

# *Review Articles on Religion and Science Around the World*

with Willem B. Drees, “Glocalization: Religion and Science around the World”; Seung Chul Kim, “Śūnyatā and Kokoro: Science–Religion Dialogue in the Japanese Context”; Luís Oviedo and Alvaro Garre, “The Interaction between Religion and Science in Catholic Southern Europe (Italy, Spain, Portugal)”; and Bartosz Brożek and Michael Heller, “Science and Religion in the Kraków School.”

## SCIENCE AND RELIGION IN THE KRAKÓW SCHOOL

by Bartosz Brożek and Michael Heller

*Abstract.* This article outlines the contributions of the Kraków School to the field of science and religion. The Kraków School is a group of philosophers, scientists, and theologians who belong to the milieu of the Copernicus Center for Interdisciplinary Studies. The members of the group are engaged in inquiries pertaining to the relationship between theology and various sciences, in particular cosmology, evolutionary theory, and neuroscience. The article includes a presentation of the historical background of the School, as well as its main original contributions pertaining to the history of the interactions between science and religion, the rationality and mathematicity of the universe, theology of science, and the role of logic in theology.

*Keywords:* cosmology; creation; laws of nature; logos; theology and science; theology of nature

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The goal of this article is to present an overview of the contributions of the Kraków School to the field of science and religion. By the term “Kraków School” we refer to the *milieu* of two institutions: the Center for Interdisciplinary Studies established in the 1980s by Michael Heller and Józef Życiński, and the Copernicus Center for Interdisciplinary Studies, founded in 2008 by Michael Heller. We limit ourselves to the presentation of the work of the Kraków School instead of providing the reader with

Bartosz Brożek is Professor, Department for the Philosophy of Law and Legal Ethics, Jagiellonian University, Kraków, Bracka Str. 12, 31-005 Kraków, Poland; and Deputy-Director, Copernicus Center for Interdisciplinary Studies, Sławkowska Str. 17, 31-017 Kraków, Poland; e-mail: bbroze@yahoo.com. Michael Heller is Director, Copernicus Center for Interdisciplinary Studies, Sławkowska Str. 17, 31-017 Kraków, Poland; and Professor, Philosophical Faculty, Pontifical University of John Paul II, Kanoniczna Str. 25, 31-002 Kraków, Poland; e-mail: mheller@wsd.tarnow.pl.

a panorama of the Polish contributions to science and religion, since the latter task would be too difficult to realize in a short article and would result in a highly incoherent narrative. On the other hand, the works of the members of the Kraków School, guided by some shared methodological precepts, form a relatively coherent whole. Naturally, we are unable to present these works in a detailed and all-encompassing way. Instead, we concentrate on several problems which are highly characteristic of the Kraków School's approach to science and religion, namely, historical studies, the rationality and mathematicity of the universe, theology of science, and logic in theology. We begin, however, by sketching a historical and methodological background of the School's research activities.

### GENIUS LOCI

The end of the nineteenth century marked the beginnings of the Kraków tradition of philosophical reflection on the achievements of science. The establishment of the Philosophical Society in 1909 cemented this approach and resulted in the works of such philosophers as Maurycy Straszewski, Władysław Heinrich, Władysław Natanson, Joachim Metallman, Zygmunt Zawirski, Bolesław Gawecki, and Tadeusz Grabowski (Heller and Mączka 2007; Polak 2013). Although it would be difficult to describe this group as a philosophical school, they undoubtedly shared the conviction that in order to philosophize in a reasonable and responsible way one needs to take into account the findings of contemporary science. Moreover, this endeavor required a close collaboration between philosophers and scientists (in fact, Heinrich was a trained psychologist as well as a philosopher, Natanson was primarily a physicist, and Gawecki studied mathematics and physics).

