

Toward a Broader Natural Science Discipline

A Master's Thesis
Submitted in partial fulfillment of
the requirements for the degree of
Master of Arts in Philosophy
Holy Apostles College and Seminary

By
Kenneth F. Klenk
Fall 2011

Research Advisor,
Dr. Timothy Smith

Reader,
Dr. Alan Vincelette


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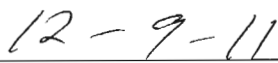
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Dedication

I give thanks to God for the opportunity to pursue the Masters Degree in Philosophy. All honor and praise be His now and forever.

To my wife, Cecilia, for her love, prayers, understanding and support throughout the process of fulfilling the requirements for this degree and also to Maria, my mother-in-law.

To my daughter, Karen Ellis, my son-in-law, Don Ellis, and my grandchildren Emily, Sarah, Elizabeth, Catherine and Rebecca Ellis for whose welfare I have done this work.

To Anthony Rizzi for awakening me to the ideas of Aristotle, Aquinas, Maritain and others and for showing me the great and urgent need to restore the wider *physisca* to its proper place in our pursuit of knowledge and wisdom.

To Monsignor Richard Mahowald who provided many interesting philosophical discussions and who encouraged me along the way.

Dedicated to the memory of my parents, Warren and Cecelia, and my brother, Warren, a true lover of knowledge and wisdom.

Table of Contents

I. Introduction	1
Purpose of Thesis	1
Motivation for Thesis	3
II. Maritain's Terminology	6
Experimental Sciences	6
Empiriological Methods	6
Empirioschematic Methods	6
Empiriometric Methods	7
Mathematical Preter-real	8
Beings of Reason	8
Beings of Reason in Modern Physics	8
III. Maritain's Analysis of the Sciences	9
Contingency and Necessity.....	10
Degrees of Abstraction	11
Philosophy – A Superior Science	13
Mixed and Empiriometric Sciences	15
Two Areas Where Science and Philosophy Interact	16
Empiriometric Science Models and Myths	19
Distinguishing Modes of Defining	20
Subalternation	21
Cajetan's Formal Objects and Formal Perspectives	22
Method and Facts	23
Change	24
IV. Maritain's Historical Context	25
The Ancients and Abstraction	25
Errors in Aristotle's Science	26
Discovering Science Itself is not a Science	26
Classical and Modern Physics and Philosophical Principles	27
Positivist Interpretation and Reaction	28
A Renaissance for the Philosophy of Nature?	30
V. Post-Maritain Efforts	31
The River Forest School – Albertus Magnus Lyceum (1963-1969)	32
William A. Wallace	36
Stanley L. Jaki	38
Anthony Rizzi	42
VI. Conclusion	47
VII. Appendix: Cajetan's Areas of Knowledge	50
VIII. Bibliography	55

I. Introduction

Small errors in the beginning lead to huge errors later on - Aristotle

Purpose of Thesis: The purpose of this thesis is to fully understand the call by Jacques Maritain (1882-1973) for a restoration of the philosophy of nature as fundamental in integrating our knowledge and in particular integrating our knowledge of philosophy of nature with that of the sciences. Jacques Maritain was a philosopher of the 20th century who made great contributions to the revival of Thomistic thought. This revival was instigated by Pope Leo XIII¹ in the late 19th century. The call for restoration of the proper relationship of philosophy of nature with the sciences was made by Maritain in his book *Degrees of Knowledge* published in French in 1931 and further elaborated upon in his book *Philosophy of Nature* published in 1951. Maritain's *Degrees of Knowledge* looks at the ways in which man's can gather knowledge from physics to metaphysics to mystical knowledge. The first part of this book provides an excellent discussion of the philosophy of nature and the sciences and their distinctions and relationship. The book *Philosophy of Nature* gives a deeper historical context and a deeper understanding of the nature of the sciences. In the introduction he says that the philosophy of nature has been lost either by being eclipsed by metaphysics or absorbed by the experimental sciences which claim all knowledge of the sensible world belongs to it. Maritain's aim was to reestablish the philosophy of nature independent of metaphysics recognizing the uniqueness of its perspective.

