History of Mathematics

Religious Heresy and Mathematical Creativity

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During the last several decades we have frequently gone to the Soviet Union and, after its collapse, to Russia, where we have often worked with scientists. Gradually a remarkable story about the relationship of science and religion in Russia has emerged from conversations with Russian colleagues. The story helps explain the birth of the Moscow School of Mathematics, one of the most influential modern movements in mathematics. The conflict at the center of the story persists today and raises fundamental questions about the nature of mathematics, not only in Russia, but throughout the world. Since the history of the issue dates to the early years of the last century we must begin with a single event then. This event kicked off a movement that is still alive.

Early in the morning of July 3, 1913, two ships from the Imperial Russian Navy, acting on Tsar Nicholas II's orders, steamed into the azure waters surrounding the holy mountain of Mt. Athos in Greece, a center of Orthodox Christianity for a thousand years. The ships, the Donets and the Kherson, anchored near the Pantaleimon Monastery, a traditional center of Russian Orthodoxy and residence of hundreds of Russian monks. Small boats loaded with armed Russian marines made their way to the dock, where the men disembarked. The marines proceeded to the cathedral of the monastery, at that moment nearly empty. There the officer in charge met with several of the religious ascetics and told them that they were to inform all their brethren to leave their cells and assemble in the cathedral. When the other monks learned of the order, they barricaded the doors of their cells with furniture and boards. Inside they fell on their knees and began crying "Lord, Have Mercy!" (*Gospodi pomilui*) and many of them launched into a unique prayer, one causing controversy in the Church, called "The Jesus Prayer." (We will say more later about the Jesus Prayer).

The Russian officer demanded that the monks come out. When he was ignored, he ordered his marines to tear down the barricades and aim water from fire hoses at the men inside. The marines flushed the recluses from their cells and herded them into the cathedral. There the officer announced to the soaked and terrified monks that they must either renounce their heretical beliefs or be arrested. Only a few stepped forward and promised to obey. The others remained obstinate, crying that the marines represented the "Anti-Christ." The officer commanded the marines to force the recalcitrant crowd onto the waiting ships which took them to the Ukrainian-Russian city of Odessa, on the Black Sea. In all, approximately 1000 monks were detained in this fashion (The sources differ on how violent this operation was; according to some sources the marines at one point used a machine gun and killed several monks; official accounts deny

this, but it was certainly a bloody affair, with many wounded.).

In Odessa the religious believers were told that the Holy Synod in St. Petersburg – the highest authority of Russian Orthodoxy – had condemned them as heretics for engaging in the cult known as "Name-Worshipping." They were forbidden to return to Mt. Athos or to reside in the major cities of St. Petersburg and Moscow. They were also warned that they must not practice their deviant religious beliefs in Russian Orthodox churches on penalty of excommunication. Otherwise they were free to go. The unrepentant monks dispersed all over rural Russia where they often lived in remote monasteries, far from central authorities, and continued there to practice their heresy and to propagate their religious faith.

Instead of dying out, as the tsarist authorities obviously hoped that it would, the heresy continued to spread surreptitiously. With the outbreak, a year later, of World War I the attention of the tsarist government shifted elsewhere. Name-Worshipping silently increased in strength, gradually moving from the countryside to the cities, where it attracted the attention of the intelligentsia, especially mathematicians, some of whom believed it contained profound insights for their field. Among the leading mathematicians who became interested in Name-Worshipping were Dmitri Egorov (1869-1931) and Nikolai Luzin (1883-1950), later the founders of the Moscow School of Mathematics. In seeing connections between mathematics and Name-Worshipping they were aided by a heretical priest, Father Pavel Florenskii (1882-1937), a former fellow mathematics student at Moscow University, where both Luzin and Florenskii studied under Egorov. At the university Florenskii

and Luzin served, one after the other, as secretary of the Student Circle of the Moscow Mathematical Society, of which their professor, Egorov, was later president. In subsequent years they carried on an 18-year correspondence, often about mathematics and religion.

