Christian Epistemology of Gabrio Piola. The *Lettere di Evasio a Uranio*

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Abstract: During the restoration of the Ancient Regime, in the first half of the 19th century in Italy, mathematicians who professed an epistemology in keeping with Catholic orthodoxy could raise their voice thanks to the existing conservative atmosphere. For some of them the adherence to Catholicism also meant the rejection of new mathematical developments achieved in the revolutionary France, also due to mathematicians all but revolutionary like Cauchy and Saint Venant, by favoring the geometric approach on the analytical one. Gabrio Piola did not belong to this category but looked forward albeit cautiously to the international scene. In the present paper focus is addressed on epistemology of Piola as it is reported in his most significant writing on the subjest, the *Lettere di Evasio a Uranio*.

Keywords: Mathematical physics, epistemology, apologetic writings, religion.

1. Introduction

Gabrio Piola Daverio (1794-1850) was born in Milan, in a rich and noble family; first educated at home, then attended a local high school. He soon showed excellent attitudes toward mathematics and physics, perfected at the University of Pavia as a pupil of Vincenzo Brunacci (1768-1818). Piola obtained the degree in mathematics in 1816 and in 1818 edited the *Elementi di geometria e algebra* by Brunacci (1809). In 1820 he was appointed as learner of the "Specola" of Brera, publishing *Sulla teorica dei cannocchiali* (1820). In 1824 he participated in the competition announced in 1822 by the "Royal Institute" of Lombardy on the analytical mechanics of Lagrange, winning it with a long article on the applications of Lagrangian mechanics, *Sull'applicazione de' principj della meccanica analitica del Lagrange ai principali problemi*. In the same year he received the offer of the chair of applied mathematics at the University of Pavia, that refused for family reasons.

Despite the renunciation to the academic career Piola devoted much of his time to the teaching of mathematics and together with Paolo Frisiani (1797-1880) gave regular lessons at home. Among his students there were Francesco Brioschi (1824-1897), later a professor of rational mechanics in Pavia and founder of the Milan Polytechnic, and Placido Tardy (1816-1914), a professor of mathematics at the University of Messina. Piola also taught religion for twenty-four years in a Milanese parish.

Piola was elected among the Dotti (learned) of the "Royal lombard institute" in 1828 (to become an effective member in 1839), he was a member of the "Italian society of sci-

ences" (Accademia dei XL), a corresponding member of the "New pontifical academy of the Lincei", in 1849. Since 1825 he was a member of the "Roman academy of Catholic religion". He participated in the conferences of Italian scientists who began to be held annually since 1839. He was also editor of a magazine, *Opuscoli matematici e fisici di diversi autori* (1832-1834) of which only two volumes came out. Among other things, this magazine was the medium of diffusion of the mathematical theories of Augustin Cauchy in Italy, containing some of his fundamental works translated into Italian.

A scholar of high culture, besides natural sciences Piola devoted himself to history, literature and philosophy. Important are his commemorations of Vincenzo Brunacci (1768-1818), *Necrologio di Vincenzo Brunacci* (1818) and Bonaventura Cavalieri, *Elogio di Bonaventura Cavalieri* (1844). The latter in particular is a well-written and well-documented essay, still useful to modern scholars of Cavalieri. His epistemological conceptions on science in general and on mathematics in particular, are contained in the *Lettere di Evasio ad Uranio intorno alle scienze matematiche* (1825), a text that still has some publishing success today. Here the truths of faith are compared with those of science, highlighting a possible agreement.

He was a friend of Antonio Rosmini (1797-1855), the greatest exponent of the Italian Catholic spiritualism; a traditionalist and fervent Catholic like Cauchy, one of the reasons why the last held Piola as a point of reference among the Italian scientists during his stay in Italy from 1830 to 1833. After some reticence Piola began to appreciate the new mathematical conceptions of Cauchy, without however coming to share them fully.[1]

