If Bošković had not been a Jesuit: On the relationship between religious culture and scientific creativity

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The idea for this presentation came after reading a brief description of Ruđer Bošković's contribution to modern physics written by Ivan Supek in his work *Filozofija, znanost i humanizam*[1]. In this description, whose general tone is very positive towards Bošković as a scientist, it is suggested that the fact that he was a Jesuit probably had a detrimental influence on his scientific creativity[2]. More precisely, it is argued that his education did not provide him with the necessary tools of modern scientific investigation[3].

Related to the idea that Bošković may have been at a disadvantage as a Jesuit as well as a Catholic priest obliged to uphold the Church's views, it has been assumed that his scientific ideas have caused him some unnecessary soul-searching[4], so that he must have had some courage to formulate ideas that were against the beliefs of the religious culture of his time[5]. Other accounts suggest that some of Bošković's views may have been entirely motivated by the desire to avoid conflict with the Church[6].

The portrait of Bošković that is being presented from these accounts is that of a man divided between two incompatible worlds, one dominated by beliefs and dogmas, and the other ruled by facts and reason[7]. His scientific achievements were consequently the work of a man of vision who somehow managed to overcome the shortcomings of his education and to survive the incomprehension, indifference, and perhaps intimidation of his religious milieu.

Against that portrait, it was argued, in the light of Ignatius of Loyola's *Spiritual Exercises*, that Bošković, as a Jesuit, must have been encouraged to cultivate a free spirit[8], a virtue, we assume, he judicially exercised by being selective of the scientific views popular in his time[9]. In this regard, Bošković was even praised by Nietzsche for his critical attitude towards empiricism[10]. Another connection between Bošković's activity as a scientist and the *Spiritual Exercises* can be seen in his conviction that any philosophical meditations should always be fruitful[11]. Finally, it was even argued that Bošković's scholastic and Jesuit breeding must have endowed him with a "subtle and sharp critical and argumentative spirit."[12] We could add to this the fact that Bošković, as a member of the Society of Jesus, living in and being supported by this community, must have had favorable conditions to devote his time to scientific research, not to mention his access to the best libraries of Europe, the possibility to meet other scholars, visiting scientific academies, etc. Although an investigation of the benefits related to a person's choice of vocation is not the main thrust of this presentation, their significance for putting into place conditions favorable to the pursue of scientific inquiry should not be overlooked[13].

Finally, there is the question of Bošković's motivation for studying nature. Although it does not at first sight provide any methodological advantage or disadvantage with regard to one's approach to the investigation of natural phenomena, it does nevertheless reveal a person's attitude towards his cultural and intellectual environment. Judging from Bošković's own words, it is difficult to accept the above- mentioned portrait that makes him a man torn between two allegiances. Indeed, in a statement addressed to the Count of Migazzi, to whom his *Theoria Philosophiae Naturalis* is dedicated, Bošković says: "I think that not only theological but also philosophical investigations are quite suitable matters for consideration by a Christian prelate; and in my opinion, a contemplation of all the works of Nature is in complete accord with the sanctity of the priesthood."[14] Why is it so? Bošković gives two reasons: the first one presents the investigation of nature as a form of spirituality[15], while the second is related to the education of the young people[16]. The second reason is interesting as it shows that, if we want to insist on the fact that Bošković was soul- searching, what really troubled him was the spread of doctrines that led to the negation of the existence of God[17].

The issue that is being alluded to in the above accounts is that of the relationship between an individual's intellectual and cultural environment on the one hand, and his ability to explore and formulate new ideas on the other[18]. This environment may consist of many factors: education, life style, relationship with colleagues

and superiors, attitude towards the dominating cultural and intellectual ideologies, and last but not least, one's own beliefs and values. Consequently, when it comes to deciding whether such environment has been detrimental or favorable to a person's scientific activity, the task appears to be almost impossible, especially considering the complexity of the interaction between these factors. It is even possible to say that an environment had no effect, not because we deny in principle the existence of such effect, but because some negative factors may be offset by positive ones or vice and versa. Therefore, one needs to present strong evidence in support of either position to establish a convincing case[19].

Despite this difficulty, I believe that there is one factor that may help us determine whether there is some degree of influence between a culture and the creative process of a scientist. This factor is the discourse with which a scientist describes his own creative activity as well as that of other people. For example, referring back to Ivan Supek's evaluation of Bošković and the culture he belongs to, we may assume that it was influenced by his own presuppositions regarding what constitutes good science, as he was himself a scientist who believed that the development of physics begins with experimentation and mathematics[20]. Furthermore, his criticism of Bošković's education may reflect a sense of uneasiness, had he had to work without being equipped with these validating tools. It is thus in this sense that a discourse regulates the creative process by influencing decisions regarding methodology, valid means of knowledge and even the pertinence of research questions. If such discourse allows one to evaluate the activity and the culture of others, when applied to oneself, it operates as a means of strengthening confidence in one's own activity by reinforcing the impression that what we are doing, we are doing it with the right instruments, with the right attitude, and for the right reason. The issue of self-confidence is therefore what is often at stake in such discourses[21].

If we were to evaluate Supek's evaluation of Bošković in the light of this notion of self-confidence, it appears to contain some inconsistencies. As we recall from the previous quotations, on the one side Supek praised Bošković's scientific achievements, and on the other, he tells us that he was deficient with regards to the tools of scientific investigation. So, if Bošković did not have the means to validate his ideas, from where did he have the confidence to come up with theories, like his curve of forces or his atomic model, that are still original even by the standards of 20th century physics[22]? Because Bošković's ideas have managed to remain valid or highly plausible for more than 250 years, one has to assume that there exists a second source of validation, at least in the eyes of Bošković, who explicitly ruled out the use of arbitrary hypotheses and fictitious explanations in his investigation of phenomena[23]. The question then becomes what are the presuppositions of the discourse by which Bošković validated his scientific approach and, subsequently, do these presuppositions have any relation with the religious culture in which he evolved? Establishing a relationship between this religious cultures, be it Catholicism or Jesuit's values, and Bošković's discourse, could weight in favor of a positive influence of such culture on Bošković's creative activity.