In August 1936, a conference was held in Kraków which may be regarded as the beginning of the so-called Kraków Circle, comprised of Józef Bocheński, Jan Franciszek Drewnowski, Jan Salamucha, and Bolesław Sobociński. The goal of the Circle was to apply modern logic to the analysis of Catholic theology. The Circle did not survive long: Salamucha's death during the Warsaw Uprising in 1944 and Bocheński's and Sobociński's emigration after the Second World War ended the group's collaboration. However, during the few years of its existence the Kraków Circle produced a number of important articles on the use of logic in theology, the reconstruction of Aquinas's arguments for the existence of God, as well as on the relationship between theology and the sciences. Moreover, the Circle's program survived in the work of Józef Bocheński and culminated in his seminal *The Logic of Religion* (Bocheński 1965).

The ideas behind the Kraków philosophy of nature exemplified by the works of Metallman, Natanson, and Zawirski, as well as that of the Kraków Circle, although not followed systematically, became one of the ingredients of the Kraków's *genius loci* and survived in the tradition of

intellectual exchange between philosophers, scientists and theologians. It is against this background that the origins of the Center for Interdisciplinary Studies in the 1980s, and the establishment of the Copernicus Center for Interdisciplinary Studies in 2008, are best understood.

What distinguishes the Kraków School from other research centers that concentrate on the analysis of the interactions between science, philosophy and theology is the method it employs. Like any reasonable method of analyzing the methodology and the findings of the sciences, the “Kraków method” embraces good command of the philosophy of science, solid knowledge of the history of science, the application of logical (formal) tools, and an interdisciplinary approach to the analyzed problems. Moreover, the method of the Kraków School is somewhat specific. It is best captured by the slogan “Philosophy in science,” which should be distinguished from philosophy of science. In his seminal article, “How is ‘Philosophy in Science’ possible?” Michael Heller (2011) suggests that the “philosophy in science” research program should concentrate on the following, interrelated problems: (1) the influence of philosophical ideas on the development and evolution of scientific theories; (2) the traditional philosophical problems intertwined with empirical theories (e.g., time, space, consciousness, so on); and (3) the philosophical reflection over the assumptions of the scientific methods (e.g., the assumption of the mathematical character of the universe, the assumption of the idealizability of nature; the assumption of the elementary character and the unity of the laws of nature). To these, one might add other issues which constitute the “philosophy in science” field of reflection: (4) science as philosophy (e.g., the fact that physical theories may be treated as the best ontologies we have); and (5) migration of concepts (i.e., the analysis of the ways philosophical and theological concepts are used in science, or *vice versa*, and how in the course of history some philosophical concepts become scientific concepts, or *vice versa*). It is against this broad methodological framework that the Kraków School carries out its studies of the interactions between science and religion.

#### HISTORY OF THE RELATIONSHIP BETWEEN SCIENCE AND RELIGION

In order to better grasp the complexity involved in the relationship between science and religion one needs, in addition to methodological awareness, an in-depth understanding of the history of the problem. This precept is the driving force behind numerous historical studies carried out by the members of the Krakow School. Below we outline only their main threads.

Medieval philosophy—as a whole—may be regarded as an attempt at reconciling reason and faith. Arguably, the main goal of medieval philosophers was to show how the articles of the Christian faith may be expressed in the conceptual scheme developed by Ancient Greek philosophers. In consequence, medieval philosophy represents the first systematic attempt at

uncovering the complexity of the relationship between religion and science (or, more precisely, religion and natural philosophy). There are episodes in this history which are well documented, such as the doctrines of Thomas Aquinas or Bonaventure. However, medieval philosophy is filled with numerous conceptions, which—although less well known—paved the way for the birth of the modern science, as well as for the development of interesting accounts of the interaction between science and religion.

One such example is the School of Chartres (twelfth century), whose conception of nature was examined in detail by Zbigniew Liana (Liana 1996). Liana argues that in the writings of Theodoric of Chartres and William of Conches one finds a passage from the mythical understanding of nature as a metaphor or symbol of religious truth to its more rational rendering, one that opened the way to the study of nature based on reasons independent of Revelation. From this point of view, the autonomous understanding of nature proposed by the School of Chartres contributed to the subsequent changes in the medieval worldview, which ultimately led to the development of modern science.