Among Brunacci's pupils, Piola was the most interested in mathematical physics, in particular in mechanics of "extended solid bodies" and fluids. He wrote important memoirs of pure mathematics on finite differences (*Sull'applicazione del calcolo delle differenze finite alle questioni di analisi indeterminata*, in *Annali di scienze matematiche e fisiche*, vol. 1, (1850), pp. 263-281) and on the theory of Integration (*Note relative al calcolo degli integrali definiti*, in *Atti dell'VIII Riunione degli scienziati Italiani* (1846)); his most important contributions are scattered through his work in mathematical physics. The fundamental works in this field are those of continuum mechanics, published in the years 1833-1848, *La meccanica de' corpi naturalmente estesi trattata col calcolo delle variazioni*, in *Opuscoli matematici e fisici di diversi autori*, (1832), pp. 201-236; *Nuova analisi per tutte le questioni della meccanica molecolare* in *Memorie di matematica e fisica della Società italiana delle scienze*, vol. 21, (1836), pp. 155-321; *Intorno alle equazioni fondamentali del movimento di corpi qualsivogliono considerati secondo la naturale loro forma e costituzione*, in *Memorie di matematica e fisica della Società italiana delle scienze*, vol. 24 (1848) pp. 1-186 and eventually *Di un principio controverso della Meccanica Analitica di Lagrange e delle sue molteplici applicazioni*, in *Memorie dell'Istituto Lombardo*, vol. 6 (1856), pp. 389-496, published posthumously edited by Francesco Brioschi, which represents a mature revision of the work of 1848 (Capecchi, Ruta 2014).

Although he was one of the brightest rational mechanicians of the 19th century, probably the brightest of the Italians, Piola is a little known and evaluated author. This is

[1] For an interesting and quite complete biography on Piola see (Filoni, Giampaglia 2006).

due to various reasons, of a general nature, associated with the scientific provincialism of Italy at the time, of a particular nature associated with the character of Piola rather shy, to his choice to write only in Italian, despite knowing the developments of the French mathematical physics. His message, however, has passed especially in Germany, and his name is one of the few to be cited in the modern literature of continuum mechanics. There are references to Piola in some important monographs of the early twentieth century in which the treatment of mechanics substantially coincides with the contemporary one. In the international literature the name of Piola is associated to two tension tensors and a theorem on the derivation of balance equations from the equation of virtual works.

1.1. Apologetic writings

The age in which Piola lived was the *Restoration*, after the defeat of Napoleon and French Revolution. Not only political restoration but also cultural. In the universities and academies many professors involved in the Napoleonic administration were replaced by loyalist people, not always up. An exception was represented by Paolo Ruffini, conservative and clerical at the highest degree, but with impressive scientific credentials. Somehow it was also put into question the modern "sublime mathematics" because the result of the godless French men. Piola will never come to these excesses; indeed he was open enough toward the "French" innovation, though he had some difficulty in fully accepting the analysis developed by Cauchy.

He defended the Catholic religion from the attacks of modern scientists, the bearers of the values of the Enlightenment in various writings (Piola 1822; 1823-1824-1825-1827; 1822-1823-1824; 1828):

- "Lettere di Evasio ad Uranio toccanti lo studio delle Matematiche". *L'Amico d'Italia*, 1, 1822, pp. 293-308; 2, 1822, pp. 285-306; 3, 1823, pp. 301-321, e 5, 1824, pp. 97-116.
- "Sulla certezza". Lettera di G. P. a G. B. in occasione del libro che ha per titolo "Teorica e Pratica del Probabile dell'Ab. Giuseppe Bravi. Memorie di religione, di morale e di letteratura di Modena", 14, 1828, pp. 433-462. One more letter of G. P. to G.B., written in his own hand, is found among Piola's papers.

Before going on to examine the *Letters* it is better to refer for a while to two other writings of epistemological nature by Piola. In 1819 Laplace had published his famous treatise *Essai philosophique sur les probabilities*, where he extended the calculus of probability even outside the natural sciences, for example to sociology and ethics. In particular, according to Laplace, a choice based on aspects not completely evident, as could be for example for the verdict of a judge, had to be based on the calculus of probabilities. The thesis that could be stimulating and worthy of study for an open mind, had caused a sensation and scandal in the closed Italian Catholic community, even among the people who could follow Laplace's mathematical reasoning.