The first evidence is based on the similarity between Bošković's description of the process of scientific discovery and that of moral development. Let's consider two passages, taken from the dedication of his major work, the *Theoria Philosophiae Naturalis,* to the Count of Migazzi. First he said,

Of a truth, that well-known old saying, " What you do, DO," which from your earliest youth [...] had already fixed itself deeply in your mind, has remained firmly implanted there during the whole of the remainder of a career in which duties of the highest importance have been committed to your care. Your strict observance of this maxim in particular, joined with those numerous talents so lavishly showered upon you by Nature, and those virtues which you have acquired for yourself by daily practice and unremitting toil, throughout your whole career, forensic, courtly, and sacerdotal, has so to speak heaped upon your shoulders those unusually rapid advances in dignity that have been your lot[24].

Then, regarding how he came about formulating his continuous law of forces, he says:

I put on one side all prejudice, and started from fundamental principles that are incontestable, and indeed are those commonly accepted; I used perfectly sound arguments, and by a continuous chain of deduction I arrived at a single, simple, continuous law for the forces that exist in Nature. The application of this law explained to me the constitution of the elements of matter, the laws of Mechanics, the general properties of matter itself, and the chief characteristics of bodies, in such a manner that the same uniform method of action in all things disclosed itself at all points being deduced, not from arbitrary hypotheses, and fictitious explanations, but from a single continuous chain of reasoning[25].

Regarding the first passage, we may not understand the full significance of the well-known old saying reported by Bošković, but it is clear that it has been important for the personal and moral development of the Count of Migazzi. Indeed, we are told that from the moment the Count deeply fixed in his mind the maxim “What you do, do!” he remembered it all throughout his career and applied it with perseverance and unremitting toil in his daily life. That allowed him to make unusually rapid advances in dignity. To use a well-known analogy, we could say that this maxim was for the Count of Migazzi a seed that produced many fruits because it was planted in good soil. This good soil was the Count's numerous talents but more importantly, his sustained commitment to the maxim.

Similarly, in the second passage, we may assume that Bošković's use of the word *continuous,* in the phrase *by a continuous chain of deduction*, indicates some form of sustained commitment. This continuous chain of deduction has its starting point in the acceptance of fundamental principles that are incontestable and as well as commonly accepted. In this passage, there is no indication that these fundamental principles were experimentally proven so that we have to presuppose, like the Count of Migazzi did with his maxim, that Bošković accepted them on trust[26]. Finally, the entire process led him to the realization of an idea whose plausibility was subsequently enhanced by observation of the phenomenal world. This realization is an objective event, as it can be communicated, evaluated, etc., like the Count's moral transformation which was witnessed, I assume, by many people.

This similarity between these two passages is therefore based on the fact that they shared the same presuppositions with regards to the process of creation, be it the acquisition of a virtue or the formulation of a new idea. Indeed, it requires the acceptance a priori of an idea followed by some degree of commitment to it. These would be the two ingredients necessary to bring about an experience of creation. In this regard, it may be interesting to note that, from the point of view of the modern scientific discourse, especially the one supported by the positivist presuppositions, these two ingredients are not acceptable as this discourse relies exclusively on doubt and such posteriori methods of validation as experimentation and

measurement[27].

A second evidence showing a possible relationship between a religious culture and Bošković's discourse, may be given by looking at the cognitive aspect of what is meant by the term *continuous*, as again found in the phrase *by a continuous chain of deduction*. If the previous discussion suggested that this term refers to a sustain act of commitment, the present discussion will try to understand what type of mental activity is being sustained by this act of commitment.

That this continuous chain of deduction involved some degree of mental discipline has already been suggested by Dubravko Tadić. Indeed, discussing what could have been different in Bošković's approach from the modern scientific methodology, he says: "In the »fundamental and incontestable« principles used by modern science there are some, at least minor ones, which resulted from Bošković's relentlessly thinking sustained by tremendously disciplined mental effort[28]." Such mental effort is known as *reflexio*. According to Peter Henrici, *reflexio* was for Bošković "the most important faculty of cognition[29]" which he used as an instrument for his criticism of empiricism. *Reflexio* is not to be understood in terms of the "psychologically reflective ability with which the consciousness (the mind) can perceive its own operation[30]," but rather in the sense of "active thinking: »meditatio quaevis« or »rectae rationis usus«. In this meaning »reflexio« has above all the primary function of a critical examination and correction of ideas. It is the ability to realise *the limits of our sensitive knowledge and thus also to think beyond these limits*[31]."

This practice of *reflexio* has its equivalent in Indian religions, especially within the various mystical schools of Hinduism and Buddhism. As a matter of fact, many terms are used to describe this practice depending on the intensity of the cognitive process involved. For example, there is *vicâra* (pondering over), *manana* (meditation), *nididhyâsana* (contemplation). They are sometimes regrouped under the term *tarka,* which, according to one of the mystical schools of Hinduism (Advaita Vedânta), "is needed (i) to ascertain the purport of scriptural passages[32], (ii) to remove doubts and contrary beliefs, and (iii) to convince us of the probability of the existence of what is to be known[33]." In other words, *tarka* is a cognitive operation that continuously questions the validity of the primary ideas derived from the senses. It does so also on the basis of accepting a priori fundamental principles. A famous example of such principles is the notion that the entire universe is Brahman, the ultimate reality, and consequently, the phenomenal world, as we experienced it, is a kind of illusion[34].

The comparison between *reflexio* and *tarka,* a cognitive function essential to the process of spiritual transformation, indicates that Bošković's approach to the investigation of the phenomenal world shares some features with the practice of mystical contemplation. What all mystical contemplations have in common, no matter the religious traditions they are issued from, is a relativisation of sense experiences. In other words, a mystic never trusts what the senses reveal[35]. Why Bošković, following a cognitive approach similar to that of the mystics, did not become one, at least not in the usual sense of the word? The answer to this question will lead us to identify the third evidence for a possible relationship between Bošković's discourse and a religious culture, however, this time, this religious culture is specific to Christianity.

What is specific about Christianity? There are essentially two major features that distinguish this religious tradition from other religions. The first, and contrary to most Eastern mystical traditions which deny any absolute status to the phenomenal reality, is that the world has been created by a personal God *whose wisdom may be known through an investigation of his creation*[36]. One will recall that this was one of the reasons why Bošković mentioned to the Count of Migazzi that a contemplation of all the works of Nature is in complete accord with the sanctity of the priesthood. If this feature is considered not entirely exclusive to Christianity, the second will set it apart without any doubt. It is the belief that Jesus of Nazareth is the Son of the God that created the world[37]. This is the principle of incarnation where a man is believed to be consubstantial with a wholly transcendent God[38]. The major implication of the principle of incarnation, with regard to the creative process, is that it is assumed that the experience of knowing the world, does not set us apart from it[39], nor does it free us from it[40], but rather makes us intimate with it. In other words, knowing the world brings about a process that may be described as a subjective transformation, an enlargement of the self, or a new mode of being in or relating with the world, depending on how we look at this experience of intimacy. This process is the essence of Christian spirituality[41]. The question is then, how is this principle of incarnation reflected in Bošković's discourse?