Both the Russian Orthodox Church and the new Communist regime persecuted Name-Worshipping after the Revolution of 1917 but it never died out. Following the collapse of the Soviet Union it has been enjoying a small resurgence in Russia. But even now it remains a "heresy," equally opposed by intellectual camps so different that their followers usually agree on very little: Marxists, the leaders of the Russian Orthodox Church, and secular rationalists.

What was "Name-Worshipping" and how could this religious movement have anything to do with mathematics? Both mathematicians and religious believers try to grasp concepts that seem inexpressible, ineffable, or even inconceivable. The history of mathematics demonstrates a number of such moments. "Infinity" was first denoted by the Greeks as *apeiron* ("endless, unlimited mass," "primal chaos"), irrational numbers ("alogoi," absence of logos) were unspeakable or unthinkable at the time of Pythagoras, and imaginary numbers were only reluctantly accepted in the Renaissance. In modern times "ideal theory" began with numbers which were only supposed to exist "ideally."

In the period 1890-1930 a great debate was occurring among mathematicians over the new field of set theory, a controversy that became connected in the minds of some leading Russian mathematicians to Name Worshipping. (Let us explain, for non-mathematicians, what set theory is about.) A "set" is a collection of

objects sharing some property and given a "name." The set of all giraffes in South Carolina could be named "SCG" for "South Carolina Giraffes." This set obviously has a finite number of elements. By its description this set is different from the set of all donkeys in South Carolina (SCD) or the set of all giraffes in Massachusetts (MG), but in each case, the number of elements of these sets is finite.

The birth of set theory at the end of the nineteenth century saw the development of debates about the nature of "infinity." Was there more than one kind of infinity, and could these different kinds be ordered? Mathematicians - at least some of them - were in a deep crisis over the foundations of their discipline.[1] At first the thought that many different types of infinities exist seemed counterintuitive. After all, is not infinity the largest of all possible numbers, a single abstraction? Nonetheless, mathematicians began to distinguish two very different "infinities." If one starts counting "1, 2, 3, 4, 5, 6, 7, 8, 9 ..." obviously the process can go on without end. The set of all the integers in this series has an infinite number of elements,. If we look at the set of points on a segment of a line, it also has an infinite number of elements. Is the "infinity" in the endless series of numerals and the "infinity" of points on a line of the same type? The new theory of infinities began in December 1873 when Georg Cantor proved that these are different: one cannot "count" the number of points on a line. Then Cantor defined an infinity of infinities, the alephs, and another infinity of other numbers corresponding to *ordered* sets, and he gave new names to all these infinities, for example, Aleph-nought and Aleph-one. A crucial point here is the idea of "naming." After Cantor assigned dif-

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[1] Hermann Weyl, "Über die neue Grundlagenkrise der Mathematik," *Mathematische Zeitschrift* 10 (1921), pp. 39-79. A particularly clear exposition of the crisis can be found in Sanford L.Segal,"The Crisis in Mathematics," in his *Mathematicians under the Nazis* (Princeton University Press: Princeton, 2003), pp. 14-41.

ferent names to different infinities, these infinities seemed to take on a reality that they earlier had not possessed. A new world of "transfinite numbers" was being created. Moreover, the concept of "naming", as we will see, became the link between religion and mathematics.

Even many leading mathematicians were reluctant to accept this new world. How do we define these new infinities? Is it possible to postulate the existence of a mathematical entity before it is defined?

According to most monotheistic religions "God" is also beyond the comprehension of mere mortals, and cannot be defined. Is it possible to postulate the existence of a deity before it is defined? If God is in principle beyond human comprehension (and in the Christian and Jewish scriptures there are many such assertions) how, in complete ignorance of his nature, can human beings worship him? What does one worship? Traditionally, religious believers have side-stepped this question through the use of symbols: prayers, names, rituals, music, relics, scents, tastes, etc. Symbolism is the term given to a perceptible object or activity that represents to the mind the semblance of something which is not shown but realized by association with it. And the importance of symbols both to religion and mathematics is one of the many bonds that brought mathematicians and religious believers together in Russia in the early decades of the last century. Both mathematicians and religious believers use symbols they do not fully master.

