agency*. In turn, the concept of *periboresis* denotes the intercommunication and mutual pene-

tration of two (or more) different natures together with their properties and energies (while preserving their otherness), leading to the emergence of *hypostases* having specific existential, but also 'causal' actions.

- (3) To treat the empirically observable differences between acting agencies (*hypostases*), Byzantine theory of action elaborated another category of Aristotle—*hexis* (ἕξις), which defines the personal, or rather, the hypostatic factor in the direction and definiteness of an action. The notion of 'hexis' sheds additional light on some recent debates on *habitus* (related with *habitudes*, the Latin translation of ἕξις), pointing out the principal limitations of the latter—developed in the search for a 'third way' in the old debate between subjectivism and objectivism, this concept remains trapped in the common frame that makes possible the very opposite position.⁴ From the point of view of Byzantine scholars, the contemporary interpretations of *habitus* operate at the level of 'movements', which makes it difficult to grasp the complexity of the Greek notion of *hexis*, and their elaboration of this concept provides important insights.

Taken together, these achievements expand the resources (or increase the 'sensitivity') of actor-network theory and other contemporary critiques of the social sciences' understanding of human actions. This is especially true when approaching some barely studied, or consciously neglected phenomena (often declared as 'artificial', or 'secondary constructions'), such as *resistance*, *suffering* and *endurance* in laboratory life (and social life in general). These phenomena need to be considered *according to their own*, and not reduced to statements such as 'being enrolled', 'being translated', and other similar connotations or attributed to the solidity and robustness of the non-human agencies involved.

Before presenting these ideas, we need to specify one important point: the theory of action of Byzantine scholars is based on the notion of 'nature', which they identify with 'essence'. However, they apply these notions in a quite different manner compared to the philosophical lexicon of Latin tradition, in which modern philosophy and social sciences are rooted.⁵ In the Byzantine philosophical tradition reality is perceived as 'active' rather

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than as the substantial static character of things, and the ‘essence’ alone and by itself is unknowable. It is considered not by itself, but rather as a source of energetic dynamism. Here the essence—every single essence—is described with a frugal and necessarily abstract set of attributes. *The essences themselves are recognizable only by their realized and realizing energies.* The plentitude of essential attributes is knowledgeable only through these energies (or, put in contemporary language—actions). That is why the Byzantine philosophical tradition could easily agree with most of the basic principles of actor-network theory—with theses such as ‘existence precedes essence’, or ‘essence itself has variable geometry, changing as time passes’ (M. Callon); with the refusal of ‘action with a point of origin’ and related refusal to attribute competence to the actor prior to the action itself having been realized; with the insistence on ‘under-determination of action’ and the element of surprise in it, and with its characterisation as an ‘event’ (Latour). Developing the notion of *hypostasis*, this tradition also has no difficulty admitting the ‘actantial’ character of the ‘objects’ and considering them as fully valued agencies in interactions.

In what follows we are briefly presenting the three key points of Byzantine implicit theory of action. The first point is intermingled with a renewed account of the empirical finding at a Bulgarian holographic laboratory, aiming ‘to land’ the discussion and to provide points of support for future enquiries. We are aware that both subjects—Byzantine orthodox philosophy of action and anthropology of holographic research—might appear to the reader esoteric and difficult to grasp, and even more so their juxtaposition. But who says that questioning the deepest principle of our understanding of the world we live in is an easy task? A humble excuse might come from the confession that it was no easy task for us either (...).

Box 1. Methodius' path to coherent optics—the initial steps

Methodius is a Bulgarian scientist who graduated from the *Optical Technical School* in Sofia and then entered Sofia University in 1956 to study theoretical physics. Prior to that he already possessed substantial experience in the field of photography. His school friend, also an optical physicist, recalls this passion of Methodius:

‘Methodius already deepened his knowledge of photographic chemistry in high school. He arranged an improvised photographic laboratory in the attic of his

home and *he has continuously 'infested' the (photo) chemistry*—he was able to produce colour photographs before he entered the university! In the 1950s it was a very complex task to mix the developing agents guided by intuition only.'

In 1961 Methodius joined the Research Institute of Cinematography and Radio Engineering (RICRE), at that time the only Bulgarian applied research institute in optics: '(...) One day—being only a first year student at the university—Methodius went to the director of RICRE and insolently began to talk with him about colour photography (...). I don't know what they were talking about, but when he graduated from the university he immediately was hired by the "Photography" department at the same institute. This was a miracle, because all graduates had three years mandatory appointments in industry and elsewhere to complete, all planned long in advance' (an interview with a colleague at Sofia University).

It was here that Methodius gained proficiency in *diffraction optics*:

'At RICRE I was expected to develop some objective criteria for image quality in filmmaking. This actually means describing fine art by means of technical criteria. It was uphill work (...). To take photography as an example—there are lenses which when examined more closely, will be found to be definitely outdated. Nevertheless photographers take fine pictures with them and say: "This lens is a perfect *artist*." At the same time they discard modern lenses with very good performance and say: "These lenses are not good for art photography." Hence, *I understood that some other characteristics of the lenses, like frequency, contrast, etc., would have to be measured*. But to do this we needed special instruments, and we had almost none. Then I happened to read some papers on diffraction and it turned out that diffraction with a lens and light could help obtain *two-dimensional Fourier transformation*.⁶ In around 1959 I got involved with the issues of diffraction optics, optical information transformations, information arrays, etc. Later when I read the first publications about holography, I found them easy to understand because I had already assimilated this mathematical apparatus (...).'

The experience in *storage media* is another precondition for holography. In the jargon of physicists, 'storage media' refer to all physical agents that change their optical properties when exposed to light. The compounds of silver used in photography are a typical example of such a medium. Methodius got into the swing of this field in a way which proved to be bound up with microelectronics—*photolithography* is the method of making the fine contours of the plates and integrated circuits:

'In the mid-1960s microelectronics was taking its first steps in Bulgaria. There was a need for photosensitive materials with great resolution to be used for integrated circuit templates. A unit at RICRE was assigned this task (...) *I have been in photography since my school years. I was keen on development (of photographic plates⁷) and that is why I joined in the research work. I was more interested in development than in the emulsion itself.*'

Later when Methodius learnt about holography, it occurred to him that ‘these plates could provide a good basis for the production of a holographic plate’. Himself dealing mostly with emulsion development, he decided that ‘(...) for a start, the processing of the emulsion for microelectronics could be optimized for the purposes of holography.’

These two events in the biography of Methodius, his contribution to the accomplishment of two different and seemingly non-related research tasks made him ‘fit’ for holography: he had mastered the mathematical apparatus of diffraction optics as a basis for holography and had become familiar with high-resolution photo-sensitive materials. To put it in the words of his colleague:

‘Methodius already anticipated the path towards holography—coherent optics, acquaintance with refractive lens properties to produce Fourier transforms. His dream at the time was to use Fourier transformations in the analysis of optical systems. This is exactly what holography is in its core—analysis and synthesis of images, multiple application of Fourier transforms. We have encountered Fourier transform in 1959, with the Russian translation of Marechall & Franson’s book “Diffraction structure des images”, describing in detail the application of Fourier transformations in image analysis and synthesis. This book had enormous influence on us—it stimulated us to specialize in coherent optics.’