The first clue comes from Peter Henrici's analysis of the notion of *reflexio*, as discussed earlier. From the point of view of cognitive psychology, one can say that the purpose of *reflexio*, as well as that of *tarka*, is to add another sense of perception, this time, a mental one, by which the world is to be investigated. Consequently, prejudices resulting from an experience of reality through the five senses are questioned, not on the basis of an a priori doubt, but by adding a new sense[42]. This way of relativizing sense experience is not different from what we usually do when we do not accept an impression given from one sense experience on the basis of another impression given by a second sense experience[43]. Similarly, today, when we look at a sunrise in the East or a sunset in the West, we "see" that it is the earth that is moving and not the sun[44]. This impression is possible because we have internalized the idea that the earth moves. In other words, by accepting an idea as true, it becomes part of one's cognitive apparatus with which we look at the world[45].

It might be worthwhile to consider more thoroughly this process of internalization by which an idea is transformed into an instrument of perception. Earlier we ask what could be responsible for Bošković's confidence to pursue his investigation without relying on systematic posteriori experimentation[46]. Similar to using instruments like microscopes and telescopes, the validity of ideas accepted a priori is established by the quality of one's observation of the world. If, for example, it allows us to see phenomena in a way unnoticed before or simply discover entirely new ones, we come to have more trust in them. Inversely, the impossibility to understand a phenomenon by observing through one's instrument, be it a physical device or an idea, may force us to question its quality and even its usefulness. Consequently, there is no substantial difference between an idea, that has become part of one's cognitive apparatus, and a device like a telescope, so that we can say, following Koyré's affirmation, that such devices are incarnations of theories[47]. Thus, we could argue, with some irony, I concede, that the construction of new instruments of observation, which is very much part of modern science, is just an extension of a cognitive process that is best described by a discourse that shares important presuppositions with a religious culture.

We could go further in the analysis of this process, explained by the principle of incarnation, by defining what is meant, cognitively speaking, by *quality of one's observations*. As mentioned above, this is the validating experience that confirms the trustworthiness of one's instruments of observation or a priori accepted ideas. First, one may ask, what do we see when we observe the world? We may see all kind of things, but what really attracts our attention, are asymmetries.

What are these asymmetries? There are essentially discrepancies between sense perception and one's tacit understanding of reality. It is tacit in the sense that we feel that there is something wrong, but we do not know what exactly. What the acceptance of an *apriori* idea is going to accomplish is consequently to transform that tacit impression into an explicit one. In other words, their validation comes at this point from their ability to clarify one's research question[48]. As such, it prepares the ground for the coming of an answer[49]. That answer is going to reestablish a new sense of symmetry between sense perception and our understanding of reality[50].

Anyone who went through the experience of resolving a difficult problem will know that this experience of resolution is accompanied by an emotional response. The emotional aspect of this experience of resolution is very often what solidifies its cognitive component and is consequently responsible for one's confidence in one's ideas. In this regard, Michael Polanyi[51] suggested a simple model that illustrates this experience of resolution.

There is a device known as a stereoscope by which two photographs of the same object taken at slightly different angles are viewed together, creating an impression of depth and solidity. Polanyi describes the relationship of the two pictures to the impression of depth by saying that the two images function as instruments or are *subsidiaries* to our seeing their *joint* image, which is their joint meaning. In fact, using the stereoscope just makes it easier to integrate the two images as one; with some training it is possible to achieve this impression of depth without it.

Using our own explanation, we can say that first we accept, on trust, the possibility that two-dimensional pictures may be viewed in three dimensions. Then, on the basis of this accepted idea, we take a distance from our two-dimensional sense experiences or refuse to accept them as valid. In other words, we do not commit ourselves to the primary two-dimensional impressions derived by the senses. “They are not really two-dimensional pictures” is something we may keep repeating in our mind to confirm one's commitment to the idea that they can be seen in three dimensions. Finally, we integrate, as a cognitive and emotional experience, the three- dimensional view of that which is represented by the pictures. This means that the idea or the belief that the two pictures can be seen tri-dimensionally is now fully validated by a concrete experience[52]. In other words, we actually see the way we believed reality could be seen. That experience is an integral transformation of the subject, a transformation that translates itself in a new (we could say: natural and spontaneous) way of interacting with the world[53].

Now that we have a model illustrating how the principle of incarnation translates itself into the creative process, we may overlay it on the structure of Bošković's discourse. This will be accomplished by looking again at his continuous chain of deduction, this time, not as a whole, but in its particulars.

According to Ivica Martinović[54], this deductive chain, or the line of reasoning that led Bošković to his original concept of forces acting between particles of matter, consists of four distinct elements:

(1) analogy and simplicity in nature; (2) a critical approach to the results of experiments and to the capacities of the senses; (3) the distinction between mathematical and physical contact; (4) the principle of continuity in nature.

The question that is at the centre of this deductive chain is whether forces between objects act at a distance or not. Since the formulation of the law of gravity by Newton, action at a distance was well accepted. Action by contact was also a primary idea derived from sense experience.

According to the cognitive model suggested above, the acceptance of the principle of simplicity brings about an experience of detachment from the tacit impression that there are two types of contact, an impression derived from sense experience. This is the second element. Then, this experience of detachment translates itself into an explicit cognition. It the present case, it is the realization that mathematical contacts, which means that the distance between objects is inexistent, is an abstract construct or a prejudice. This explicit cognition is in fact a negative statement, as it denies the possibility of having two types of contact, and it is at the same time a question, as it channels one's efforts of investigation, that is, one's *reflexio*, into looking for one single explanation for all actions between objects. Finally, the realization of the illusory nature of the concept of mathematical contact will make room to the positive formulation of the principle of continuity in nature. This principle is now a reality available to be tested, to be used as a new tool for probing the phenomenal world. It is objective in the sense that it can be communicated; it can also be the object of consensus or generate opposition. In short, it is a piece of knowledge that can change the course of scientific investigation.