Another example is the so-called conception of double truth, analyzed by Bartosz Brożek (Brożek 2010). It is usually claimed that the conception originated in the Middle Ages and was developed by Latin Averroists, notably Siger of Brabant and Boethius of Dacia. It is also claimed that it can be found in the writings of other authors, for instance Pietro Pomponazzi and even John Buridan. A more careful historical analysis reveals, however, that none of the mentioned authors can be said to have held a double truth idea. At the same time, however, the accounts of the interactions between natural philosophy and theology they offer are quite illuminating. Siger of Brabant seems to have struggled to reconcile Aristotelian philosophy with the articles of Christian faith, and indeed often confined himself to the presentation of the philosophical doctrines, without addressing directly their apparent incompatibility with Christianity. Some fifty years later, John Buridan had no such problems. By introducing the distinction between the natural order (*ordo naturalis*), which can be investigated with the power of human intellect, and the supernatural order (*ordo supranaturalis*) based on revelation, and indicating that it is only the former that constitutes the proper domain of natural philosophy, he eliminated the possibility of contradiction between faith and reason.

The birth of modern science was arguably the second important event in the history of science and religion. It is thus not surprising that the members of the Kraków School have devoted much attention to some of the leading figures of the first scientific revolution. Zbigniew Liana analyzed the interactions between science and occultism from the Renaissance to the Enlightenment (Heller et al. 2001). He also devoted several studies to the conceptions of Giordano Bruno (Heller et al. 2001), while Tadeusz

Sierotowicz prepared the first Polish translations, together with a commentary, of some of Galileo's writings (Sierotowicz 2006, 2009, 2013).

Another important thread in the Kraków School's historical studies of science and religion is devoted to Russian philosophy, and in particular to the doctrines developed in the nineteenth and twentieth centuries. In her two monographs, Obolevitch (2003, 2006) analyses the philosophical writings of Vladimir Solov'ev and Semen Frank, two of the most important Russian philosophers of the nineteenth century. She not only uncovers their interest in modern science, but also provides an in-depth analysis of their accounts of the relationship between science and religion—a conception which is developed against the backdrop of the peculiar Russian idea of all unity. In a more recent study (Obolevitch 2014), she traces the origins and consequences of the neopatristic renaissance in Russian thought in the twentieth and twenty-first centuries, and concentrates on such figures as Georges Florovsky and Vladimir Lossky. Her analyses provide an impressive panorama of the contemporary Orthodox philosophy and theology, in particular concerning the relationship between science and religion.

The members of the Kraków School have also carried out a number of studies pertaining to the views on science and religion expressed by the leading scientists of the twentieth century. To this category, there belong studies devoted to the conceptions of Werner Heisenberg (Grygiel 2011), Erwin Schroedinger (Koleżyński 2011), E.T. Wittaker (Pabjan 2011), Wilhelm Ostwald (Janusz 2011) and Georges Lemaitre (Heller 2009). Also, the newest history of science and religion, exemplified by the series of conferences on divine action organized since 1987 by the Vatican Observatory and CTNS has been the subject of extensive study. In a monograph (Sierotowicz 1997), Tadeusz Sierotowicz offers an all-around analysis of the different approaches to science and religion represented by the participants of the conferences. He also suggests that any discussion pertaining to science and religion requires an appropriate "space," and believes that such a "space" is to be found in the concept of a worldview. Worldviews are the most general pictures of the world, constructed from scientific, religious, philosophical, and artistic elements. Sierotowicz claims that it is at this level that the meeting between science and religion takes place, and hence a methodologically sound analysis of the relationship between them is possible only within the context of worldviews.

Finally, Heller et al.'s textbook (2001) constitutes the Krakow School's attempt at a synthesis of the history of science and religion. The book covers the accounts of the interactions between science and religion since their beginnings in the Ancient Greek philosophy to the birth of modern science. Two further volumes devoted to modern and contemporary history of the topic are in preparation.