Consequently, when the first publications about holography appeared in the journals in the early 1960s, Methodius ‘became interested in holography and optical recording’. *Trivial as these words may be, they outline his path for the next 40 years—holography and coherent optics became his destiny.*

Aristotle's theory of action in the Latin and Byzantine tradition: Res against $\pi\rho\acute{\alpha}\gamma\mu\alpha$

The Byzantine philosophers preserved and developed a specific stand toward reality, which escaped the attention of modern philosophy and social science—reality is perceived as ‘active’ rather than as the substantial static character of things (‘the objective nature of objects’, as Latour named it). *Reality is acting and hence act-ual.* Hence the difference between the Latin *res* and the Greek $\pi\rho\acute{\alpha}\gamma\mu\alpha$. Both are translated as ‘something’, ‘object’, ‘thing’, but (in effect) are not unequivocally identical. While *res* suggests mainly objective or substantial detachment, *pragma* means above all ‘deed’, ‘some-

thing actual', 'active', 'exercising influence', 'achieved'. While *res* underlies a vision of a world based on static self-determination, *pragma* describes a world founded on dynamic interactions. The Aristotelian notions of δύνωμις and ἐνέργεια have been translated in the Latin tradition as *potentia* and *actus*, as well as *possibilitas* and *actualitas*, to designate the modality of being and are used in talking about categories. As 'potentiality' and 'actuality' they are at the fore in the table of the so-called 'modality categories'.

Strangely enough to this line of reasoning, in book 9 of the *Metaphysics* Aristotle refers to the triad of *essence* (οὐσία), *force* (δύνωμις) and *energy* (ἐνέργεια), stressing their difference from the categories.⁸ Everything which is in being and therefore has essence, possesses certain forces which can be reduced to only one capable of constantly being employed—the force of exercising influence and of undergoing influence. The influence of every force is called 'energy'/'action'. Aristotle distinguishes *two kinds of actions*. *The first* and more multitudinous kind comprises actions, which today we can call '*causal actions*', while Aristotle calls them simply '*movements*'. They are actions incited by a certain external cause, which cease when the cause is no longer there. They have a beginning and an end; they have a limit (πέρας). In relation to this Heidegger points out that

(...) The Greek 'ἔργον' has the same double sense in which we use the German *Arbeit* (work): (1) work as occupation, as when we say, for example, 'He didn't make the most of his working time'; (2) work as what is diligently worked upon and gained through work, as when we say, 'he does good work'. *Energies are the activities, the ways of working* (ἔργα in the first sense), *which are occupied with work* (ἔργον in the second sense): *the ways of being-at-work*. It is necessary to hear this double sense: precisely to be caught up in enactment and so to have something to produce. When we encounter [something] what moves, we speak of *forces* (δυνάμεις) and *activities* (ἐνέργεια), which are themselves related to movement, to the moving of what moves: κατά κίνησιν (Heidegger 1995, 41).

It is important to note that at this point Aristotle does not introduce any radical difference between the *movements* of humans, animals or physical bodies—they all have a beginning and an end, they have a limit (πέρας) and a cause, independently of whether this is an 'external' cause or an internal goal (τέλος) of the human actions that has initiated and guides them.⁹

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There exists, however, a *second kind of action: the energy qua energy* is called the manifestation of the essence and its force, which is bound to the last and supreme purpose of this essence. That is why Aristotle identifies this energy with the entelechy, the causal purpose, the form, with the existence and essence. This other kind are the *existential actions and for every concrete being the word is to be used in the singular*.¹⁰ It should be noted that the essence coincides with its essential energy in just one conditional aspect. *They are one and the same but essence carries energy*. For its part, energy is no essence, it belongs to essence: *it is its existential action. Energy is the existence of essence and its manifestation*. This type of energy can be defined as *existential*.

In his book on Eastern and Western interpretations of Aristotle, published in 2004, David Bradshaw provides comparison between two kinds of action, outlined by Aristotle and further developed in Byzantine philosophical tradition. The table below summarises the main differences between ‘causal’ and ‘existential’ action.

Table 1. Summary of the differences between the two Aristotelian kinds of action

Kinesis (<i>‘movements’, causal actions</i>)	Energeia (<i>existential actions</i>)
1. Has a termination.	1. Has no termination.
2. Is not an end, but for the sake of an end.	2. Is an end or has end within it.
3. Complete when it achieves what it aims at, i.e. during whole time or at final moment.	3. Complete at any moment because it does not lack anything which coming into being later will complete its form.
4. Must cease before perfect tense can apply.	4. Present and perfect tense apply simultaneously.
5. Has parts which are different in kind from one another and from the whole; the ‘whence’ and the ‘whither’ give them their form.	5. Homogeneous.
6. Occurs quickly or slowly.	6. Does not occur quickly or slowly.
7. In time.	7. In ‘the now’.

Source: Bradshaw, D. (2004), *Aristotle East and West*, Cambridge Univ. Press, 10.

When considering the comparison, it is important to stress that it is misleading to a certain extent since it analytically divides the two kinds of action, while *for every concrete and actually existing being they are carried out together, and not in isolation from one another*. It should also be noted that the existential energies might vary in their intensity (we don't mean the divine energies)—not only at different hypostases, but also at one and the same hypostasis according to the existential states and periods of the later. Also, when saying that existential actions (energies) are manifested in 'the now', i.e. the coincidence of past and present, *this does not mean that they cannot be studied over time*. We are tempted to say metaphorically that existential actions could be observed empirically rather as an 'index', as a surplus or a redundancy of the ongoing causal actions,¹¹ which could be attributed to given hypostasis (agency) in a reflexive stand 'after' the actions have been carried out.

Mediating essential energy: Hypostasis, perihoresis and hexis

Hypostasis is supreme, not nature?

Already the earliest Greek-speaking Christian philosophers emphasized the *difference between essence and its energies* to explain the unknowableness of the divine essence and at the same time the knowableness of God: God stands out in His energies. Creation is related to the latter, but not to God's essence. Energy is God Himself but not His essence. The fundament of these theological reflections is a basic premise of the Byzantine Christian philosophers, namely that the *essence of every thing is uncognizable in itself—what makes it cognizable is the manifestation of its own energy*. Developing this idea further, the Byzantine philosophers particularize the system of concepts.

The most important concept here is *hypostasis* (ὑπόστασις). The introduction of the concept in Christian philosophy is theologically based: it denotes 'three in one'—the persons of the Holy Trinity. Already the initial, far from precise, definitions of this concept signify something important: the common essence is no longer considered supreme and

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also, *essentialism in ancient Greece seems to take to personalism*. From then on, *hypostasis is supreme, not nature!* The more developed definition specifies that *'hypostasis' is what exists in itself and individually; at the same time, it is one essence in togetherness with properties* which distinguish the specific hypostasis from the other hypostases of the same nature (Maximus Confessor, *Epistulae*, Migne PG 91, 557D). Besides this, Maximus describes the hypostasis as an *acting subject* (ἐνεργῶν) (Maximus Confessor, *Opuscula theologica et polemica*, Migne PG 91, 205BC). He underlines especially the irreducibility of the hypostatic order to the natural (essential) one. *Every being has its hypostasis*. This means *every* being, be it animated or not. Everything self-existent (πρᾶγμα αὐθύπαρκτον) has a hypostasis which contains its essence and through which it manifests its energies.