What is interesting to notice is, although we speak of deductive chain, the different elements do not follow the pattern *if A = B and B = C then A = C,* where each proposition “naturally” follows from the previous one. Although we feel that there is a logical sequence between the propositions, they, to use one of Bošković's ideas, do not touch each other[55]. This is so because the propositions of the deductive chain are different from the point of view of their range of applicability.

Indeed, the principle of simplicity is a general principle that can be applied in arts as well as in philosophy and theology[56]. The critical attitude towards sense experience is also general but more specific to one's observation of the phenomenological world[57]. Following this progression from general to specific, the third proposition, namely, the distinction between mathematical and physical contacts, is only specific to the deductive chain pertaining to problem of forces between objects. This last proposition acts as a kind of inhibition preventing us from drawing any conclusion based on the idea that there is such a thing as no-distance contact between objects[58]. Finally, from a very specific proposition will emerge a new principle, the principle of continuity, whose applicability is as general as the one that started the chain of deduction. Thus, similar to a blind man's cane that has become an extension of his arm, the principle of simplicity is now a cognitive instrument *through* which the principle of continuity is realized. To use Polanyi's model, the principle of simplicity is now seen *subsidiarily* while the principle of continuity is the *focus* image. This means that, Bošković's deductive chain, as identified by Martinović, is a kind of cycle, where one moves, cognitively speaking, from a general principle to a specific application and then back (or ahead) to a new general principle[59].

It may exceed the limits of this presentation to analyze the subsequent cycles in Bošković's investigation of reality, but suffice to say that the next cycle will bring him to formulate his concept of the continuous curve of forces. In this new cycle or deductive chain, the starting point is the final point of the previous chain, that is, the principle of continuity. This principle will also cause an experience of detachment that will be manifested by the realization of a new prejudice: sudden change of movement due to collision

between objects is a mental construction. So, if continuity is a valid principle, which is itself based on or contains the valid principle of simplicity, then, one may ask whether there is, in addition to Newton's notion of attractive force, a repulsive force acting between objects. As discussed previously in relation to the experience of validation of one's instruments of observation, each cycle of deduction validates the finding of the previous ones. It is like constructing a building where each additional floor confirms the solidity of its foundations. By this process of validation, each floor in the structure, except the first and the last[60], has a double nature: it is a product of the preceding one as well as an instrument of the subsequent one. This process of successive validation is, I believe, that which accounted for Bošković's confidence in his theory of the continuous curve of forces.

The principle of incarnation, which has been used to establish the connection between Bošković's creative process and the religious culture he belonged to, is in fact not exclusive to his scientific approach. Indeed, any experience of learning a skill is a form of incarnation. Learning a language, for example, is not just memorizing vocabulary and rules of grammar: it is also the assimilation of a culture. Depending on how thorough we pursue the acquisition of that language, our sense of intimacy with the culture it is part of, will be deep or shallow[61].

Thus, the question is not whether the process of incarnation is exclusive to a group of persons[62]; it is rather whether the discourse we use to describe our creative activity acknowledges it or not. I cannot say whether Bošković was aware of the connection between his description of how he came to formulate his continuous theory of force on the one hand, and the presuppositions of the Christian discourse on the other. However, the least I can say is that there is no contradiction between these two discourses. Absence of contradiction would be, in the last resort, my argument in favor of the idea that Bošković was positively influenced by the culture he identified himself to.

I began this presentation with Supek's analysis of Bošković's culture. We may now ask ourselves, what are the presuppositions of Supek's own discourse? More specifically, why did he insist on the importance of precise experimentation and measurement? The reason given was that without these instruments of validation modern science would not have been possible. But is this the only reason, at least, for other advocates of the modern scientific method? Why do we need experimentation and measurement in the first place? If they do not change anything in the process of creativity (except when expectations are not met), what do they add to the progress of science? A strengthening of confidence? Perhaps, it always help having one's theory confirmed by experimentation[63]. But, I think, the main purpose of concrete experimentation and measurement is to be able to use our scientific discoveries as tools to transform and control the world. This is probably where we could trace the influence of a culture on one's creative activity. We have a choice: either we study the world to experience God's wisdom, as Bošković suggested to the Count of Migazzi, or to be seized by its beauty, as suggested by Poincaré[64], or to control and master it[65]. The second alternative, although fully justified in the context of man's survival or adaptation, appear to transform man into a total stranger or maintains him in a state of disincarnation in his own world. This makes us wonder, given the fact that man is issued from this world, if the entire modern scientific discourse, the one that distinguishes between facts and values, that absolutizes reason, is not fueled by a wrong myth. Myths[66], similar to a priori accepted ideas, are like trees: we appreciate them for their fruits. If they do not produce anything valuable, we cut them. Bošković's concerns regarding what he called “the spread of the canker” is therefore not just an arbitrary judgment of value; it is rather a direct consequence of the research method with which he gathered the confidence to suggest, though his continuous law of forces, a new and original vision of reality.

Footnotes

1 Ivan Supek. *Filozofija, znanost i humanizam*. Hrvatska akademija znanost i umjenosti, Zagreb: Školska knjiga, 1995.

2 “Iako isusovac, Bošković je bio svjetski čovjek” Supek 1995, p. 63. “Otrgnut u svojem djetinjstvu od rodnog grada, Bošković je sačuvao mnoge osobine svojega kraja, i dobre i loše. Djelo velikog učenjaka nosi i pečat njegove zaostale sredine.” Supek 1995, p. 69.

3 “Nedovoljno obrazovan u najvažnijoj disciplini svojeg vremena, a pritisnut skolastičkim naslijeđem, on je htio suviše; odatle i njegova tragična veličina, bogatstvo vizija, a siromaštvo konkretnih eksperimenata i matematički izraženih prirodnih zakona.” Supek 1995. p. 69.

4 “Uvidevši da potpun sklad između egzaktnih nauka, kojima se bavio, i teologije nije moguć, Bošković je nastojao da bar ne dođe u sukob sa katoličkom teologijom, nesumnjivo po cenu potiskivanja konflikata, što ga je moralo stajati duševnih patnji.” Andrija B. K. Stojković. “Dualizam Boškovićeve filozofske koncepcije” in *Proceedings of the International Symposium on Ruđer Bošković*, Dubrovnik, 5th - 7th October 1987, Zagreb 1991, p. 37.