Names are symbols, and the significance of assigning names to objects has been a controversial question throughout the history of philosophy and religion. One of the great theological disputes of the middle ages, that over nominalism, revolved around it. When one invents a name, does one at the same time create something new, or does one merely give a label to an existing thing? For example, we might ask, "Is the term 'virtual reality,' so commonly used in computer science, a human construction or a tag attached to something already existing?"

The issue goes back to the beginning of human thought. In Genesis we are told, "God said 'Let there be light' and there was light." He gave the thing a name before he created it. The ancient Egyptian God Ptah is described in Memphite theology as creating with his tongue that which he first conceived in his head. Naming God is forbidden in the Jewish tradition, and in the mystical Kabbala (Book of Creation, Zohar) a large role is assigned to language in the act of creation. In the first verse of the gospel according to St. John we read, "In the beginning was the Word, and the Word was with God, and the Word was God." Words are names, and one of the leaders of the Russian Name-Worshippers, the monk Ilarion, said "the name of God is God!" ("Imia Bozhie *est'* sam Bog").

Intellectual and artistic Russia at the end of the nineteenth century and in the first decades of the twentieth was seized with the question of the significance of symbols. The Symbolist Movement affected ballet, music, literature, art and poetry, as the names Diaghilev, Stravinsky, Belyi, Stanislavsky, Nemirovich-Danchenko and Meyerhold remind us. Now we should add the mathematicians Egorov and Luzin to such lists. Indeed, there was even a connection between the literary and mathematical movements. Andrei Belyi, the symbolist poet, was the son of a Moscow mathematician, and he majored in mathematics at Moscow University where he studied under Egorov and together with Luzin. He was familiar with Name-Worshipping. Belyi once wrote an essay called "The Magic of Words" in which he claimed, "When I name an object with a word, I thereby assert its existence." We can ask, "Does this apply both to mathematics and to poetry? If the object is a new type of infinity, does that infinity exist just after you name it?"

At the heart of the Name-Worshipping cult was the "Jesus Prayer" *(Iisusovaia molitva)*, a religious practice with ancient roots. In the Jesus Prayer the religious believer chants the names of Christ and God over and over again, hundreds of times, until his whole body reaches a state of religious ecstasy in which even the beating of his heart, in addition to his breathing cycle, are supposedly in tune with the chanted words "Christ" and "God." According to Name-Worshippers the proper practice of the prayer brings the worshipper to a state of unity with God through the rhythmic pronouncing of his name. Franny observed in J. D. Salinger's novel *Franny and Zooey* that in this state of ecstasy "you get an absolutely new conception of what everything's about."

The Jesus Prayer has always been part of the Russian Orthodox tradition but it took on an unusual prominence in the late nineteenth century after the publication in 1884 of a book entitled *The Way of the Pilgrim,* later translated into many languages, in which the potency of the prayer was acclaimed. The prayer became popular throughout Russia. According to some sources the Empress Alexandra and her notorious advisor Rasputin sympathized with the heresy and unsuccessfully tried in 1913 to stay the hand of Tsar Nicholas II in arresting the heretical monks in Athos. But the establishment of the Orthodox Church won out with its view that the Name-Worshippers were pagan pantheists who confused the symbols of God with God Himself. The Church officials advised Nicholas to squelch the heresy before it hopelessly split the faith and the nation. Since that time Russia has had four different governments – tsarist, the Provisional Government of 1917, the Soviet govern-

ment, and the current post-Soviet government – but the position of the Church on Name-Worshipping has remained the same.

On the question of whether more than one kind of infinity exists, each of which can be given a name, not all mathematicians agreed with Cantor. For some of them set theory can not apply to the line, what they called "the continuum." The debates got very complex and also very heated.

French and Russian mathematicians were leaders in this debate. The French who wrestled with set theory included Emile Borel (1871-1956), Rene Baire (1874-1932), and Henri Lebesgue (1875-1944); they were the inheritors of a great and powerful mathematical tradition, and at first they taught the Russians more than they learned from them. Both Egorov and Luzin came repeatedly to Paris to talk with their French colleagues. They usually lived in the academic heart of the city in the Hotel Parisiana, near the Pantheon. The concierge of the building remembered many years later both the devotion of the Russian visitors to their studies and their religiosity.