Now it is clear that *the hypostasis* does not possess the natural energy partially or separately but *extrapolates it according to its hypostatic properties*. The character and intensity of this extrapolation depend on the way the hypostasis exists and *not* on the existence of nature. Because of this, the *hypostatic characteristics leave a strong imprint on the manifestation of energy*. Existential action of concrete hypostasis can be stronger or weaker, more dispersed or more concentrated; it can change its intensity and concentration in time.

Perihoresis: the hypostasis' acceptance of other natures while preserving their otherness; the importance of the body

At this point another important step was made. In addition to his *causal* (moved by contingent goals that have limits) and *existential* (as manifestation of his own nature) actions, *man in his hypostases is potentially able to accept the existential energies of other natures*. In its original form, this notion refers mainly to the essential energies of God, but the same principle can also be applied, we should say today, to the energies of every other non-human being.

The Orthodox tradition maintains that the God-blessed—the saints, are filled with divine natural energy and thus live the life of God Himself. This is their *deification* (θεώσις). The two spheres of cognition—

habitual human experience and immediate spiritual knowledge of God—are subordinates. The place where experiences gained through knowledge in both spheres should come together, get co-ordinated and act jointly is the body—*the body is the point in which the existential and causal energy of nature are held together*. At the same time, it is the abode of supernatural energies. The body is the absolute owner, co-ordinator and mediator of every human experience, both its own and the supernatural. The body keeps and conveys the energies to the world.

The tradition interprets the deification of the human body analogously with the deification of Christ’s body by force of the *periboresis* within the hypostatic union. Already at the dawn of Christianity, this term was used to denote the interaction between the human and the divine nature in the hypostatic union of Christ and later found universal application. The *periboresis* (περιχώρησις, interpenetration, *Durchdringung*) denotes the intercommunication and mutual penetration of the two natures together with their properties and energies. Yet, despite the interpenetration, *these natures preserve their otherness (Anderssein)*.¹² The term indicates that in the hypostatic union, human nature *is not absorbed* by the divine but enters in *συνεργία* (synergy, co-operation, *Mitwirkung*) with it.

The expression ‘ἀντίδοσις ιδιωμάτων’, exchange of properties, has the same meaning. It expresses the fact that the properties of the two natures are not simply attributed to the hypostasis. There is a real exchange between the natures and their properties and co-ordination between the human and the divine energies. In Christ’s hypostatic union, *there is asymmetry* in the interaction in which the divine nature is leading but *not* radically predominant over the human. Specifically, through its action deity makes human nature capable of penetrating through its proper energies into the divine.

The *periboresis* in man means that all available energies—the supernatural, as well as the existential and causal natural actions, are in a state of *συνεργία* (synergy, co-operation). It follows as a logical consequence that the body (and through it the human psychosomatic integrity), accepts and assimilates the actions (energies), which the other creatures—both humans and non-humans—originate. Once assimilated, these energies

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enter into synergism with the energies in the human body. Similarly, the human energies enter into synergism with the recipient human and non-human hypostases. It is important to note the asymmetry of these interactions, which results from the differences in the natures and the hypostases (see Tchalakov & Kapriev 2005, 414–416).

Box 2. Methodius' path to coherent optics—gaining yet more experience

Together with experiments and the understanding of the *physical properties* of the things under study, *computerized mathematical modelling* lies at the heart of work in holography and coherent optics in general. Here, too, RICRE was the nucleus of Methodius' experience in this field. Early in the 1960s, he familiarised himself with computers and realized their capacity to resolve research problems. He became one of the few physicists-researchers (and not engineers, professionally engaged in the designing of computer machinery), who were then aware of the important changes that computers necessitated in the organization of research:

'Today it may seem quite natural and a matter of course but in those years the problem for us, the physicists and chemists, was to define our task in a way that would involve a computer for its resolution. *Colour photography opened my eyes to the advantages of using a computer.* I took up colour photography while I was at secondary school. Selecting filters for the negative in the enlarger is something that really matters for a good colour photo. Photographers would do it by eye. In the early 1960s I went on a business trip to Czechoslovakia, where I visited a film studio and I saw that the technical parameters—transmission data, etc., had been input into a computer. So, filtration was computerized. Then and there I realized the potential of the computer. Since that time the computer has been my highly valued aide.'

Lasers are yet another of the premises for holography. So Methodius did not hesitate to leave RICRE to join the first laser research team in Bulgaria:

'In the mid-1960s my colleague G. K. was head of a laboratory at Sofia Technical University. When I was working at RICRE, he promised to buy a laser. He did buy one, a Soviet argon laser, if with a very low coherence length. But it *was the first laser in Bulgaria*, and we used it to record the first hologram in Bulgaria. It was not very clear but one could still recognise some sort of a screw (...).'

Hence, about 5 years after the invention of the laser, Methodius found himself standing beside the first imported laser and using it to record holograms! Although the work on the first holograms at the University lab was not successful, it was of exceptional importance for the future scientific path of Methodius.

Scientific circles in Bulgaria and in the Soviet Union at that time *firmly associated the name of Methodius with holography and optic technologies in general and did so for a long time*. In the mid-1960s lasers and holography emerged as one of the most neoteric fields of physics—the fact that there was a laser in Sofia and that the first hologram had been recorded, caused quite a stir and was widely discussed among scientific circles in the country.

Academician Angel Balevsky, chairman of the Bulgarian Academy of Sciences, recalled in his lifetime:

‘I heard about optical recording a long time ago. It was again Methodius who told me about it. He was working at Sofia Technical University at that time (...) some kind of recording in crystals. I went to see what it was all about. And he explained to me that when recorded in a crystal, one and the same image could be reproduced entirely from every single point of the recording and each point would hold the whole information contained in the image, though from a given perspective. After that he came to the Academy of Sciences and what followed was something I would define as explosive (...). In a way, suddenly hopes went high that an external memory for computing machinery could thus be designed. Already at that time *he proved he could enter crystals and put information in them*. I guess, at the time he was one of the few scientists, if not the only one, who had become highly proficient in this field. This gave him the courage to get down to work on the external holographic memory.’

The Deputy Minister of the then newly founded Ministry of Electronics also visited the laboratory and invited Methodius to join his advisory group as an expert in photolithography and optical methods. The same group that drafted the first ‘Complex program for the development of electronics in Bulgaria’. The participation in this group familiarized Methodius with an agency as important as lasers, computers, storage media and the Fourier analysis—the *modern methods of planning*, special statistical techniques for optimization *called D-plans*. They were discovered in the USA in the early 1950s and used in nuclear and missile weapons design. They made it possible to set the target after several shots only, or to specify the area in which the results could be expected after a couple of experiments only, etc. The D-plans accelerated the work and decreased the expenses in research. The Soviet mathematicians led by Kolmogorov rediscovered D-plans a few years later. Thereby these methods were gradually declassified, but at the time when Methodius became familiar with them, they were seldom used and difficult to apply.