## THE FIELD OF RATIONALITY

In the context of the relationship between science and religion, the problem of the rationality of the universe as well as of our cognitive undertakings finds fertile ground. From the theological perspective, the universe, which is God's creation, must be seen as rational and purposeful. The scientific perspective is similar and dissimilar at the same time: one of the presuppositions of the scientific method is that the world can be investigated in a rational fashion, but the method of science is "blind" to purpose and values. This arguably is one of the sources of tensions between science and religion, which are clearly visible at two distinct levels. First, the theological doctrine of miracles seems to be incompatible, at least at face value, with the scientific assumption that ultimately every phenomenon which takes place in the universe may be explained by recourse to the methods of science. This problem is strictly connected to the question of the divine action: how can God act in the world? One of the strategies often employed in this context is to claim that God acts through the indeterminacies of the laws governing the universe. This tactical maneuver to save divine action in the world of science is problematic; it heavily relies on quantum theory, the correct interpretation and fundamental character of which are highly debatable. It also, at least in some of its formulations, is dangerously close to the theologically compromised doctrine of the so-called God of the gaps.

Second, one can take a more holistic perspective and consider the rationality and purpose of the universe as a whole. While science cannot investigate this problem, it remains a *locus classicus* of theological thought. This may easily lead to the temptation to impose some theological constraints on science, as it seems to be the case with creationism and, in a much subtler way, the intelligent design movement. In other words, if the question of the purpose of the universe is transparent to the methods of science, this constitutes an opportunity to abuse the theological mode of thinking, disregarding the autonomy and self-contained character of the scientific endeavors.

The Kraków School is sensitive to both aforementioned dangers. In reply to them, Józef Życiński said:

Instead of God hidden in Heisenberg's uncertainty, or expressed in the so-called physical chaos, we propose a model, in which the role of God immanent in cosmic history is contained in laws of nature as well as in what we metaphorically call the "boundary conditions." The expression denotes theologically conceived boundary conditions in which non-physical (i.e., biological, psychic, spiritual) factors are also taken into consideration in a system considered "from God's point of view" (again metaphor). (Życiński 1997, 15)

Thus, Życiński believed that in order to explain how divine action is possible one does not need to postulate "gaps" in the laws of nature through

which God would operate; instead, he stressed God's immanence *in* those laws. The same argument helps to understand how purposefulness in the universe and the existence of values is not incompatible with the "blind" mechanisms of evolution:

The God kenotically hidden in nature engages human species in the process of evolution which, on the level of our existence, manifests itself above all in the sphere of culture. In the emerging reality of cosmic growth, our pain is not eliminated but it receives a radically different meaning. The sense of rationality can be discovered both in the immanent divine Logos and in emerging structures of the evolving universe. (Życiński 2014)

Życiński extended this view by contemplating the unreasonable effectiveness of mathematics in the natural sciences and postulating that it can be explained by the idea of the field of rationality. By this concept he refers to the network of potentially existing structures which, at the appropriate time, are instantiated as the laws of physics. On this view, the universe is embedded in a larger whole of the potential patterns, which may be "invisible" to the method of physics, but may be contemplated by theologians, philosophers, and mathematicians (Życiński 2013; Heller 2014).

A similar idea—that of the formal field—was developed by Michael Heller. The formal field "involves some potentiality, as it contains not only the already discovered mathematical structures, but all possible such structures" (Heller 1997, 236). Thus, the formal field is not an axiomatic system, but the whole of (possible) mathematics. A sufficiently rich axiomatic system (which captures some aspect of the formal field), is always subject to Gödel's and similar theorems, while the formal field escapes any axiomatization. At the same time, it may be interpreted ontologically "as something which enjoys some kind of existence and conditions the possibility of the mathematics we create, as well as the unreasonable effectiveness of mathematics in modelling the world" (Heller 1997, 238).