The French tended to be skeptical of set theory, or at least the furthest extensions of it into discussions of new types of infinities. A few of them, such as Borel, were at first attracted to it but gradually became more hesitant. The old French establishment of mathematics, represented by Emile Picard, stoutly resisted. Picard acidly remarked "Some believers in set theory are scholastics who would have loved to discuss the proofs of the existence of God with Saint Anselme and his opponent Gaunilon, the monk of Noirmoutiers." Picard thought that he could dismiss set theory by linking it to discussions of religion, exactly the way the Russians thought they could strengthen it. The French worked within the tradition of Carte-

sian rationality; the Russians were speculating within the tradition of Russian mysticism.

A contrast between the cold logic of the French and the spirituality of the Russians is not new in the history of culture. Leo Tolstoy in *War and Peace* compared Napoleon's Cartesian logic in his assault on Russia with his opponent Kutuzov's emotional religiosity. After the critical battle of Borodino the novelist described the Russian general Kutuzov kneeling in gratitude before a holy icon in a church procession while Napoleon rationalized his "miscalculation." Tolstoy saw Borodino as a victory of Russian spirit over French rationalism.

Eventually the French mathematicians lost their nerve and yielded the field to their Russian colleagues. The French could not stomach the thought that new infinities could be created simply by naming them, and that these new infinities then became legitimate, and even necessary, objects of study by mathematicians. Some of the French actually feared that one could lose one's mind pursuing the problems of set theory applied to these infinities. They noticed that the founder of the field, Georg Cantor, had a series of attacks of depression after 1884. Baire, who already had some digestive problems, fell badly ill in 1898, as if being punished for his flirtation with the new ideas, and eventually killed himself. Borel, after referring to the illnesses of Cantor and Baire, told his friend Paul Valery that he had abandoned set theory "because of the fatigue it caused him, which made him fear and foresee in himself serious illness if he persisted in that work."

The Russians did not have these problems. They rejoiced in what they saw as the fusion of mathematics and religion. At the time of the Russian Revolution in 1917 Father Florenskii was living in

a monastery town near Moscow and he translated the religious ideas of Name-Worshipping into mathematical parlance. He stated his goal as creating a "synthesis between religious and secular culture." He expounded the view that "the point where divine and human energy meet is 'the symbol', which is greater than itself." The development of set theory was to Florenskii a brilliant example of how naming and classifying can bring mathematical breakthroughs. To him a "set" was simply a naming of entities according to an arbitrary mental system, not a recognition of real objects existing in nature. When a mathematician created a "set" by naming it he was giving birth to a new mathematical being. Mathematicians who created sets by naming them, according to Florenskii, were performing an intellectual and religious act similar to what Name-Worshippers do when they named and worshipped God.

When Egorov, Luzin, and their students created a new set they often called it a "named set," in Russian "imennoe mnozhestvo." Thus the root word "imia" ("name") occurred in the Russian language in both the mathematical terms for the new types of sets and the religious trend of "imiaslavie" ("Name-Praising", or "Name-Worshipping"). In Luzin's personal papers in the Moscow archives the historian can see today how obsessed he was with "naming" as many subsets of the continuum as he could. Roger Cooke studied Luzin's papers and noted that he "frequently studied the concept of a 'nameable' object and its relationship to the attempted catalog of the flora and fauna of analysis in the Baire classification.... Luzin was trying very hard to *name* all the countable ordinals." At one point Luzin scribbled in infelicitous but understandable French "nommer, c'est avoir individu" ("naming is having

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[2] Roger Cooke, "N. N. Luzin on the Problems of Set Theory," unpublished draft, January 1990, pp. 1-2, 7. Luzin's notes are held in the Archive of the Academy of Sciences of the USSR, Moscow, fond 606, op. 1, ed. khr. 34.

individuality").[2]

The circle of eager students at Moscow University which formed around Egorov and Luzin at about the time of the beginning of World War I and continued throughout the early twenties was known as "Lusitania." This group caused an explosion of mathematical research that still affects the world of mathematics.