Methodius and 'deep-relief lenses', or a story of dedication and endurance

In our previous paper on the topic we developed the opposition between 'entrepreneurial' and 'other' sciences and defined the latter as based on specific inter-corporeal relationships of 'coupling, unity and sharing' between human and (still timid and inconclusive) non-human agents that make the scientist sensible to the *invisible* and *silence* in the habitual application of given research methods and in habitual research practice in general. (Tchalakov & Kapriev 2005; see also Tchalakov 2004). These are relationships that last for many years and often are the only point of support enabling the human agent to bear the harsh pressure of other human agencies aiming to dissolve this unity, these agencies being fed by their firm conviction that the other part of the couple, the non-human agent, is simply *non-existent*. Although in the framework of actor-network theory any 'translation', any outcome of the 'trial of strength' could be questioned again and again and new orders might emerge, we should admit some *internal temporality of translation*, or to put it differently—'*every battle has a proper duration*'. Some battles are resolved with a single strike, while others might be settled as a relatively stable state of lasting tensions, attacks and counterattacks, often with no final victory at all. In the first paper cited at the top of this paragraph, we provided two such examples, where after many years of endurance the researchers proved their claims and eventually got the recognition of the scientific community. It is important to stress, however, that the same could be true for less successful cases, where recognition never came, where scientists finally gave up in despair, or were kicked out of their laboratories, or disappeared in the GULAG prison camps, etc. So we would like to fix the *phenomenon of endurance*, of inability to follow the 'scientific common sense' arguments (even if they are lined with solid evidences and mathematical formulae) and to resist the corresponding pressure on human actors, and then to ask: what is the benefit Byzantine philosophy's *implicit theory of action* could provide in studying such phenomena.

It the *Appendix* we present a renewed account of some empirical findings at a Bulgarian holographic laboratory discussed earlier (Tchalakov 2001; 2004). This is the story of Bulgarian physicist Methodius and his wife

Rossitza and the difficulties they encountered during their research in a new field many of their colleagues believed futile and nonexistent, and even to be in contradiction with 'the classical laws of physics'.

We could perfectly analyze this story in the framework of actor-network theory and describe the trajectory of the two scientists as simultaneously crossing (or balancing between) several distinct lines of interaction with other agencies: the relationships and tensions among the members of their small team, the growing pressure from the other lab colleagues, the changing status of science in Bulgaria and the rapid decline of research funding and standards of living in general, the suppliers of far from perfect computer programs, the search for suitable equipment, and growing difficulties in the supply of consumables, in publishing research results, etc.¹³

In another vein, we could analyze Methodius and Rossitza's actions according to their modes of coordination, to the various regimes of engagement¹⁴ they are simultaneously immersed in—the *familiar world* of the laboratory, which, with the advancement of research gradually loses its inherent meanings, its completeness and functionality: the old mathematical formulae for diffractive and refractive lenses became pointless, computer programs inappropriate, lab facilities that 'do not come in handy'. But also in the *regime of justification* during the power games with the upper echelons of the hierarchy (the lab director, the Academy Board, the newly established National Research Fund), as well as inside their small team, when Methodius failed to justify their research program to his younger collaborators.

Yet our focus is not on the unfolding actor-network in holographic research, but on one specific aspect of it—Methodius' and Rossitza's work during the tough period between the end of 1990 and early 1997, when eventually two of their articles were accepted by the US *Journal of Modern Optics*. It is our claim that in studying their activities during that period, accounting simply for their 'causal actions' and related actor-networks is not enough and cannot fully explain their success. Framing our data in terms of *energies, of their existential actions* could help to reveal some underestimated aspects of actions that had taken place, and open ourselves to new, hitherto neglected sources of data. But what should be the empirically observable evidence about the presumed 'duality' of their actions? —Two arguments have to be taken into account.

First, we have to admit the possibility of an existential action ‘alongside’, ‘throughout’, or ‘in addition to’ the well-known causal action. Heidegger rightly insists: *energeia*—ἐπί πλέον, extends further, and he adds: ‘this cannot then mean that outside the circle of what moves [the ‘causal’ actions the social sciences only know—I. Tch., G. K.] we would find still other forces and activities as well’ (Heidegger 1995, 41). It is a well known fact that what we observe is directly related to our research equipment—hence the insistence of actor-network theory on being ‘infra-theory’, i.e. the lowest possible interference in the field of study maintaining the critical distance from (and allowing the expression of) the studied agencies, and enabling researchers to follow agencies’ chains of translations (Latour 1993). So to observe the actions ‘extended further’ we need to design and calibrate the corresponding instruments that are able to identify the existential actions alongside the ongoing causal actions.

Second, in searching for relevant tools of observation we should keep in mind that the ‘ontological’ assumption about two types of actions is still too general and abstract—if we agree with the Byzantine scholars that *the essence of everything is uncognizable in itself* and that it is accessible to knowledge only through *manifestation of its own energies*. We therefore need to consider the orderly system of concepts they have developed when analysing God’s and human energies: *hypostasis* (ὑπόστασις)—*perihoresis* (περιχώρησις)—*hexeis* (ἕξεις), and which mediates between the abstract ontological assumption and empirically observable phenomena.

Outrunning the course of our analysis, we could ‘translate’ the ANT semiotic notion of *actant* (or ‘acting agency’) as a specific *hypostasis* (as existence of given nature, or in which more than one natures exist in perihoresis). In turn, the actions of a given hypostasis are always mediated by its ‘stable inner states’ (*hexeis*). In humans, the hexeis are eventual results of voluntary activity and (collective) practice and as such they ‘filter’ the hypostatic energies. Hence, when studying an actor-network and the agencies / hypostases involved, *it is not the immediate manifestation of pure essential energies that is observed, but rather the mediated and ‘framed’ energies*. We will consider this process of mediation in greater detail below and then will continue with the case of the ‘deep relief lens’.

Hexeis: The hypostasis' stable inner states

The differences in the existential actions (energies) carried out by the specific hypostases are explained by the introduction of another category of Aristotle—*hexis* (ἕξις). It defines the personal, or rather, the *hypostatic* factor in the direction and definiteness of the actions. In the Byzantine tradition, the *hexis* (ἕξις) is understood mainly as an 'inner personal state' as opposed to 'θέσις', translated as 'emplacement' or 'position'. The latter concept belongs to the order of concepts describing the nature and refers to the natural ordering (fixation, standardization) of the being.