5 “Iako je bio svećenik nije se libio prihvatiti i one spoznaje koje nisu bile u skladu sa službenim naukom Crkve. To potvrđuje i činjenica da se kao znanstvenik neskriveno zalagao za Kopernikov heliocentrični sustav.” Vjesnik.hr Newsportal (26.3.2011). Gordan Pandža, *ZNANOST U SUSRET 300. GODIŠNJICI ROĐENJA RUĐERA BOŠKOVIĆA: Čovjek koji je anticipirao temeljna načela moderne fizike.*

6 “Let us remember that is search of those foundations he often came back to the idea of the divine role of the creator, which was his duty anyway, because he belonged to that order which considered itself most competent to defend the principles of the Roman-Catholic Church. However, in spite of that, his scientific and critical mind dominated in almost all of his preoccupations; the basic characteristic of his investigation was the strictness in carrying out, striving for reasons and proof, and in that sense, to a careful reader and connoisseur of the conditions of his time, Bošković's references to the divine competence would often seem as an act of imperative agreement with something that was required.” Radomir Đorđević. “Ideas of R. Bošković about the Nature of the Cognition Process” in *Proceedings of the International Symposium on Ruđer Bošković*, Dubrovnik, 5th - 7th October 1987, Zagreb 1991, p. 75-6. Žarko Dadić, in his monograph on Ruđer Bošković (Zagreb: Školska Knjiga, 1998, p. 63), also argued that

the distinction between relative and absolute space was an attempt by Bošković to accommodate Newton's mechanics, which he accepted, to the official view of the Church and, accordingly, of the Collegium Romanum.

[7] In this regard, Nikola Stanković and Ivan Šestak said: “Nekima je to nepoćudno pa u javnom govoru o Boškoviću, čak i o tristotoj obljetnici njegova rođenja, izostavlaju njegovu vezu s vjerom. [...] U takvom mišljenju je implicitno prisutno gledište da se znanosti i vjera nikako ne mogu pomiriti. Ako bi nekim slučajem, ipak, neki znanstvenik još uvijek živio u ‘zabludi’ vjere, valja izostaviti taj podatak da mu se ne bi okrnjio ugled i proglasilo ga se ‘dvoglavim’.” Nikola Stanković and Ivan Šestak. “Odnos vjere i znanosti u Ruđera Josipa Boškovića” in *Od Dubrave do Dubrovnika*, uz 300-godišnjicu rođenja Ruđera Boškovića, Neum-Dubrovnik, 2011, p. 20. Implicit to the present discussion on how Bošković and his environment was perceived is a criticism of an epistemological paradigm that presupposes a division between two types of “minds.” This presupposition is rampant in the field of religious studies and its main characteristic is the idea that mankind has undergone a fundamental conversion from being irrational, superstitious to being rational and realist. This “conversion” occurred around the the 16th century and found its strongest expression at the time of the 17th century. Since that moment, everything that preceded it, is marked as negative and consequently, as something mankind should rid itself of. The struggle, which still continued today, is to convert or enlighten those who are still stuck in the past. From the point of view of the history of religious throught, this model manifests the presuppositions of a discourse specific to a mystical world view. In other words, the so-called incompatibility between two worlds, in the present case identified as religion and science, is relative to a mode of thinking dominant in the discourses of the mystics. What makes this model contradictory is therefore the fact that it explicitly criticizes that which it implicitly accepts.

[8] “Such freedom of spirit, present in *De lumine*, is certainly connected with original spiritual heritage of the religious community to which Bošković belonged.” Ivica Martinović. “Bošković on his own Theory of Forces: From a Sentence to the Theory of Natural Philosophy,” in *Proceedings of the International Symposium on Ruđer Bošković*, Dubrovnik, 5th - 7th October 1987, Zagreb 1991, p.32.

[9] “I put on one side all prejudice, and started from fundamental principles that are incontestable, and indeed are those commonly accepted;” English translation by J. M. Child. Latin-English edition of Bošković's *Theoria Philosophiae Naturalis,* Chicago, London: Open Court Publishing Company, 1922. p. 9.

[10] “najveći trijumf nad ćutilima koji je dosad bio polučen na Zemlji” and “zadavši smrtni udarac materijalističkoj atomistici” (*Jenseits von Gut und Böse*, 1895) Cited in Ivan Supek. *Ruđer Bošković: vizionar u prilelomima filozofije, znanosti i društva*, Zagreb: Školska Knjiga, 2005, p. 127.

[11] “Prema knjižici *Duhovnih vježbi* Svetog Ignacija meditacija mora doći do nekog ploda.” Stanković 2011, p. 23.

[12] Arcangelo Rossi. “R. J. Bošković's Philosophy of Space” in *Proceedings of the International Symposium on Ruđer Bošković*, Dubrovnik, 5th - 7th October 1987, Zagreb 1991, p. 10.

[13] In this regard, the Buddha said 2500 years ago, that family responsibilities or life as a layman, made impossible the pursuit of intellectual and spiritual goals. The physical division of society, based on one's goal of life, is a transposition of the presuppositions of mystical discourses. By this, I am not saying that the Jesuits were like the Buddhists. There is a fundamental difference between the two: if for the latter, their communities became centers of attraction, the communities of the former are centers of diffusion. This means that another dynamics and motivation, in addition to the mystical ones, is at work in the case of the Jesuits.

[14] English translation by J. M. Child. Latin-English edition of Bošković's *Theoria Philosophiae Naturalis,* Chicago, London: Open Court Publishing Company, 1922. p. 9.

[15] “For it is marvellous how exceedingly prone the mind becomes to pass from a contemplation of Nature herself to the contemplation of celestial, things, and to give honour to the Divine Founder of such a mighty structure, lost in astonishment at His infinite Power and Wisdom and Providence, which break forth and disclose themselves; in all directions and in all things.” (Child 1922 p. 9).

[16] “There is also this further point, that it is part of the duty of a religious superior to take care that, in the earliest training of ingenuous youth, which always takes its start from the study of the wonders of Nature, improper ideas do not insinuate themselves into tender minds; or such pernicious principles as may gradually corrupt the belief in things Divine, nay, even destroy it altogether, and uproot it from its very foundations.” (Child 1922 p. 9).