In 1821 Paolo Ruffini (1765-1822) wrote *Riflessioni critiche sopra il saggio filosofico intorno alle probabilità*, in which he challenged Laplace's positions, partly on the basis of his Catholic prejudices, which saw the capacity of free will violated and threatened

the role of divine providence, in part with arguments of merit that highlighted some real contradictions of the mathematical theory. Piola shortly after the death of his friend Ruffini, indeed just to commemorate it, took up the thesis of Ruffini and combined it according to his positions, in the short paper *Riflessioni critiche sopra il saggio filosofico intorno alle probabilità del signor conte Laplace fatte dal dottor Paolo Ruffini*. The initial part of the paper, from which the spirit of the Restoration becomes clear, is of some interest.

> The philosophical essay on probabilities, and some other part of the works of Mr. Laplace present the scandal of various dissonant passages from religion and morality, very badly placed among the beautiful scientific truths taught by that first-rate Geometer. Those learned men, who connect the rectitude of the heart to the knowledge of the spirit, saw with regret to enter in such a way into the mathematical sciences, by themselves pure and innocent, a spirit of vain fallacy *resembling that which in the past century smeared with so many proscriptions the venerable names of reason and philosophy* [emphasis added] (Piola 1822, pp. 308-309).

Note the fierce attack of the Enlightenment century.

Apart from some considerations of technical nature, probably, the most convincing criticism by Piola to the use of probability in the human sciences is the following comment:

> Let's imagine a case. The cause of an accused innocent hangs from the judgment of an assembly and the peremptory sentence is about to come out. He whose life is deciding, in the midst of the disturbance which causes him the uncertainty of the human judgments he raises the Father of enlightenment a fiery prayer to clear the mind of his judges and make his innocence clear. [...] If while on the ground on his knees, he is soliciting that divine benefit, he is approached by one of those who are infatuated with new doctrines and tells him: what are you doing here? to what vain do you sigh? Do you want to know your fate? come and see. And in doing so, he led him before Laplace's packs to evaluate on them the probability of the favorable sentence. Would this approach not precipitate the indignation not only of the oppressed person, but of everyone who still preserved the good of the intellect? (Piola 1828b, last page)

Of some interest also a letter to the friend astronomer Giuseppe Bianchi (1791-1866) entitled *Sulla certezza che contiene una critica a uno scritto di Giuseppe Bravi*. Bravi talked about certain types of certainty, taking up a theme that was widely discussed in the 18th century. There are three types of certainty, the metaphysical, the physical and the moral. That metaphysical, obtained through the sole reason, as we have in some branches of philosophy and in mathematics, would be the only form of certain knowledge to be valid according to Bravi. Of the other two types of knowledge one can only give a probability character, to be calculated according to the mathematical rules developed by Laplace. Piola disputed the affirmation; mainly for what concerns the moral certainty, because a doubt about it undermines the Catholic religion. Another element of criticism was the minimization of the role of Ruffini in the discussion on the calculus of probabilities.

The criticisms, even if originated by a strong prevention due to his religious belief, develops on sufficiently rigorous arguments. Piola disputed Bravi not to have distinguished between certainty and evidence – a difference that still embarrasses many philosophers today. For Piola, certainty is a state of our mind that believes to have seen the truth. The evidence is the actual clear recognition of the truth. Certainty would come after the act of recognizing of the truth (evidence). Mistaking evidence and certainty is mistaking cause and effect.

2. Letters of Evasio to Uranio

The *Lettere di Evasio ad Uranio toccanti lo studio delle Matematiche*, hereafter referred to as *Lettere di Evasio ad Uranio*, or even more simply as *Letters*, represent the apologetic text of Piola having most editorial success. Their publication was quite lively; even today, copies can be found. On the net there is an e-book to download with just over a euro. They are the object of interesting comments in (Bottazzini, Nastasi 2013; Fliloni, Giampaglia 2003). Below some editions.

Table 1. Edition of the letters

1822-1824. *Lettere di Evasio ad Uranio toccanti lo studio delle Matematiche*. L'Amico d'Italia, vol. 1, 1822, pp. 293-308; vol. 2, 1822, pp. 285-306; vol. 3, 1823, pp. 301-321, and vol. 5, 1824, pp. 97-116.
1824? "Annotations to the *Lettere di Evasio ad Uranio toccanti lo studio delle Matematiche*." *L'Amico d'Italia*, vol. 8, 1825, pp. 237-246. Two other editions are registered under nos. 57 and 58.
1824. *Lettere di Evasio ad Uranio*. Novara: Girolamo Miglio. It is a reprint of the letters limited to the first three of them.
1825. *Lettere di Evasio ad Uranio intorno alle scienze matematiche*. Modena: Tipografia Reale. The book collects the Letters now reprinted with some retouching of the author whose name is still missing. This edition, promoted by the Archduke Massimiliano, was curated by the astronomer Giuseppe Bianchi, as can be seen from the correspondence Bianchi-Piola.