In his *Categories*, Aristotle defines the ἕξις / *hexis* as an accidental form that characterises the existing (being) by its stable and lasting attributes. He distinguishes ἕξις / *hexis* from 'διάθεσις' / *diathesis*, also translated as *disposition*, and referring to the *less stable* attributes that are easy to remove and to change. The *stable inner states* (*hexeis*) can also be considered as dispositions, while the reverse is not true. What possesses a certain stable attribute also possesses a certain disposition, while what exists in a given disposition does not obligatorily manifest a certain stable attribute. Yet, it is possible [over time] for a given disposition to settle in the nature of the thing and to become a stable attribute, a *hexis*. *The leading examples are knowledge and (moral) virtues*. Aristotle insists that knowledge, even acquired at some limited level, is something that lasts and that is difficult to eliminate from the soul, provided the latter is not influenced by some other events such as diseases, etc. He stresses that those who are less advanced in their knowledge and are easily influenced by the opinion of others can be said to have failed to achieve this given quality as a stable attribute, although they are open to knowledge to a certain extent. Aristotle distinguishes two types of attributes as 'stable inner states'—some are *present from birth*, and some are *assumed during life* (Aristotle, *Categories*, VIII, 825–828).

Maximus Confessor¹⁵ decidedly introduced this topic into Byzantine philosophy, relating *hexis* with the triad of *essence* (οὐσία), *force* (δύναμις) and *energy* (ἐνέργεια). Here, too, the *hexis* is taken neither as something against nature, nor as something natural, but rather as actualisation of some 'virtual' stand. It takes a specific mediating position and is defined by a certain potentiality.

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Maximus frames the principles of being in a very personal, hypostatic perspective. He defines hexis as ‘constitutive characteristics’ (συστατικὴ ιδιότης),¹⁶ which stays in stable relations with the concept of *energy* and is used in the context of the triad ‘εἶναι—εὖ εἶναι—ἀεὶ εἶναι’ (being—good being—eternal being), i.e. in the contexts of the being’s dynamic structure he unfolds. He considers these ‘stable inner states’ as pillars of self-determination, where *hexis* directly associates with what is realized in the time process¹⁷ and is related with the way of life (τρόπος ζωῆς). Thereby he stresses the relation of hexeis not with the principle of nature, but *with the manner the natural forces are used in the framework of a given way of life*.

The *hexeis*, the ‘stable inner states’ are described by Maximus as *mediators* between *forces* and *energies*—they mediate between intention and realization, between theory and practice, between internal and external, they provide the corresponding hypostatic determination of natural energies while invariably operating at the level of potentiality. The hexeis rather add the specific definiteness of being in the *tropes* (tropoi) of its dynamics, hence they are taken as a fundamental demonstration of human freedom. Indeed, both the forces and energies are natural, but they are defined and specified hypostatically via the ‘filter’ of the stable inner states, the hexeis. By personification of his natural energies a man becomes responsible for the constitution of his own being. In a number of cases Maximus is prone to accept that there are some grounds for the assumption that the human hexeis are given by birth, but nevertheless he considers the hexeis in their final presence as resulting from *human practice* and voluntary activity.¹⁸

The existential actions in science (and any other specialized activity of humans)

Presenting the case of Methodius, Rossitza and ‘deep relief lenses’ (see the *Appendix*), we are asking the question: *Is the study of their causal actions sufficient to reveal the solid ground of their resistance to the following factors?*

- well-grounded criticism of their colleagues concerning basic claims of their study;
- the resistance of the ‘deep relief lenses’ to being translated into theoretical and mathematical models the two researchers were developing, and lasting uncertainty about their essential properties, which the existing laboratory equipment could not reveal adequately;¹⁹
- the institutional pressure to redirect their research towards more lucrative areas;
- direct charges of irresponsibility, coming from their younger collaborators;
- the overall consequences resulting from the deep economic crisis in the country, which seriously reduced the available resources—both for research (attending the conference on Optical Computing in Salt Lake City, US, was simply unthinkable, the supply of scientific literature, consumables, etc., became irregular) and for maintaining the normal standard of living of their two young daughters.

It is still possible to try to answer the above question by causal (including actor-network) analysis—i.e. an analysis limited only to the level of ‘movements’, the ‘causal actions’. For example, one could say that after coming under the critical fire of Russian mathematicians and their lab colleagues, the two researchers found new powerful (if distant) allies among their Japanese and US colleagues.²⁰ Hence Methodius was being gradually marginalized in his own laboratory and called ‘the-man-who-has-taught-us-many-things-in-science’, or ‘the-man-who-could-not-be-trusted’, but at the same time he constituted himself in a quite different way for the scientists who attended the Kobe conference—as a ‘man-with-strong-impact-on-researchers-in-Japan’ and who would be conducive to ‘perestroika’ in the USA and to the declassification of the work of Morris.

Proceeding along this path, we could identify another important ally of the direction of research Methodius and Rossitza pursued—the magic mirrors. These ancient artefacts—with their tacit and enigmatic, but steady presence of accomplished facts—confirmed the possibility of

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white light non-refractive optical processing. But they too were open to various interpretations. Being unable to achieve convincing theoretical and experimental results, the two researchers could face a situation when instead of ‘proof’, the magic mirrors might strengthen the disbelief of their colleagues. Thus in the light of the ‘unshakable’ mathematical evidence produced by Prof. Bobrov, the ‘magic mirrors’ arguments raised little more than a giggle of fun among the fellow scientists in the lab.

Still at the level of ‘causal’ actions, we could identify the ‘deep relief lenses’ as yet another ally. Timid and evasive, they nevertheless ‘responded’ to the researchers. And this happened early enough. When one of us once asked Rossitza what made them resistant to the criticisms of their colleagues (including mathematical proof that their ideas are groundless), she replied:

On the eve of our visit to Kobe we made an experimental deep-relief lens using bi-chromated gelatine and *we saw* that this behaved according to the theory. I personally calculated the formulae for these lenses using ‘Reduce®’ software (a predecessor of ‘Mathematica®’, working on an XT computer). They had been published lately to be as clear as possible for optical scientists (...). But when prior to this, Prof. Bobrov wrote us this letter proving mathematically that from the point of view of diffraction optics such lenses are impossible, Methodius hesitated—we had possibly made a mistake somewhere along the line? However, I was completely positive about our results, not only because I had done the calculations, but *because I had already seen that our lens—although it was not perfect and had a lot of ‘noise’—gives a white focus when directed to the sun, unlike diffraction lenses, which give a rainbow focus. No one could convince me that what I have seen with my own eyes is nonexistent*’ (from the interview).

So it is true that Methodius and Rossitza were not completely ‘alone and ousted’, as we stated in the *Appendix*—they were an actor-network, they had allies they had enrolled to a certain extent and which provided their strength to the actor-network. Yet we will continue to ask: *was this enough to explain their ability to endure the hardship of carrying out their research for more than five years?*

True, they aroused the interest and gained recognition from their colleagues in Japan and the USA, but soon after their return from Kobe these relationships were ‘on hold’—Internet was not available yet, they

had no money to travel, journals arrived irregularly, and for a few years even the postage money for international mail became scarce (this also had to be paid from their own pocket). So these allies were temporarily 'passive'—they would probably support Methodius' work provided he was able to elaborate the theory and to offer convincing enough mathematical and experimental proofs. However, by 1990 these were still to come.²¹ Instead, the suspicious and distrustful colleagues in the lab were around them everyday, repeating the arguments of Bobrov's mathematical model, as a young PhD student in Methodius' group recounts:

(...) I worked on physical and mathematical modelling in the project, while the other younger colleague was designing computer software (...). At one point I stopped using the term 'synphase optics' and Methodius took this badly. I was positive that we were working on high order diffraction elements—this is how leading Russian scientists defined our work. All this became clear enough when Bobrov sent us his analytical report with equations—till then we used integrated digital methods only, not analytical ones. And according to his analytical calculations in the focal plane it became apparent that Methodius' claims were groundless. Hence the results we had obtained proved to be banal and already well known (...). That is how we came to see that 'there is nothing new under the sun', that our work was senseless and, together with the software designer, I decided to withdraw. Methodius said the Russian colleague is incorrect and began to search for other solutions (from the interview).