The idea of the formal field (or the field of rationality) complements Heller's analyses of the mathematicity of the universe. Heller introduces this concept in the following words:

In the investigation of the physical world one method has proved particularly efficient: the method of mathematical modeling coupled with experimentation (to simplify, in what follows I shall speak of the mathematical method). The advances in physics, since it has adopted the mathematical method, have been so enormous that they can hardly be compared to the progress in any other area of human cognitive activity. This incontestable fact helps to make my hypothesis more precise: the world should be ascribed a feature thanks to which it can be efficiently investigated with the use of the mathematical method. Thus the world has a rationality of a certain kind—mathematical one. It is in this sense that I shall speak of the mathematicity of the universe. (Heller 2006, 48)

According to Heller, to say that the world is mathematical is equivalent to the claim that it possesses a feature which makes the mathematical method efficient. In the quoted passage Heller hints at one of the aspects in which the mathematicity of the world should be understood: the efficiency thesis. It says that the mathematicity of the universe is evident once one considers the enormous success of the mathematical method during the last 300 years. The success cannot be a pure coincidence, as the efficiency of mathematics in uncovering the laws of nature seems “unreasonable” (Wigner 1960).

The second aspect of the mathematicity of the universe may be called *the miracle thesis*. It is possible to imagine worlds which are *mathematical* in a certain sense, yet nonidealizable. Heller considers a hierarchy of such worlds. “The most nonmathematical” is a world in which no mathematical and logical principles are observed (including any stochastic or probabilistic laws). Next, he suggests considering a simplified model of the world: let us assume that the world in question may be in one of only two states, represented by “0” and “1.” Now:

The history of this world is thus a sequence of “0”s and “1”s. Assume further that the world had a beginning, what may be represented by a dot at the beginning of the sequence. In this way, we get, for example, a sequence:  
.011000101011 . . .

The task of a physicist is to construct a theory which would enable to predict the future states of the world. Such a theory would amount to the “encapsulation” of the sequence of “0”s and “1”s in a formula (which is shorter than the sequence it encapsulates). Such a formula may be found only if the sequence of “0”s and “1”s is algorithmically compressible. But this leads to a problem. Such a sequence may be interpreted as a decimal expansion of a number in  $(0,1)$  and—as well known—the set of algorithmically compressible numbers belonging to  $(0,1)$  is of measure 0 (. . .). Thus (. . .) there is zero-measure chance that a sequences of “0”s and “1”s, representing our world, belongs to the set of algorithmically compressible sequences and so the physicist, who investigates such a world, may have no rational expectation to discover the theory she is looking for. (Heller 2006, 51–52)

This observation underscores “the other side” of the mathematicity thesis: not only is the universe mathematical (and hence penetrable by *some* mathematical method), but it is also mathematical in a nonmalicious way (and hence penetrable by *our* mathematical methods).

It should be clear by now that the analysis of the mathematicity of the universe, although an intriguing problem on its own, has far-reaching consequences for the study of science and religion. One of Leibniz’s famous sayings is “*Dum Deus calculat et cogitationem exercet, mundus fit.*” Within the framework provided by Życiński and Heller, this may be interpreted as the claim that God takes advantage of the field of rationality to create the laws governing the universe, and it is through those laws enabling the cosmic evolution (together with the biological and the cultural evolution)



that He is immanently present in the universe. This holistic view is clearly different from what the proponents of direct divine action, as well as of intelligent design suggest, as the position adopted by Życiński and Heller does not violate the autonomy of science, while underlining its inherent limits.

To further consolidate this view, in one of his latest books, *Philosophy of Chance* (Heller 2012), Heller argues that chance should not be considered as a breach in rationality, but rather as a perfectly rational strategy of the evolutionary processes. Heller observes that probability calculus is as good a mathematical structure as any other; in consequence, the fact that certain laws of physics are probabilistic does not invalidate the claim that they are rational. Moreover, he insists that the probabilistic character of some of the physical laws may be the prerequisite for the evolutionary occurrence of qualitatively new phenomena. In other words, chance is neither contrary to God's design (or, as Heller prefers to put it, it is not something incompatible with the Mind of God), nor it is evidence that there is no cosmic plan involved and that the real face of God is that of a blind watchmaker.