The letters, four in number, are written by the master (Evasio) to a young mathematician disciple (Uranium). The names do not refer to really existing people. Uranium refers to the Greek heaven and indicates the abstract scientific interests of the young; less clear the etymology of the name of the master Evasio, Piola himself. There is, for example, a saint Evasio.

In the first letter, the most interesting one from the point of view of the following paper, Evasio-Piola expounds his Christian-style epistemology. First of all, the value of faith, or belief in the Christian religion, is exalted:

> We have, or my Uranio, a treasure far more precious than any human wisdom, a treasure that cannot be lost to illness, or death, but that may be snatched away from

> us if we do not take due care. It is Religion I am referring to (Piola 1822-1824, Letter I, pp. 294-295.)

According to Piola, religion has a higher degree of evidence than science, including mathematics. He arguments first that religion is not less evident than mathematics. Both refer to principles that are obvious to intuition but cannot be rationally proved. Even the certainty derived from mathematical demonstration is entrusted to a kind of faith; the belief that the argumentations of logic are not fallacious.

> We entrust a problem to calculation, which for some kind of mechanism leads us to the solution, without seeing any of those intermediate links which connect the data of the question to the result: we remain convinced, but not persuaded (Piola 1822-1824, Letter I, pp. 296-297).

Furthermore, the mathematical knowledge is clearly incomplete:

> The more you study the more you penetrate the views of the great geometers and find how to expand, on all sides, the province of what can be known but which is still not known (Piola 1822-1824, Letter I, p. 296).

From this point of view it does not make much sense to affirm that religion requires a sacrifice of reason:

> When I think to that language, I hear so frequently, that Religion requires a sacrifice of reason, that reason, which triumphs in mathematics, where everything is light and evidence, I cannot remain convinced of such thoughtlessness, since it seems rather to me that my reason very often finds itself, in the study of mathematics, in such circumstances, where its freedom is no greater than when faith proposes to believe the mysteries and dogmas of revelation (Piola 1822-1824, Letter I, p. 297).

Moreover religion is superior to mathematics because even without study, men can be convinced of its truth with the highest degree of certainty. We must be careful, however, that religion is under attack even by valuable scientists. It is claimed for example:

> The society would have been able to give the greatest benefits, if the ecclesiastical power, increasingly intolerant, always armed with thunderbolts had not hindered and impeded their careers (Piola 1822-1824, Letter I, p. 303).

A sneaky attack on religion comes from trying to put God aside in explaining natural phenomena.

> So naming God, the Creator, the infinite Wisdom, the Divine Providence governing the world, as the Galileo, the Leibniz, the Euler never get tired to do, is now in disuse among mathematicians, and in each case the most philosophical name of Nature is used, and Nature is said that it did, it predicted, it preordained; Nature that makes, keeps, provides etc., perhaps without noticing that this custom is very old, and already disapproved by Seneca (Piola 1822-1824, Letter I, p. 305).

The second letter focuses on the contestation of the application of mathematics to moral sciences, with a clear statement:

> But I already wrote to you, that a barrier separates the moral sciences from the science of quantity: thus my assertion is in conflict with that of some of the great geometers (Piola 1822-1824, Letter II, p. 287).

As already commented in the previous section, the controversy dates back to Laplace's publication of the text *Essai philosophique sur les probabilities* of 1819, translated into Italian by L. M. Fanelli in 1820.

While the first two letters represent the *destruens* part with respect to the mathematics, the last two letters represent the *costruens* part. The third letter is dedicated to pure mathematics. Piola shows how some concepts of mathematics help to conceive the existence and essence of God. Among them there is the concept of mathematical infinity. Which gives an idea of the infinite in general. The presence of evil in the world is explained with an argument already used by Leibniz, referring to the laws of statics (which is not a pure mathematics however).