This is the outline of the situation in Methodius' group by the end of 1990—at a time when neither a theory nor mathematical apparatus had been developed. Even more, it appeared initially that their research had taken a wrong direction. The progress made was slow, the shortages and scarcities grew. The foreign allies were 'far away', while the distrust and hostility of the colleagues in the lab was mounting.

Instead of giving up, the two researchers decided to launch new experiments, aiming to produce another version of 'deep relief lenses' with ion lithography on glass. Having no funding, they paid the expenses from their own savings. True, they were helped by some old friends, and paid only the overhead, but still they also had to cover their 500 km travel to the Black Sea town where the facilities were located. To meet the costs Rossitza found additional work as an interpreter, and Methodius did

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commercial mathematical calculations for some new private firms, while at the same time they both continued their work on theory and mathematical modelling.

Box 3. Methodius—a scientist in coherent optics

The two boxes above provided a short outline of the initial periods of Methodius' research biography. Even without describing his work and experience gained during the next two decades of research at CLOSPI—the unique holographic lab he established and of which he became the first director in 1974, the reader already understands that by the end of his stay at RICRE, after more than 15 years in photography, photochemistry and diffraction optics, backed by his training in theoretical physics and Fourier analysis, he has emerged as a scientist in a specific *hypostasis* and specific *bexeis*, manifested in his research approach to the problems he studied. The short statements of his colleagues: Paul (an old friend from the University and RICRE) and Clement (his last PhD student from the 'deep relief lenses' project) provide some hints to this 'existential' layer of Methodius' actions:

Paul: 'In the 1960s we wrote a number of reports together with Methodius, sending them up the scientific hierarchies—mostly forecasts about the future of optical methods in electronics. They proved true, if difficult to implement in Bulgaria. But this was his style—something which was to appear 30 years later in Japan, he wrote that this would appear within 5 years in Bulgaria. In other respects Methodius was able to foresee the perspectives for developments earlier than many top scientists. I will tell you this: Methodius is a suitable candidate for the 5th floor at IBM, going to work twice a week with an input of ideas for the lower floors to elaborate (...). He is a passionate researcher, but at the very moment he reaches clarity about the feasibility in principle of what he is studying, he loses interest. As a physicist he has always neglected technology, the practical implementation of his results (...). This is one of the reasons he easily takes on commitments, but rarely fulfils them to the very end.

(...) He does not like reading too much—he believes when you read too much you become involved in other people's ideas and you lose your own original ideas. That is why he has 'reinvented the bicycle' several times. But there is a proverb: "If Einstein had read Poincare, he would never have arrived at his equations!" So I am not certain if this is a weakness of Methodius or not (...).'

Clement: '(...) Thanks to Methodius I deepened my knowledge and experience in many areas. The end result was negative (...) but I have learned so much

with him! He is full of ideas, he thinks so fast (...). Perhaps that is why it is so difficult to work together with people like him, not easy at all.'

Instead of a conclusion

In trying to understand the behaviour of Methodius and Rossitza, should we—as sociologists—give up too and define it as a case of 'obsession', or use some similar kind of psychological explanation? Is it not possible to join the Byzantine orthodox scholars and to say that this behaviour was a manifestation of their specific energies, of their existential 'living in research'? Was it an outcome of *periboresis*, their existence being modified by their lasting 'optic life' in which they have assumed the specific 'energies' of light, of recording media, of technical apparatuses they have been working with for so many years? And which settled as 'stable inner states' of theirs, as specific *hexeis*?²²

Let us look at the last statement with which Rossitza ended her answer above: '*No one could convince me that what I have seen with my own eyes is nonexistent!*' To see with 'your own eyes'—we know that 'seeing', just as 'understanding' and 'observation', is heavily dependent on equipment and the position of the 'eye'. It is worth comparing Rossitza's statement with the statement of another experienced colleague in the lab:

(...) One has to know the material very well. One should measure almost everything possible in order to be able to establish relationships. Otherwise no conclusion can be reached as to whether there is an effect or a defect—whether what one is looking at is caused by vibrations or by other well-known things (...). Or on the other hand if there is something really new here (...). In our field a newcomer [young scientist] needs an introductory period before he enters real research work. [He needs] *to touch* the crystals, *to see* what will happen under various conditions, *to record*, *to delete*, *to light up*, *to apply a magnetic field*, *to read* what has been recorded, *to analyze* the crystallographic orientations, *to calculate* a bit and hence to try seeing the vectors.²³ Because all of these effects are tensors in their nature, they depend on the vector of the light wave. So he/she needs to know in advance all these things, in order to be able to interpret the phenomena correctly²⁴ (from an interview with Margarita, CLOSPI, 1994).

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When Rossitza says ‘my eyes’, this does not mean ‘naked eyes’ in the sense of a virgin and unbiased gaze, but rather ‘enlightened eyes’, eyes taught to see after many years of both theoretical and practical experience. Seeing, according to Aristotle, was one of the existential actions, but to see ‘what you are actually seeing’ is another issue, it is *seeing modified by perihoresis and framed by specific hexis*.

It is our general inference that Methodius’ fierce disagreement with Bobrov and his colleagues, his inability to succumb to ‘scientific common sense’, and his persistence to dig unrelentingly both in theory and experiments in search of his ‘deep relief lenses’ have the same source. They stemmed from his *perihoresis* with humans and other strange entities inhabiting the realm of coherent optics he entered some 40 years ago—a perihoresis, out of which *his hexeis of experimental scientists and holographic researchers* has settled.

We will leave the problem of research methodology—how to identify the empirical evidence behind such claims during fieldwork—for further elaboration since this exceeds the limits of our paper. Yet juxtaposition of the *Appendix*, provided at the end of the paper, with the Boxes 1–3 above could be interpreted as a description (if rather general) of how Methodius ‘infested’ (the term his school friend and colleague used) the fields of coherent optics and photochemistry. In the course of this infestation a number of agencies have left their traces on Methodius’ body: storage media, Fourier transforms, computers, lasers, special techniques for statistical optimisation called D-planning, etc. They ‘entered’ Methodius via numerous mediators such as other people, books, and software—via ‘patches’ of the ‘small intellectual technologies’ Bruno Latour writes about in one of his latest book when citing Marcel Mauss’ definition of ‘habitus’ (Latour 2005, 210–213).²⁵

Appendix

The story about ‘deep relief lenses’

Methodius is a Bulgarian physicist who in the early 1970s gained popularity in the international community by designing an efficient medium for recording micro-holograms. A few years later he was appointed

director of a new research laboratory designing holographic optical memories for computers. In the mid-1980s, after a decade of intensive research, the dreams of holographic storage had slowly faded away. But at that time Methodius was already working on the new problem of finding out what was in the 'gap between the wave and the corpuscular nature of light'.