¹ See encyclical *Aeterni Patris* found at http://www.vatican.va/holy_father/leo_xiii/encyclicals/documents/hf_l-xiii_enc_04081879_aeterni-patris_en.html; article 31: "We exhort you, venerable brethren, in all earnestness to restore the golden wisdom of St. Thomas, and to spread it far and wide for the defense and beauty of the Catholic faith, for the good of society, and for the advantage of all the sciences".

The purpose of this thesis is two-fold. First is to give a complete description of Maritain's analysis that leads to his understanding how philosophy and science depend on each other in arriving at an integrated understanding of nature and that these disciplines need to converse with one another. Second, is to investigate the work the River Forest School and of several physicist-philosophers since Maritain who have made contributions in this area. The last physicist- philosopher we will discuss, Dr. Anthony Rizzi, is particularly important for recognizing that the integration of the philosophy of nature and the modern sciences is not two disciplines but one single discipline or *physica* which is the wider physics that incorporates the foundational principles of the philosophy of nature and the modern empiriological sciences. Therefore, the pursuit of Maritain's goal would require persons who were trained in both the fundamentals of Aristotle's and Aquinas' logic and natural philosophy and also in modern physics – i.e. physicist-philosophers.

While there were disagreements along the way related to distinctions that were made by Maritain, the more profound question of bringing these disciplines together is the most important and urgent one. The lack of an explicit philosophy of nature as a basis of science is creating much confusion in the culture as scientific findings alone are being used inappropriately to drive decision making related to ethics and politics.

This call for a return to the philosophy of nature had received attention in the 1960's when the Albertus Magnus Lyceum (1963-1969) of the River Forest School was formed and began its mission of bridging the gap between philosophy and science. Maritain called for a return to the critical realism of St. Thomas Aquinas to pursue this goal. However, it was at this time (post- 1965) that the climate created by the Vatican Council II left the Leonine revival of the philosophy of St. Thomas in ruins. Since the restoration effort that Maritain

called for depended on the Thomists to bring it forth, this decline devastated the support needed to develop this seminal idea. After 1970, Fr. William Wallace, author of *The Modeling of Nature*, and Fr. Stanley Jaki, author of *The Relevance of Physics* and many other books were among the few who continued to investigate the relationship between philosophy and modern science. As part of this thesis, we will look at the contributions of these two influential men who were both physicists as well as philosophers. More recently, Rizzi has written a book called *The Science before Science* in which he repeats Maritain's call for a return to placing *physica* (another name for the philosophy of nature) at the foundation of knowledge and integrating it more fully into the explicit training of physicists in today's universities

Motivation for Thesis: The idea that there is no absolute truth, that there isn't anything beyond the material, that all that is has come about by chance, that all motion is relative, that man has no essence, that there isn't a God and that heaven is just a fairy tale² are some examples of the various beliefs that are common in our culture and believed to be deduced from science.

We look to science for answers. Yet a small minority of the people are scientists and most of them are specialists and not aware or conversant across scientific disciplines. Their knowledge of the facts that science has revealed is through the authority of others, which is to say, their so-called knowledge amounts to little more than a faith in the notion of scientific authority. How many people have taken the time to arrive at all these conclusions and followed closely each argument? How many have taken the time to look at the fundamentals

² Ian Sample, "Stephen Hawking: 'There is no heaven; it's a fairy story'", Guardian.co.uk, 15 May 2011 22.00 BST, <http://www.guardian.co.uk/science/2011/may/15/stephen-hawking-interview-there-is-no-heaven>

and basis of our knowledge of the physical world? How many are able to say that the conclusions of science are true and well-founded.