Lusitania was at first a small secret society, and the place of religion in that society is illustrated by the names the members gave each other; Egorov was called "God-the-father," Luzin was "God-the-son" and each of the students in the society was given the monastic title of "novice." They all went to Egorov's home, an apartment not far from the university, three times a year: Easter, Christmas and Egorov's Name-Day (again the emphasis on "names").

But how long could such a religiously-oriented group exist in the Soviet Union, where the campaign against religion was gathering force? In their effort to combat religion the Communists made no distinction between orthodox believers and heretics. The three men most involved in the effort to link religion and mathematics followed different paths in responding to this threat. Florenskii was the most defiant, refusing to take off his priest's robe, causing the Soviet leader Trotsky to inquire at a meeting they both attended "Who is that?" Egorov also continued his religious practices and worked closely with Florenskii in inspiring the "True Church" movement aiming at a religious revival in Russia despite the Soviet efforts to suppress religion. Luzin was much more cautious, refused to attend meetings of the Name-Worshippers, and concealed his religious convictions.

Meanwhile, the Moscow School of Mathematics flourished. It grew until it included dozens of young mathematicians, many of them now prominent in the history of mathematics (e.g., Andrei Kolmogorov,

Pavel Aleksandrov, Aleksandr Khinchin, Mikhail Lavrent'ev, Lazar Lyusternik, Petr Novikov). It was inevitable that as the group increased in size that it would lose its earlier ethos. Some of the students of Egorov and Luzin were out of sympathy with their teachers' religious impulses. A few were even members of the Young Communist League. Divisions, rivalries, and ideological disputes began to develop among Moscow mathematicians.

In 1930 Ernst Kol'man, a militant Marxist mathematician who was never a member of Lusitania himself, attacked Florenskii and Egorov in an address to mathematicians, castigating their use of "mathematics in the service of religion," "mathematics in the service of priestcraft." He continued the attack in subsequent articles, saying "Diplomaed lackeys of priestcraft right under our noses are using mathematics for a highly masked form of religious propaganda."

Responding to such denunciations, starting around nineteen thirty the Soviet authorities moved heavily against the Name-Worshippers. Fortunately, the most important mathematical work had already been done. They arrested Father Florenskii, the main ideologist of mathematical Name-Worshipping, and eventually sent him to a labor camp in the Solovetsky Islands, far north in the Arctic Ocean, where he continued to do scientific work. On December 8,1937, he was executed by firing squad. In one of his last letters to his grandson, who lives in Moscow today, Florenskii wrote, "Above all I think about you, but with worry. Life is dead." All Florenskii's voluminous writings were removed from Soviet libraries, and even mentioning his name was forbidden.

Dmitrii Egorov, president of the Moscow Mathematical Society, was arrested in 1930 and exiled to a camp near Kazan, on the Volga River. There he went on hunger strike because the prison guards would not permit

him to practice his religious faith. Near death, Egorov was sent to a local hospital where he was recognized by a physician, the wife of a mathematician named Nikolai Chebotaryov. The two Chebotaryovs did everything they could to try to save Egorov's life, but it was too late. We are told that he died in the arms of Dr. Chebotaryova. Egorov's name, like Florenskii's, was not to be mentioned in Soviet society. The Name-Worshippers became the object of name censorship.

The most talented of the mathematicians connected with the religious movement, Nikolai Luzin, was subjected to a show trial, known even today as the "Luzin Affair." One of the ideological charges against him was that he "loved" capitalist France, where he often worked, and was a friend of the French mathematician Emile Borel. Borel was at that moment Minister of the Navy in the French government, and therefore was obviously a "militarist" eager for aggression against the Soviet Union. In a great act of heroism, one of the most famous physicists in the Soviet Union, Peter Kapitsa, wrote a confidential letter to the Soviet leaders Molotov and Stalin, pleading for mercy for "one of our greatest mathematicians, known throughout the world." Luzin was reprimanded but miraculously saved, and continued mathematical work until his death in 1950, although no longer in set theory but instead in applied mathematics, and no longer in communication with his French friends. The persecution of the Name-Worshippers continued throughout the Soviet period, with arrests as late as the nineteen eighties, up to the time of the Gorbachev years starting in 1985.