He was inspired by the earlier works on holographic memory, when his team ran into difficulties intrinsic to the very nature of linear and diffraction optics. Would it be possible to create an optical element combining the advantages and avoiding the shortcomings of both? He browsed through related studies but found nothing. Then he discussed the matter with a prominent Russian scientist and he told him that there was neither a theory, nor did he know how this could be practically approached. Later Methodius came across an article on old bronze mirrors known as 'magic mirrors'. Roentgen analysis has revealed that on their back surface the ancient masters had engraved a likeness of Buddha or of some other deity with a relief of 10–15 micrometers. These mirrors appeared rather sophisticated optical correlation devices—as soon as one focused a sunbeam on the wall, the image of Buddha could be seen on the light spot, but in the case of sunspots, atmospheric changes, etc., the image of Buddha would change, and the ancient people used it to predict their future. These long forgotten skills of working with sunlight increased Methodius' conviction that there could be something in the gap between diffraction and refraction optics. Together with his wife Rossitza (researcher in the same laboratory) they plunged into the new realm dubbed 'in-phase optics' and stayed there for 10 years.

In 1988, they established an autonomous working group in the lab, working on a 'deep relief lens'—an as yet unknown physical entity combining the best features of both refraction and diffraction optics. A single lens of this kind was supposed to do the job of a complex optical system. The first preliminary results of their work were reported in the spring of 1990 at the International Meeting on Optical Computing, held in Kobe, Japan, and raised significant interest (see endnote 20).

However, after these initial successes things went wrong—a renowned Russian scientist from Saint Petersburg refuted the basic proposition after reviewing their results.

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After the mathematically proven unfeasibility of the project the team broke up simply because some of the humans realized that the non-human agents they had been trying to ‘discipline’ were actually non-existent. Methodius was accused of being ‘irresponsible’ by his younger collaborators for giving priority to this (yet) unborn non-human entity, the deep-relief lens. Being a prominent researcher, they claimed, he was ‘responsible for his people’ and must use his reputation to secure profitable, if applied, projects that would help the scientists to survive. It was in the early 1990s, when government spending for science decreased almost 10 times and the average salary of researchers approached \$150, causing a massive brain drain. If Methodius agreed to follow these demands, he had to abandon the ‘deep relief lenses’, to desert them, and to withdraw his ‘responsibility’.

The other colleagues in the lab also lost their faith. Methodius’ reputation as a founding father and outstanding scientist was shaken. He and Rossitza soon found themselves alone and ‘ousted’. However, regardless of their colleagues’ skepticism and the uncompromising mathematical evidence against them, they continued their work at the price of stringent hardships. They used the lab instruments to make the first models of the deep relief lens from bichromatic gelatin plates, then gained access to the secret military institute and produced new lenses through ion lithography on glass, paying the costs out of their own pocket This standstill lasted for six years until 1997, when their final results were published in the *Journal of Modern Optics*. Prior to that, in late 1996, other colleagues working in the same field published their results at a conference in the USA. Methodius and Rossitza gradually regained their popularity among the colleagues.

Notes

- ¹ Earlier version of the paper was presented at the Workshop ‘Expérimenter, éprouver, assembler’, held on 27–28 September 2007, CSI, Ecole des Mines, Paris.
- ² See Tchalakov & Kapriev (2005).
- ³ And hence has its roots in ancient theatre (and jurisprudence).
- ⁴ See Bourdieu and Wacquant (1991, ch. 1, p. 3); Bourdieu (1987, part 1); Latour (2005, 210–211).

- 5 Because of this, the metaphysical ideas presented in this paper could in no way be inscribed in the last century 'essentialism – existentialism' debate, initiated and developed by the representatives of Thomism.
- 6 'In Russia the best specialists in holography are graduates of the Moscow Institute of Aviation. They are neither physicists nor chemists, but they are well grounded in the Fourier transformations' (physicist at the lab).
- 7 'Development' is a technical term in photography describing the consecutive chemical treatment processes on the plate after it has been exposed to light.
- 8 '(...) Translated with *actus* the specific Greek meaning of *energeia* is completely lost in Latin, and later in the scholastic tradition and new European philosophy. As specific concept it reappeared in the West rather lately, first in "nature-philosophy" and natural sciences, although categories similar to *energeia* played some role in some philosophers like Leibniz. It is only in the last century when the role of categories, related with *energeia*—such as *will, aspiration, desire (wanting), existence, etc.*—increased substantially. But the notion of *energeia* itself is still not used in humanities and social science—with the only exception of late Heidegger, which devoted special course on IX book of Aristotle's *Metaphysics*, where the concept of *energeia* plays central role' (Horujii 2000, part III, 1). On difficulties in philosophical acceptance of Aristotle in the Western tradition see also Bradshaw (2004), and Tchalakov and Kapriev (2005, 412–413).
- 9 A brief reference to Heidegger clarifies the grounds of Aristotle reasoning: '(...) in the concept of δύναμις κατὰ κίνησιν there is also a reference to τέλος which inheres in its very constitution. *This does not mean anything like "purposeful behaviour"* (italics ours), but rather: an inner ordering of something towards an end, a conclusion, an accomplishment' (Heidegger 1995, 85). When he discusses 'what [according to the Greeks] it signifies that man has a relation with what he produces' (and, as he says, 'not in order to correct Marx'), he again refers to τέλος: '(...) What is produced, what is intended for production, is the έργον (ergon, deed). This does not result arbitrarily and by chance from any work or activity whatsoever (...). Indeed, how the work is to appear, its outward appearance must be seen in the production and for it. The outward appearance, είδος (eidos), is already seen in advance (...). In the είδος of the έργον, its being-at-an-end—the ends, which it encloses—is in advance already anticipated. *The είδος of the έργον is τέλος* (italics ours). The end that finishes, however, is in its essence, boundary, πέρας. To produce something is in itself to forge something into its boundaries (...). Every work is in its essence "exclusive" (a fact for which we barbarians for a long time now lack the facility)' (ibid. 118).