The problem of rationality is not limited to the question of whether the structure of the universe is rational; rationality is also a feature of our actions (or rather, we would like to think so). This leads to the issue of the rationality of faith, since the alleged tensions between science and religion are often stated in terms of the opposition between reason and faith. In his book *Racjonalność wiary (The Rationality of Faith)*, Stanisław Wszolek provides an in-depth analysis of the various dimensions of rationality (Wszolek 2003). He claims that the opposition between faith and reason presents us with a false alternative. The received conceptual framework, inherited from medieval and early modern philosophers, stresses the differences between knowing and believing. However, there are many conceptions of rationality—for example, the one proposed by Charles Sanders Peirce—which underline the constant interplay of faith and reason. As Wszolek puts it, faith is—at its roots—reasonable, while reason cannot operate without faith.

#### THEOLOGY OF SCIENCE

In his book *Nowa fizyka i nowa teologia* (Heller 1992, translated into English as *The New Physics and a New Theology* [Heller 1996]), Michael Heller proposed to develop, by analogy to philosophy of science, a new theological discipline, theology of science, understood as “an authentic theological reflection dedicated to the sciences: to their existence, their foundations, their methods, and results” (Heller 1996, 96). When doing science one investigates the universe. This statement is almost tautologically true because the universe can be defined as the totality of things that are

investigated in the process of doing science. The universe is given to the sciences in their method. In this sense the limits of the scientific method are the limits of the universe. Everything that transcends the empirical investigation transcends, from the very definition, the universe of the sciences. We should notice, however, that the limits in question are defined “from the side of the sciences,” that is, by approaching them from within the domain controlled by the sciences.

The basic theological tenet concerning the universe is that it has been created by God. This statement should also be understood as a tautology if by the universe we mean everything that has been created by God. It is therefore evident that the universe of the sciences and the universe of theology differ from each other, and this difference is a consequence of different methods employed by these disciplines. The universe of theology is “bigger” than the universe investigated by the sciences. This is so not only because the universe of the sciences coincides with what we call the “material universe” and the theological universe goes beyond the realm of matter, but also because the method of theology is able “to see” in the “material universe” some aspects that are transparent for the scientific method. Precisely at this point there appears the possibility of doing theology of science. Its goal is to investigate those aspects of the world that are inaccessible for the method of science but which can be grasped with the help of typically theological tools. Heller notes:

The purpose of the theology of science is the same as that of all theology [i.e., the reflection over the Revelation], but always with reference to the specific object of a given theological discipline. The theology of science is dedicated to a critical reflection on those data of Revelation which allow us to contemplate the sciences as a specifically human activity. (Heller 1996, 99)

There is a theological problem which is particularly suited to be analyzed against the background of the sciences, that is, the doctrine of creation. In this context, theology of science may pose a number of crucial questions. First, how can scientific theories of the origin of the universe enrich the theological doctrine of the creation? And, on the other hand, how can theological reflection contribute to our understanding of scientific theories of the origin? The latter issue is a delicate one, since theology should not play the role of a “judge” influencing acceptance or rejection of scientific theories or models. Second, how can scientific theories pertaining to the growth of complexity in the universe, life and intelligence included, enrich theological reflection on the place of man (and humanity) in the creation? How can the cosmological and biological scenarios of evolution be included in the theological account of creation? And finally, third, can scientific data concerning the above issues contribute to, or even enforce, a reinterpretation of some aspects of the theological doctrine of creation?