[17] “This is what we have seen for a long time taking place, by some unhappy decree of adverse fate, all over Europe; and, as the canker spreads at an ever increasing rate, young men, who have been made to imbibe principles that counterfeit the truth but are actually most pernicious doctrine, do not think that they have attained to wisdom until they have banished from their minds all thoughts of religion and of God, the All-wise Founder and Supreme Head of the Universe.” (Child 1922 p. 9).

[18] This issue is still actual today and it finds its most vivid expression in the debate between Creationism and Evolutionism. For many advocates of the latter, for example Richard Dawkins, that adherance to religious views is a serious obstacle to free inquiry and the progress of science.

[19] This makes the neutral position the zero hypothesis. Moreover, when it comes to understanding the nature of the relationship between creativity and

the culture in which a creator evolves, the position that argues that the latter flourished *in spite of* the prevailing culture seems to express an ideological prejudice towards that culture whereas the position based on the *because of* type of relationship is more neutral or indeterminate as it assumes that it is impossible to identify all the factors involved and that what appears to be a negative factor may as well be responsible for fostering creativity. This makes the *in spite of* position even harder to prove as history shows that men were creative under all types of repressive environment.

[20] "Razvoj moderne fizike počinje eksperimentalnim mjerenjima i primjenom matematike." (Supek 1995. p. 63).

[21] With regard to the building up of self-confidence, this discourse may be confronted to many issues, some internal, some external. An internal issue is whether scientific concepts describe a reality out there or whether it is just a useful construction that allows one to act efficiently on a world that is always elusive to the human mind. External issues, which are often intimately connected to the internal ones, are those issues that address the type of culture in which scientific activity ought to evolve. Discussions of these external issues often transform the discourse into an instrument of cultural and ideological apology.

[22] Regarding this issue, Ivica Martinović, analysed Bošković's terminology used to describe the ideas mentioned in his treatises, ideas designating his own findings as well as those of other scientists. He argued that Bošković's terminology, more specifically, the words *sentencia, theoria,* and *hypothesis*, indicates a difference in self- confidence with regards to the value and truthfulness of his ideas. ("Bošković on his own Theory of Forces: From a Sentence to the Theory of Natural Philosophy" in *Proceedings of the International Symposium on Ruđer Bošković*, Dubrovnik, 5th - 7th October 1987, Zagreb 1991, pp. 29-36) .

[23] "The application of this law explained to me the constitution of the elements of matter, the laws of Mechanics, the general properties of matter itself, and the chief characteristics of bodies, in such a manner that the same uniform method of action in all things disclosed itself at all points being deduced, not from arbitrary hypotheses, and fictitious explanations, but from a single continuous chain of reasoning." (Child 1922 p. 9). The possibility that Bošković arrived at his conclusions using a different approach than what characterizes modern physics has also been suggested by Dubravko Tadić: "Bošković has left a scientific legacy of many hypotheses which can only now be appreciated. They have not influenced and do not influenced the development of physics. Modern scientists have reached analogous conclusions and theoretical insights independently. However, they made use of modern knowledge and modern mathematical and theoretical methods." Dubravko Tadić. "Bošković's Theories on the Structure of Matter" in *The Philosophy of Science of Ruđer Bošković*, Proceeding of the symposium of the Institute of Philosophy and Theology, S. J., Zagreb: Institute of Philosophy and Theology, 1987, p. 121.

[24] Child 1922. p. 7.

[25] Child 1922. p. 9.

[26] Trust does not mean "blind faith." Trust is always based on some degree of rationality and personal experience. There are many reasons why a person trusts the validity of a statement: because it was said by a trustworthy person, or it is the object of a consensus, or just because somehow it makes sense without knowing exactly why. What is important at this point is the decision to accept.

[27] The posteriori method of validation may provide us with safeguards against wild speculative thinking, but it cannot account for the sense of anticipation scientists have with regard to the explanatory potential of certain assumptions and the commitment they may have towards theories that have not yet been experimentally validated. In this regard, Michael Polanyi, in his book *Personal Knowledge* (The University of Chicago Press, 1962), has given ample evidence that intellectual passions and commitment to one's own ideas are important, if not essential, components of scientific creativity. As such, Bošković may be compared to scientists like Einstein, who did not wait for an experimental confirmation of his theory of relativity to accept it as valid, and Galileo (the one many consider the founder of modern science), who vehemently defended the validity of the heliocentric system without any concluding evidence, especially in the light of Tycho Brahe's reformulation of Ptolemy's geocentric model. In fact, for these scientists, mental experiments played a much more important role than concrete experimentation. For more details regarding Galileo's own approach, see Alexandre Koyré. *Études d'histoire de la pensée scientifique*, Paris: Gallimard, 1973.

[28] Tadić 1987, p. 121.

[29] Peter Henrici. "The Theory of Knowledge of Ruđer Bošković in His Time" in *The Philosophy of Science of Ruđer Bošković*, Proceeding of the symposium of the Institute of Philosophy and Theology, S. J., Zagreb: Institute of Philosophy and Theology, 1987, p. 31.

[30] Idem. p. 35.

[31] Idem. p. 36. Italics mine.

[32] This is a specific requirement of this school. These scriptural passages are from the Vedas and it was important for this school to establish whether their primary purpose was to reveal the absolute reality (Brahman) or to indicate a sacrificial action. The second alternative was always considered the default interpretation, given the evolution of Hinduism, that is, a religion that moved away from the actual practice of sacrifices to the internalization or spiritualization of this practice.

[33] Satchidananda Murty *Revelation and Reason in Advaita Vedânta*, Delhi: Motilal Banarsidass, 1974, p. 149-150.

[34] In early Buddhism, the idea that Everything is Suffering, that is the First Noble Truth of Buddhism, is another example of a fundamental principle on which meditative and contemplative exercises were developed. To some extent, if science is searching for the ultimate explanatory principle, the theory of everything (TOE), mystical discourses take these principles as their starting points. Hence, based on the presuppositions of such discourses, we can say like Saint Augustine did: “Faith is to believe what you do not see; the reward of this faith is to see what you believe.”