> To make headway in addressing the issue, we pretend that someone of those men just now mentioned, proud and censors, are conducted to visit a complicated machine-constructed by skillful craftsman in the act of operating. He, on examination, says to the very skillful mechanic: Look, my friend, that swivel goes very slow, that lever moves almost nothing: why this huge amount for that cylinder? why that counterweight which delays the movement? If you are so clever, you have to make a quick motion on the lever and the swivel, lighten all the parts to ensure that each furnish the maximum effect possible. Forgive, will soon respond the wise maker (Piola 1822-1824, Letter III, pp. 316-317).

The fourth and last letter is dedicated to those that Piola calls mixed mathematics, or the mathematical physical sciences. They are based on empirical principles, mathematical laws or experimentally extracted forms. As such these principles can be fallacious and history has shown it, Piola takes into account the possibility of error in the establishment of the principles and the risk that there is to give an absolute value to the deductions from them, which sometimes may be in contrast with religion.

In the letter Piola traces the days of creation as referred to by the Genesis. He compares the results of science with what is stated in the Genesis and shows how science can provide some explanations but not all of them. There are numerous quotations from Newton's *Principia* and *Opticks*. Here and also in the other letters Piola proves to be a profound connoisseur of scientific literature, recent and past confirming. The last letter ends with the following comment:

> It remains for us to continue to proceed in such a wonderful endeavor and to seize the best fruit; and after recognizing God, by pondering his works, still recognize his dominion over us, the benefices that we owe, and our obligations to him, and among ourselves. This also we are told by Newton with that judgment, with which I do end: "For so far as we can know by natural Philosophy what is the first Cause, what Po-

> wer he has over us, and what benefits we receive from him, so far our Duty towards him, as well as that towards one another, will appear to us by the Light of Nature (Piola 1822-1824, Letter IV, p. 116).

3. Concluding remarks

Given the ideology of Piola, outlined in the previous pages, it is not surprising that he had become a mathematician and not a physicist. In this way his faith ran no risk. And when he was detached from pure mathematics to move toward mathematical physics he did it by dealing with solid mechanics, a subject that certainly could not give rise to heretical ideas.

References

Bravi G. (1829). *Ragionamento critico della teoria del probabile e sopra un relativo articolo pubblicato nelle memorie religiose e letterarie di Modena*. Bergamo: Mazzoleni.

Capecchi D., Ruta G. (2007). "On Piola's contribution to continuum mechanics". *Archive for the history and exact sciences*, 61, pp. 303-342.

Bottazzini U., Nastasi P. (2013). *La patria ci vuole eroi. Matematici e vita politica nell'Italia del Risorgimento*. Bologna: Zanichelli.

Filoni A., Giampaglia A. (eds.) (2006). *Gabrio Piola 1794-1850. Biografia di un matematico umanista*. Missaglia: Bellavite.

Laplace P.S. (1819). *Essai philosophique sur les probabilités*. Paris: Courcier.

Piola G. (1828). "Sulla certezza. Lettera di G. P. a G. B. in occasione del libro che ha per titolo *Teorica e Pratica del Probabile* dell'Ab. Giuseppe Bravi". *Memorie di religione, di morale e di letteratura*, 14, pp. 433-462.

Piola G. (1826?). "Sull'applicazione del calcolo delle probabilità alle scienze morali. Lettera seconda di G. P. a G. B.". Fund Piola, Polytechnic of Milano.

Piola G. (1823-1824-1825-1827). "Veglie di un filosofo". Memorie di religione, di morale e di letteratura di Modena, 3, pp. 441-464; 5, p. 41-64; 7, pp. 51-70; 8, pp. 413-446 e 11, pp. 225-254.

Piola G. (1822-1824). "Lettere di Evasio ad Uranio toccanti lo studio delle Matematiche". *L'Amico d'Italia di Torino*, 1, 1822, pp. 293-308; 2, 1822, pp. 285-306; 3, 1823, pp. 301-321; 5, 1824, pp. 97-116.

Piola G. (1822). "Riflessioni critiche sopra il *Saggio filosofico intorno alle probabilità* del signor Conte Laplace fatte dal Dottor Paolo Ruffini ecc". *L'Amico d'Italia di Torino*, 1, pp. 308-318; 2, pp. 63-72; 157-169.

Ruffini P. (1821). *Riflessioni critiche sopra il saggio filosofico intorno alle probabilità del signor conte Laplace fatte dal dottor Paolo Ruffini*. Modena: Società Tipografica.