In the summer of 2004 Loren Graham met with a prominent mathematician in Moscow known to be in sympathy with Name-Worshipping. The mathematician implied he was a Name-Worshipper without stating it outright. His apartment was decorated with the symbols of

Name-Worshipping, including photographs of its leaders. His library was filled with rare books and articles on Name-Worshipping. Graham asked if it would be possible for him to witness a Name-Worshipper in the Jesus Prayer trance. "No," replied the mathematician, "this practice is very intimate, and is best done alone. For you to witness it would be considered an intrusion. However, if you are looking for some evidence of Name-Worshipping today I would suggest that you visit the basement of the Church of St. Tatiana the Martyr. In that basement is a spot that has recently become sacred to Name-Worshippers."

Graham knew about this church; forty-five years earlier he had attended a student dance in the building after the church itself had been eliminated by Soviet authorities and converted into a student club and theater. Now, in the post-Soviet period, it has been restored as the official church of Moscow University, as it was before the Revolution. It is located on the old campus near the Kremlin, in a building next to the one that housed the Department of Mathematics when Egorov and Luzin dominated that department. It is the church where they often prayed. Graham asked the mathematician, "When I go into the basement, how will I know when I have reached the sacred spot?" The mathematician replied, "You will know when you get there."

The next day Graham went to the Church of St. Tatiana the Martyr, and made his way to the basement. There he found a particular corner where the photographs of Father Florenskii and Dmitri Egorov, founders of mathematical Name-Worshipping, faced each other, and he knew that he was in the place where Name-Worshippers liked to come, alone, to practice the Jesus Prayer. But six months later, in December 2004, he visited the basement again and found that the sacred spot had been eliminated by the Church, which had finally realized that Name-Worshippers were coming to the basement to celebrate their "heresy." Now an official chapel of the Church occupies the basement, with a priest guarding over it and ensuring the orthodoxy of all worshippers. Jesus Prayers are not practiced there any more. Thus, the struggle over Name-Worshipping continues today. The Communists and the Church officials, dogmatists alike, oppose it.

This story is a tragic and dramatic one, like many stories about Stalinist Russia, but this one also contains a deep philosophic question about the nature of mathematics. Where do the concepts and objects used by mathematicians come from? Are they *invented* in the brains of mathematicians, or are they in some sense *discovered,* perhaps in a platonistic world? Florenskii, Egorov, and Luzin believed that the objects of mathematics are invented not through analysis but through mystical inspiration and naming. They thought that French mathematicians like Baire, Borel, and Lebesgue were mistaken in their commitment to Cartesian rationalism.

We were trained in the tradition of Western rationalism, and we do not share the mysticism of the Russian founders of the Moscow School of Mathematics. We would point out that naming is not identical with creating. We can name "unicorns" but that does not make unicorns real. We also note that the basic idea behind Name-Worshipping is not new; there are many similarities in Name-Worshipping to other types of religious and meditation practices, including variants of Hinduism, Buddhism, Judaism, and Islam. The practice of "talking in tongues" of Protestant evangelicals is also related. The endpoint, as in Name-Worshipping, is a state of glottal ecstasy. We do not see this state as one usually conducive to scientific creativity.

But the reason that this episode is different is that in this case mysticism may actually have helped science. In the early twentieth century mathematicians truly differed among themselves about the existence of various infinite sets. The French, with their secular, rationalist worldview, had neither the courage nor the motivation to enter the frightening world of the hierarchy of infinities. The French feared what the Russians exalted. And in the hands of the Russians what earlier seemed like fanciful unicorns became useful mathematical objects. (A similar situation may have occurred more recently in string theory when Anglo-Saxon and Russian mathematicians and physicists were ahead of French scholars.).

If we had been mathematicians in the period 1900-1930 we surely would have hesitated along with the French mathematical establishment, constrained by our rationalism. The Russians, on the other hand, believed they had absolute freedom to invent mathematical objects and to give their inventions names. Following their approach the Russians created a new field, descriptive set theory, at a time when mathematicians elsewhere faltered. And the Moscow School of Mathematics, founded by Egorov and Luzin, still exists today. And the significance of their achievement is still with us.

მათემატიკის ისტორია

რელიგიური ერესი და მათემატიკური შემოქმედებითი პოტენციალი

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