[35] This is because reliance on sense experiences is directly related to one's desires and the need to act to fulfill these desires. In other words, commitment to the validity of sense experiences transforms what is perceived into fulcra of one's actions. There is consequently a direct connection between one's view of reality, that which we accept as real, and one's desires. Previously, I mentioned that the reason why we study nature does not seem to give any methodological advantage, however, in the light of a mystical approach to the investigation of the world, an approach based on a critical stance towards sense experiences, I have to say that it does so if we recognize the essential role of such criticism in Bošković's own approach. In this regard, Alexandre Koyré is of the opinion that Platonism, with its mystical presuppositions, played an important role in the development of modern science since Galileo. I would therefore add that this influence is to be seen in Bošković as well.

[36] “The order and harmony of the created world results from the diversity of beings and from the relationships which exist among them. Man discovers them progressively as the laws of nature. They call forth the admiration of scholars. The beauty of creation reflects the infinite beauty of the Creator and ought to inspire the respect and submission of man's intellect and will.” (Catechism of the Catholic Church, #341). Most religions have this concept of creator-god. What is different, however, are the relations between this creator- god, his creation, and men. In religions where sacrifices are at the center, elements of the created world are given back to the creator-god as a sign of gratitude or as a means to ask for more from his creation. Mystical traditions like Buddhism and the Yoga do not attribrute essential role to such creator-god, if they have such a concept. Muslims may be gratetul for Allah's creation, but it has no spiritual connotation at all. In fact, a spiritualisation of nature would be a form of idolatry. And finally, contrary to pantheistic religions, in Christianity God is not to be confused with nature nor with men.

[37] “Belief in the true Incarnation of the Son of God is the distinctive sign of Christian faith” Catechism of the Catholic Church, #463. The incarnation of the Logos is not to be confused with the Hindu incarnations of Krishna or Rama. These incarnations of the god Vishnu are not considered consubstantial as their bodies, like everyone else's bodies, are going to be cast away like old cloths at the moment of death. (Bhagavad Gîtâ, II-22)

[38] The Catholic view of men is best summarized in the Catechism of the Catholic Church (Part One, Paragraph 6).

[39] This refers to a quote by Jacques Monod defining science as an instrument of alienation: “Armed with all the powers, enjoying all the wealth they owe to science, our societies are still trying to practice and to teach systems of values already destroyed at the roots by that very science. Man knows at last that he is alone in the indifferent immensity of the universe, whence which he has emerged by chance. His duty, like his fate, is written nowhere.” Quoted in John C. Hess, 'French Nobel Biologist Says World Based On Chance', New York Times (15 Mar 1971), 6.

[40] This refers to all mystical philosophies, including gnosticism, which affirms that the world is an obstacle to the realisation of the spiritual reality.

[41] “No attempt to describe the essence of Christianity can set aside this relationship [a concrete relationship with Jesus of Nazareth] between Christ and the Christian. Of course, this is true in a certain way of all religions and their founders. But there is here something specific to the followers of Jesus. For some religions the founder, wise man, or prophet who initiated them is someone who either revealed a special way of life that need to be followed or who taught a set of doctrines we are commanded to believe in order to attain happiness. The believer, once he knows the way or message or salvation, does not need to keep alive the presence of the prophet and the concrete events of his history. It suffices to be thankful to him for having shown a way toward God. [...] Christ belongs to the very goal of salvation: salvation, as the Christian understands it, is always determined in its very core by a relationship with the concrete Jesus who lived and suffered among us and whose kingdom will have no end.” José Granados. “The Christian Confession of Faith in Jesus Christ” in *Catholic Engagement with World Religions*, Maryknoll, NY: Orbis Books, 2010, p. 179.

[42] At this point, the experience of doubt is a result of an apriori accepted principle and not this principle itself.

[43] For example, knowing that someone is present in a dark room by the sound he makes despite the fact that he is not seen.

[44] This example is also given by Bošković in his *Theoria* (#159) (Child 1922. p. 127).

[45] This statement contradicts to some extent the idea that a theory or a model “exists only in our mind and does not have any other reality (whatever that might mean).” Stephen Hawking. *A Brief History of Time: From the Big Bang to Black Holes*, London: Bantam Books, 1988, p. 10. Tri-dimensional vision is also just in the mind, as it is processed from two eyes seeing only in two dimensions, and yet, it does correspond to a feature of reality. Thus, assimilated ideas do allow us to “seize” reality or part of it. However, the question what exactly we are seizing still remains open for interpretation.

[46] I do not want to say by this statement that Bošković did not use experimentation, but rather, because he accepted different presuppositions with regard to the process of scientific discovery, it was not viewed as the only source of validation. This is also true of Galileo who, according to

Alexandre Koyré, did not prioritise experimentation: “On le voit: la manière dont Galilée conçoit une méthode scientifique correcte implique une prédominance de la raison sur la simple expérience, la substitution de modèles idéaux (mathémathiques) à une réalité empiriquement connue, la primauté de la théorie sur les faits.” (Koyré 1973, p. 83)

[47] Koyré 1973, p. 59. Koyré also added that, if we want to attribute to Galileo the paternity of modern science, it is not on account of doing experiments, since they were done before him, but precisely in the fact that he is the first to have conceived of a telescope, not in terms of an instrument for measurement, but to see what is beyond the senses. “Le téléscope galiléen n'est pas un simple perfectionnement de la lunette «batave»; il est construit à partir d'une théorie optique; et il est construit pour un certain but scientifique, à savoir pour révéler à nos yeux les choses qui sont invisibles à l'oeil nu. Nous avons là le premier exemple d'une théorie incarnée dans la matière qui nous permet de franchir les limites de l'observable, au sens de ce qui est donné à la perception sensible, fondement expérientiel de la science prégaliléenne.”

[48] To understand this passage from tacit impression to an explicit one, let's imagine entering a room where we feel that something has changed (the tacit impression) and say: “someone has moved something in it” or something similar (the explicit impression). From this explicit impression comes the question: “What has been moved.”

[49] Christian dogmas work, at the cognitive level, in the same fashion. They are to be understood as questions and not as ready-made answers, as some critics of religion believe them to be. Consequently, there is no conflict between a dogma and an hypothesis: both function as questions, or starting points, in their respective sphere of activity.

[50] This is, I believe, the fundamental difference between a mystical approach that maintains, through reflection and meditation, a constant awareness of the limits of the senses (a subjective experience of distance based on the idea that sense experiences are always false), and the approach based on the principle of incarnation where the senses are to be distrusted and trusted alternatively depending on whether one is at the stage of asking a question, the *reflexio*, or of having found an answer.

[51] Michael Polanyi and Harry Prosch. *Meaning*, Chicago and London: The University of Chicago Press. 1973, p. 34.