However, theology of science is not limited to the questions connected to the concept of creation. For example, at least from the time of the Vienna Circle, it is well known that the scientific method is insensitive to values: normative and evaluative sentences do not belong to the scientific language. However, this does not mean that values are not present in the world. From the theological perspective, the universe is an implementation of the creative plan of God. (This has nothing to do with the so-called Intelligent Design movement.) This plan contains in itself not only those aspects of the world that the sciences attempt to decipher with the help of their own methods, but also those aspects of reality that in axiology are called values. To see the sciences in the light of values would constitute another task for theology of science. Axiology of science, analyzing epistemic values as present in scientific methodology, is now quite fashionable in the philosophy of science. However, theology of science aims at something different: to contemplate science itself as an authentic theological value.

Let us illustrate this point by considering Einstein's famous question: Why is the world comprehensible? The very existence of science and the successes of its method testify to the fact that the world can be rationally investigated. The method of science presupposes that the world possesses a the property capable of answering questions addressed to it, provided they are formulated in the correct language (typically in the language of mathematics). Philosophical analysis of Einstein's question can disclose its nontrivial character but is unable to go any further. However, when contemplated in the light of theological principles, this question can be put into a broader context showing its deeper meaning. The world has been created by God according to God's rational plan. Science is but a human endeavor to decipher this plan. The rationality of the world remains very close to the concept of *Logos*—the immanence of God in his creation. Thus, the theology of *Logos* is a pivotal part of the theology of science (Heller 1992).

It is noteworthy that the program of the theology of science has recently culminated in a collection of essays (Mączka and Urbańczyk 2014).

#### LOGIC IN THEOLOGY

The analysis of the role of logic in theology is instrumental to any attempt to account for the relationship between science and religion, since without a structural characterization of theology, as well as of the possible formal connections between theological and scientific theories, no such account can be developed. In pursuing the project of "Logic in Theology" the members of the Kraków School follow in the footsteps of the Kraków Circle (described above); however, the goal is no longer to apply the tools of contemporary logic to the reconstruction of Thomistic theology, but

rather to provide formal analysis of all kinds of theological problems, as well as the interrelations between theology and the sciences.

There are a number of questions that serve as guidance in this endeavor. The first is whether there exists *the* logic of theology. In terms of the philosophy of logic, it boils down to establishing whether logic can be domain-specific. This turns out not to be the case. There are many examples of logical systems designed for some specific domain, but they always ultimately find applications in other domains. In the same way, one should not expect to develop *the* logic of theology, that is, a formal system that would be suitable only for the reconstruction of theological discourse. Logic, understood either as providing the structural characterization of thought or else as the formal basis of language, will always remain domain independent (Brożek forthcoming).

A related problem is whether there exists one particular formal system, which—even if it can be applied outside of theology—would be the proper one to reconstruct theological discourse. In other words, the question is whether theology is tied up to one particular type of logic or rather makes use of different formal systems. It comes as no surprise that theologians should be logical pluralists. Different theological problems require different logical tools. One way of explaining this fact hangs together with the observation that there are, broadly speaking, two kinds of formal systems: those, which assume the perspective of a perfect agent (i.e., someone who has full knowledge of the relevant facts) and those which are designed to model the reasoning of imperfect agents. To the first category there belong classical and intuitionistic logics, while the second group embraces all kinds of nonmonotonic systems (a logic is monotonic if an addition of a new premise to a set of previously accepted premises never reduces the already established set of consequences; otherwise it is nonmonotonic). Now, the argument runs, theologians speak of different kinds of situations. When they strive to say something regarding the nature of God (or from God's perspective), they are dealing with a perfect agent, and hence they need to utilize the first kind of logic. On the other hand, when their goal is to describe the reasoning of humans (i.e., imperfect agents), they will usually need some kind of nonmonotonic system (Brożek and Olszewski 2013; Dadaczyński 2013).