We look around and we see a great lack of teaching at the fundamental level of natural philosophy and consequently little in the way of scholarly research. The Enlightenment philosophies, of course, did a great deal of damage to this fundamental level of knowledge. Today it is all but disappeared from education. When we look at the road travelled in the last 100 years with the advent of quantum mechanics and relativity in physics, we see the consequences of the principles embraced by idealistic philosophies.³ The conclusions grafted onto the work of Heisenberg and Bohr would never be possible in a world dominated by the philosophy of Aristotle and St. Thomas. Only in a world of idealism could the dismissal of the law of causality and belief in action at a distance be tenable. For the most part, physicists cling to the real world and reject the nonsense that they are being told by the idealistic philosophies. It was this distorted and ungrounded metaphysics of these philosophies that led to the great divide between the humanities and the physical science that even today is a chasm of tremendous breadth.⁴ But the lack of a means for physicists to interpret their results in quantum physics and relativity led them to the very ideas that were the antithesis of the foundational principles that all of physics was based upon. Thus physics would absorb these conflicting ideas and live with them. However, the impact would be

³ Idealism in philosophy is opposed to realism. Idealism distrusts the senses and consequently relies of a system of ideas in order to create a world view. Descartes is the father of idealist philosophies and most philosophical development since then has been in accordance with this fundamental theme.

⁴ For an example of the wideness of this gap see C.P. Snow, *The Two Cultures and the Scientific Revolution* (New York, Cambridge University Press, 1959). Comment: Mathematics is fundamental to physics. From the time of Plato (and before) it has created wonder in the minds of many for the exactness of its principles. The other sciences are not so inclined to mathematical representation and the physicist tends to look condescendingly at them for the reason that mathematics is not easily applied.

reflected in the attitude among physicists that if you keep reinforcing the mathematical formalism the connection to the real doesn't need to be made. A student of physics is taught this way starting in such introductory courses as mechanics where motion is relative and doesn't need a cause, in electricity and magnetism when, for example, electric and magnetic fields are separated from their sources; in relativity when they are taught the Lorentz transformation and the facts that time dilates, length contracts and mass increases in a moving frame although they have only vague ideas how it relates to the world in which they are living. They are told to "get used to it". The "it" is the mathematical representations that are used. Their grounding in the real world is damaged at this point and confidence in the mathematical representation takes precedence – a kind of a return to Plato's ideas that mathematics contains the true because of its 'perfection'. There is an implicit belief in the mind of some physicists in the perfection of mathematical representations and that if we found the ultimate mathematical representation it would contain all that is necessary to explain the universe without the need for a Creator.⁵

There seems to be something missing in our understanding of the way man comes to knowledge. The missing piece is an understanding of the fundamentals. We are making large errors today because of small errors in the beginning of our knowledge. This is where the great divide occurs between the modern sciences and the humanities, including philosophy. There are two roads – the realist and the idealist – and there are mutually exclusive of one another. The philosophy of Aristotle and St. Thomas Aquinas is a realist philosophy. It begins with the observation that things exist or as G. K. Chesterton said, "That there is an 'is'". This existence is outside of the mind. The mind is able to grasp this reality. This world

⁵ Many physicists believe that once we understand the mathematical equations that unite all of physics, we will have all the necessary reason for existence of the world. The world is necessary in their thinking and once we uncover all of the equations, there will be no need for a creator.

is intelligible by us and we can obtain knowledge that is true about the world – and that ‘truth’ is the conformance of our ideas to reality. Based on these fundamental ideas “science is naturally realistic” and most scientists would agree that what they do is to learn the truth about the world that is not part of themselves. The realist road is the road of Aristotle and St. Thomas Aquinas. The idealist road is that of Descartes and his progeny. Modern physics is in between the two – being pulled to idealistic conclusions on the one hand while being based albeit inchoately upon the foundations of realist philosophy on the other. Modern physics arose from the foundation of the real but its results are being interpreted through the idealistic eyes of our predominate culture.