- ¹⁰ Heidegger strongly disagrees with the translation of δύναμις and ἐνέργεια as *possibilitas* and *actualitas* and appeals for re-establishing their original meaning: *force* and *energy*. Yet he is not clear enough in his interpretation of Aristotle's dual meaning of energy: '(...) We speak of activities in the *plural* (ἐνέργειαι): there are many kinds of such forces and activities which indeed correspond to the many kinds of beings that move and which like these beings are also present (...). But over and against these present activities there is ἐπί πλέον: ἡ ἐνέργεια—the ἐνέργεια in the singular, stated simply and understood singularly, uniquely. We translate ἐπί πλέον: the ἐνέργεια, taken singularly, extend "further". This means: over a broader realm. And yet this cannot then mean that outside the circle of what moves we would find still other forces and activities as well. Instead, the ἐνέργεια in the singular means a πλέον in the sense of something "higher" and "more essential"' (Heidegger 1995, 41; see also Tchalakov and Kapriev 2005, 109–110).
- ¹¹ Aristotle provides a hint about the 'embedding' of the two kinds of actions, referring to the simultaneity of [the process of] seeing and what is being seen or happiness and having been happy—according to Aristotle, 'happiness' is exactly existential action and *not* a state, as the English translations suggests: *'The action which contains a goal in itself is a deed* (πράξις) [transl. ours – I. Tch., G. K.] (...). When I am seeing, I also, and at the same time, have seen; when I am minded I also, and at the same time, have been minded; when I am engaged in intuition, I also, and at the same time, have been so engaged. On the other hand, when I am learning, I am not also, and at the same time, in the state of having learned; when I am recovering my health, I am not also, and at the same time, in the state of having done so. Prosperity and having prospered are simultaneous, as are happiness and having been happy. Were this not so, it would be necessary for the relevant carrying-on to cease at some point, as is the case with thinking. In fact, this is not the case. *Rather, when one is living (in whatever manner), then one has already lived.* Given this discrimination of procedures, one lot are to be labelled processes (movements – kinesis – I. Tch., G. K.), the other *activities* (*energeia*). All *processes are incomplete*, e.g. attenuation, learning, walking and building, which are both processes and incomplete procedures (...). By contrast, it is the same thing that has seen and that is seeing, that has and that has had, intuition. And our word for procedures of this latter kind is *activity* (*energeia*), for those of the former kind *process* (kinesis)' (Hugh Lawson-Tancred transl. of Aristotle's *Metaphysics*, Book 9, chapter 6, 1048b, 18–30).
- ¹² Cf. e.g. Maximus Confessor, *Ambigua ad Thomam*, 5; *Opuscula theologica et polemica*, 16; *Disputatio cum Pyrrho*, in Migne PG 91, 1053B; 208AB; 337CD.
- ¹³ An attempt at ANT analysis of the research at the holographic lab established by Methodius was made in Tchalakov (1998).

- ¹⁴ See Thévenot (2006). For an attempt to apply Thévenot's approach to the case of the holographic lab in Bulgaria see www.ifz.tugraz.at/index_en.php/filemanager/download/226/ws130303_TchalakovPaper.pdf.
- ¹⁵ More on Maximus' doctrine of hexeis can be found in the detailed analyses of P. G. Renczes, *Agir de Dieu et liberté de l'homme*, Paris 2003, 18–19, 192–372.
- ¹⁶ Disputatio cum Pyrrho, in Migne PG 91, 352A.
- ¹⁷ Disputatio cum Pyrrho, in Migne PG 91, 324D–325A.
- ¹⁸ In the *Metaphysics*, Aristotle also relates this topic to his doctrines of forces and energies. Interpreting the way energy precedes force in time, he draws our attention to the fact that δυνάμει are preceded by other things that put it in motion, the first of which is always ἐνέργεια. Man originates from man, *the educated man from educated man*. That is why he believes one cannot be a builder without building anything, or be guitarist without ever having played the guitar—those who learn to play guitar are doing this by actually playing guitar, and the same is valid for the other cases. It is true that the student does not completely master the knowledge, but nevertheless he has to possess some knowledge, since something of what has emerged had already been emerged and, in general, something put in motion had already been in motion. Energy precedes δύναμις (force) both by origin and by time (Aristotle, *Metaphysics*, IX, 8, 1049b17–1050a2).
- ¹⁹ It appeared that, unlike classical refractive and diffractive lenses, the new lenses behaved unpredictably with every new material used for their fabrication.
- ²⁰ Upon their arrival back in Sofia, Methodius and Rossitza received two letters. In the first one Prof. Ichioka, the president of the conference, stated that '(...) we have learned much from your excellent presentation and have benefited greatly from the many discussions we have had with you. I am looking forward to seeing you in Salt Lake City.' In the other letter, Dr. Yoshikaza Hori, a leading researcher at Matsushita E.I.Co., added: 'Your idea of a magic mirror and its applicability to optical computing has had a strong impact on researchers in Japan and the world and is highly evaluated (...). When you have a chance to come to Japan, please visit our research lab of Matsushita Co.'

Methodius also remembered that after delivering the report, Prof. Coulfield from the University of Alabama in Huntsville came to him and asked whether he was familiar with the studies of Dr. Morris: 'I answered that I had not even heard of him. Then he said he could not be known because Morris' studies had been kept secret for many years. Prof. Coulfield, using the Russian word, expressed his hope that my work would lead to 'perestroika' in the USA and that the studies of Morris would be finally declassified' (from an interview with Methodius and letters from Japan).

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- 21 We should not forget that instead of allies, Japan and US colleagues might also be considered as competitors, carrying out their own research according to the path Methodius and Rossitza have outlined.
- 22 One should keep in mind that they were ‘alone’, but not literally alone—because they are *two*, knitted together by their *love* and *trust* to each other. Two phenomena, which according to Byzantine scholars also fall under the heading of ‘existential’ actions—and not under the heading of ‘states’, as the moderns would say. This certainly was by itself an important point of support—similarly to the communion with their unborn, but already responding, ‘deep relief lenses’. Referring to our previous paper, we should mention that the cytologist Barbara McClintock, the hero of Evelyn Fox-Keller’s book, was left with her only ‘love’ and ‘trust’—with her maize plants and their chromosomes, and this lasted more than 20 years (Fox-Keller 1983). In this context, Latour’s famous metaphor of Pasteur’s microbiologization gains another meaning—as evidence of the *perihoresis* between human and non-human natures.
- 23 Please pay attention to the abundance of infinitive verbal forms, an indicator of the genuinely sensory, bodily character of her relationship with the non-human agent she was studying.
- 24 Yet we should not underestimate the fundamental power of seeing: ‘The most fascinating in optics is that you are seeing so much. That is why I chose optics after the university’ (from interview with a German physicist).
- 25 Is it at random that *habituses*—although remaining at the level of ‘causal’ actions—seemingly refer to the same phenomena Byzantine scholars called *hexeis*? In the literature, the two concepts are justly considered identical, since the later is a Latinized version of the first. True, Pierre Bourdieu distinguishes between ‘linguistic habitus’ and ‘corporeal hexis’ (Bourdieu 1982, 83–95), but in his later writings he agrees on their sameness in principle. Yet there is an important difference in the nuances of the two concepts, provoked by the Latin and Greek cultural milieus (or ‘forms of life’) they had been used in. In the Greek context *hexis* refers to the ‘stable inner state’ mediating between force (δύναμις) and energy (ἐνέργεια), hence related to both kinds of energies—to the energies in the proper sense and to the ‘movements’. In the Latin context, however, *habitus* appears much closer to the domain of causal movements and to the attributes of the substance, since it characterizes something in the world in its reference to the other things and in its positioning at some established order.

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