Logical analysis can also constitute a point of departure for theological considerations. For example, it may be easily shown (Rotolo and Calardo 2013; Brożek forthcoming) that any description of God with the use of modal terms leads to a “modal collapse.” Alethic modalities (it is possible that  $p$ , it is necessary that  $p$ ), deontic modalities (it is obligatory that  $p$ ), as well as epistemic modalities (it is known that  $p$ ), when applied to God, turn out equivalent to  $p$  itself (i.e., “it is possible that  $p$ ” is equivalent to “it is necessary that  $p$ ,” which is equivalent to “it is obligatory that  $p$ ,” which is equivalent to “it is known that  $p$ ,” which is equivalent to “ $p$ ”).

From the logical point of view such a collapse is unwelcome, as it renders a complex network of modal notions useless. However, contemplated from the perspective of theology, it is at least intriguing, as it shows that in the case of God, possibility, necessity, obligation, knowledge, and fact are one and the same.

Still another logical problem connected to science and religion is the formal dimension of intertheoretical relations. The formal theory of intertheoretical relations, often ignored by philosophers and theologians alike, seems essential to the understanding of the relationship between theology and science (Brożek 2010). This is an approach that takes science and theology as two separate sets of sentences (i.e., as two separate first-order theories) and asks the question what is the relationship between them. From the logical point of view, one might speak of various possible relationships here: that of mutual translatability, or partial translatability; one can also treat theology as providing science with a set of presuppositions; it is also possible to utilize Bocheński's idea of the "religious hypothesis" (Bocheński 1965)—Bocheński claims that the act of religious faith may be logically accounted for as a hypothesis that makes our worldview (including science) more coherent. (This phenomenon can be reconstructed by the means of the formal theory of belief revision coupled with the logical measure of coherence.)

It should also be noted that the works of the members of the Kraków School pertaining to the logic of religion are not limited to the aforementioned problems, but include also the analyses of the ontological arguments (Wszolek 2011), the reconstruction of Aquinas's *quinque viae*, and the problem of analogical reasoning in theology (Wolak 2005), as well as other historical and systematic studies (Piechowicz 2011).

#### BEYOND RESEARCH

The research activities of the Kraków School constitute a perfect platform for the engagement (in recent years mainly through the Copernicus Center for Interdisciplinary Studies) in other kinds of projects, such as academic conferences, teaching, popularization, and publishing. Those activities are largely possible thanks to two major grants the Copernicus Center received from the John Templeton Foundation: "The Limits of Scientific Explanation" and "Science for Ministry in Poland."

During the last five years the Copernicus Center has organized fifteen conferences and international seminars devoted (at least partly) to the issue of science and religion. They served to discuss such problems as logic in theology, the language of theology, theology of science, the problem of causality and divine action, theology and mathematics, religion and culture in Russian thought, human being and the universe in Eastern thought, and Eastern-Christian discourse and Russian philosophy.

In education, the Copernicus Center has been organizing a postgraduate e-learning course in science and religion, as well as preparing a series of fifteen online courses, covering the history of science and religion, some methodological issues (introduction to theology, philosophy of science, biblical studies) and specific problems (e.g., evolutionary theory and religion, neuroscience and religion, cosmology and religion). The courses will be launched within the next two years.

The Copernicus Center has also devoted much attention to the popularization of the science and religion problematic. In cooperation with the weekly *Tygodnik Powszechny* they are publishing a series of popular articles on the main problems and questions generated by science and contemplated from the religious perspective. They also organize the annual Copernicus Festival, a five-day event devoted to the role of science and religion in culture. Further, the website [naukaireligia.pl](http://naukaireligia.pl) developed and run by the Center is the first place in the Polish Internet for discussing science and religion. The webpage is rich with educational material, video lectures, and popular as well as academic-level articles.

Finally, Copernicus Center Press publishes two series of books. The *Science and Religion Library* includes important works on the topic (e.g., by Ernan McMullin, Olaf Pedersen, Alvin Plantinga, Daniel Dennett, Michael Heller). A different project is a series of mini-e-books: short electronic texts on the relationship between science and spirituality, written by philosophers, theologians, historians, scientists, novelists, and poets. Some of the books published by Copernicus Center Press are reviewed by Willem Drees in this issue of *Zygon*.

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