II. Maritain’s Terminology

Before beginning a discussion of Maritain’s view of the various sciences, there are several terms that he uses often in his work that we will explain below. A proper understanding of this terminology is needed to appreciate Maritain’s presentation.

Experimental Sciences- these are all of the modern sciences like physics, chemistry, biology, etc. that use specially designed and controlled environments to observe and measure properties of substances under their investigations.

Empiriological Methods – empiriological methods are used in experimental and observational sciences. They use logical means (i.e. schemas or mathematics) to explain experimental or observational facts. Empirioschematic and empiriometric methods are specific types of empiriological methods.

Empirioschematic Methods – methods which use schemas to organize the scientific facts collected experimentally. For example, in biology, plants and animals are organized into kingdom, phylum, class, order, family, genus and species; another is the tree of life

which is used to represent the time line of evolutionary facts. These are examples of schemas used by biology. In chemistry, the periodic table is an excellent example of a schema (actually many schemas) to represent the experimental findings of the characteristics of the elements. In physics, before the adoption of the quark theory, schemas were used to classify the large number of elementary particles that had been observed according to their type – meson, boson, leptons etc. There is also cross-talk between disciplines, for example, in chemistry, atomic physics (quantum theory) is used to enhance the schemas used in the periodic table by assigning quantum numbers to electrons in the atomic shells. Quantum calculations are difficult in the many body problems of larger atoms so simplifications and approximations are used.

Empiriometric Methods – These are methods which use mathematics to represent or image the experimental facts or data. For example, Newton’s theory of motion and gravity, Maxwell’s equations for electricity and magnetism, the laws of thermodynamics, quantum electrodynamics and similar theories all use mathematics to represent their understanding of nature, explain existing fact and to make predictions of how new experiments can be used to further test the theories themselves expressed mathematically. Modern physics uses empiriometric methods and attempts to bring all physical facts into a mathematical representation. Modern physics is the only science where mathematical representation is used to the exclusion of other techniques. When experimental facts cannot be represented mathematically it is because a mathematical theory has not yet been found and that part of physics in this situation is considered immature. In chemistry, geometry is used to represent angles and positions of the bonds that are created between atoms in molecules; and the ideal

gas law is a mathematical relationship used as an approximation to the behavior of gases. These are further examples of empiriometric methods.

Mathematical Preter-real - this term is used by Maritain to describe the realm of mathematics – arithmetic, geometry and analytical geometry. The preter-real is the world of idealized being separated from all sensible being. Points, lines and circles (non-idealized) are observed in objects. The mind abstracts them from sensible matter and idealizes them. The mathematical world is a separate world from the world of sensible being – its being is resolved in the imagination. A circle can exist in matter for that is where we got the idea of circle – the solar disc, a pie, etc. – that circle is a real being. The abstraction of the circle in the mind is the idea of a circle – and that abstraction is a real being. However, the idealization of the circle as used in geometry and mathematics subject to rules and algorithm is a being of reason.

Beings of Reason – beings that only exist in the mind and not in the real world. For example, dark as the absence of light, nothing as the absence of something, and infinity as the limit of an integral are all examples of beings of reason. Also, concepts such as category, and subject and predicate of a sentence are also beings of reason. Propositions in logic are beings of reason. Mathematics beyond the basic concepts of shapes and whole numbers are beings of reason – for example the square root of -1. There is a way in which they are referentially related to the real since mathematics glances off the material world and forms a separate world besides the real that Maritain calls the preter-real. The concept of real being is opposed to beings of reason. Real beings are things that have a real existence outside the mind. Mathematical entities such as functions, integrals, derivatives and groups are not real beings of reason. They are idealizations that exist only in the mind.