[52] A professor of mine described a similar experience of resolution he went through in the context of the practice of Zen. This experience is known as *satori* and it is generated by an intense reflection on a *kôan*. A *kôan* is like a riddle such as "Two hands clap and there is a sound. What is the sound of one hand clapping?" The account goes as follow: “At the extremity of his great doubt, there will come an interesting moment. This moment is hard to describe but on reflection afterward we might say that there comes a point when the monk realises that he himself and the way he is reacting to his inability to penetrate the *kôan* are themselves the activity of the *kôan* working within him. The *kôan* no longer appears as an inert object in the spotlight of consciousness but has become part of the searching movement of the illuminating spotlight itself. His seeking to penetrate the *kôan*, he realises, is itself the action of the *kôan* that has invaded his consciousness. It has become part of the very consciousness that seeks to penetrate itself. He himself is the *kôan*. Realisation of this is the response to the *kôan*.” Victor Sōgen Hori. “Teaching and Learning in the Rinzai Zen Monastery” (in Journal of Japanese Studies. 20:1. 1984. p. 30). Henri Poincaré, in his chapter “L'invention mathématique” of his *Science et Méthode* also gives an account of the experience of resolution.

[53] It is in this context that we may view Bošković's experimentation: it was done as short-range extension of his transformed or cognitive apparatus, very much similar to the actions of a skilled surgeon whose precise intervention incarnates years of learning, training, and experience.

[54] Ivica Martinović. “The Fundamental Deductive Chain of Bošković's Natural Philosophy” in *The Philosophy of Science of Ruđer Bošković*, Proceeding of the symposium of the Institute of Philosophy and Theology, S. J., Zagreb: Institute of Philosophy and Theology, 1987, p. 67.

[55] If we do not have a tight cause-effect relationship between two propositions, the alternative explanation is to say, as the Buddhists also believe, that proposition A being present, proposition B occurs. In other words, A is the condition for B to occur. What is different is essentially the question of time. If A is not present long enough, B does not occur. This model confirms the importance of commitment in the creative process.

[56] Bošković's principle of simplicity seems to be very close to the modern reformulation and interpretation of Occham's razor principle which states that "when you have two competing theories that make exactly the same predictions, the simpler one is the better." With regard to arts, this principle, or rather value, became an important factor in the development of Japanese arts, especially after the 16th century.

[57] In theology this critical approach appears to manifest itself in a symbolic interpretation, as opposed to a literal one, of the Bible. The decision whether to adopt one or the other is determined by the principle one has decided to uphold. For example, if the idea of reconciliation is the general principle that explains Jesus's saying and actions, his altercations with the Pharisees cannot be literally interpreted as opposition to the pharisaic establishment.

[58] Like in the stereoscope example, the idea “They are not really two-dimensional pictures” is a specific application of the general principle accepted a priori. Within the context of the process of creation, the function of this specific “incarnation” of the general principle is to bring the activity of *reflexio* to a point of saturation. Once one has exhausted all possibilities of contradicting the validity of the accepted principle, one is ripe to move to the last stage of the chain. See Hori's description of *satori* in note 52.

[59] We can now say: “The law of continuity is simple.” Semantically speaking, the predicate *simple* qualifying the subject *law of continuity* is now

included in what is meant by the concept of the law of continuity. Consequently, the return to the status of generality is also an expension in terms of the concretness of one's understanding of reality. In other words, to say that the world is continuous tells us more about this world than just saying that it is simple. This also means that more intimacy with the world gives us more autonomy in it. From the presuppositions of the discourse based on the principle of incarnation, the notion of intimacy and autonomy are like the two faces of a same reality.

[60] In principle it may be true, but in practice, we have no idea when a chain started and where it is going to finish. However, if we were to draw a paralled between Bošković's chain of deduction and his own understanding of the structure of matter, we may also argue that, even in principle, there is no beginning and no end. This statement also implies that there is no absolute distinction between what we know and how we know it, that we tend towards a fusion between the instruments of knowledge and knowledge itself, an idea also congruent with the principle of incarnation.

[61] It is in the experience of learning a new language that we see how intimacy, the degree of assimilation, and autonomy, the degree of ability to do things with the language, are interrelated. The more were understand and can express oneself with a language, the more we are participating in the culture supported by it.

[62] This is where such discourse may become apologetic and ideological.

[63] If we view experimentation as a question we ask the world, it is just an extension of one's observation. As such, no matter how sophisticated the experiment is, it is still dependent on the pertinence of the question we ask.

[64] "Le savant n'étudie pas la nature parce que cela est utile ; il l'étudie parce qu'il y prend plaisir et il y prend plaisir parce qu'elle est belle. Si la nature n'était pas belle, elle ne vaudrait pas la peine d'être connue, la vie ne vaudrait pas la peine d'être vécue. Je ne parle pas ici, bien entendu, de cette beauté qui frappe les sens, de la beauté des qualités et des apparences ; non que j'en fasse fi, loin de là, mais elle n'a rien à faire avec la science ; je veux parler de cette beauté plus intime qui vient de l'ordre harmonieux des parties, et qu'une intelligence pure peut saisir. C'est elle qui donne un corps, un squelette pour ainsi dire aux chatoyantes apparences qui flattent nos sens, et sans ce support, la beauté de ces rêves fugitifs ne serait qu'imparfaite parce qu'elle serait indécise et toujours fuyante. Au contraire, la beauté intellectuelle se suffit à elle-même et c'est pour elle, plus peut-être que pour le bien futur de l'humanité, que le savant se condamne à de longs et pénibles travaux." Henri Poincaré. *Science et Méthode*. p. 9-10.

[65] If intimacy with the world gives us more autonomy, the question is then: what is the priority? For Bošković, intimacy appears to have been the priority whereas modern society, based on profits and power, seems to have inverted the priorities.

[66] Myths are also similar to scientific model in their attempts to "seize" the regularities of reality. Because what we experience from this reality are always concrete events, a myth, as well as a model, ought to be disconnected from the primary ideas resulting from the sense experience. To some extent, the abstractness of a myth is proportional to the range of the regularity it tries to encompass. This relationship between the degree of abstractness and the range of applicability is valid, I believe, for scientific models as well. In order to concretize what it has seized in an abstract manner, myths and models have to recuperate what is available from the culture with which they try to relate.