Beings of Reason in Modern Physics – Physics uses many beings of reasons beyond just those that come from mathematics. An example is the relative motion of bodies. One considers only the bodies at rest and the bodies in motion (removing the environment – one of the categories) and considers the motion of these bodies from a moving reference frame where some of the moving bodies are at rest and some of the bodies at rest are moving. In doing this the real moving object that has the impetus (a quality of the body) is lost and an object that doesn't have impetus now has some. This act of the imagination is useful in certain situations to reduce the complexity of the mathematics used to represent this system of moving objects but one must keep in mind the assumptions (i.e. what is lost of the real situation). Another example is found in the solution of problems involving pulleys. Often the mass or weight of the string is assumed to be zero – this is clearly a being of reason – but it is useful in simplifying the calculations. Another example is the use of an actualized infinity. An example of this is saying that the gravitational potential energy goes to zero at infinity which allows a functional expression written as $1/r$ to go to zero when r is infinite. Still another example is the use of the concept of space. Space is a concept abstracted from the extended matter and used to represent extension itself. It is a being of reason used extensively in physics. It is one of those beings of reason that is used so often that it is believed to be a real being by many physicists.

III. Maritain's Analysis of the Sciences

Maritain's analysis of the sciences including the philosophy of nature and the empiriological sciences is a thorough and lucid description which he details in *The Degrees of Knowledge* (1931) and elaborates further in the *Philosophy of Nature* (1951). Underlying all of this is his call for extricating the philosophy of nature from metaphysics and placing it

in its rightful place as the foundation of the empiriological sciences and the interpreter of the facts discovered by these same sciences. Maritain makes many distinctions between the philosophy of nature and the sciences in his books and consequently has been misunderstood by some that followed him to be calling for barriers or frontiers between the philosophy of nature and the sciences. Maritain was calling for uniting the philosophy of nature and the sciences so that they converse with each other. He further referred to this unity as that of the body with the soul – which is an intimate unity. Maritain never said how this integration would be actualized but he clearly said that it should be done. The discussion to follow summarizes Maritain’s analysis.

Contingency and Necessity: The primary aim of science for the moderns is different from that of the ancients. For moderns the dignity lies in the experimental sciences. For the ancients the dignity is found in metaphysics. However, they agreed on one thing – that mathematics provides a most perfect science. Science for the ancients (i.e. the philosophy of nature) provides the reasons for being of things and strives to find that knowledge that is necessarily true such that “it cannot not be true”.

Maritain points out that science bears on the necessary and not the contingent. The contingent is not the object of science. The conflict between the individual and the universal begins here – the object of science is necessary but the real world involves contingency – i.e. things could be other than what they are. The laws of science provide us with the necessary relations that derive from the fact that they are concerned with essences or natures.⁶

Laws are substitutes for natures or essences. Science is of natures and essences and consequently only of incorruptible things. Whereas the singular or individual thing is

⁶ Jacques Maritain, *The Degrees of Knowledge* (University of Notre Dame Press, Notre Dame, Indiana, 1995), 30

corruptible, the generalizations or abstractions that science uses are creations of the mind and therefore incorruptible because they are ideas. St. Thomas summed up the idea very concisely that “the understanding knows the universal and necessary reasons of contingent things”.⁷

Certain sciences such as mathematics have for their matter necessary things (i.e. idealized beings of reason)– but physics – understood as the physics of Aristotle or *physica* have contingent things for its matter. The mind is capable of arriving at essences only through abstraction, though a lot of hard work and in an imperfect way through the sensible encounter with the object. In the inductive sciences we have to content ourselves with “substitutes, manageable equivalents” in the laws which do not penetrate to the essences of objects that they explain.⁸

We succeed in obtaining essences of ourselves and those things ‘belonging to man’ and of which we can have an intimate acquaintance. For things that are below us, we are forced to have a knowledge that is built upon the sensible effects alone.

There is a distinction we can make between mathematics and philosophy as deductive in their development on the one hand and science which on the other hand is inductive. Mathematics and philosophy are sciences of explanation. They reveal to us the “intelligible necessities inherent in the object”.

Degrees of Abstraction: We can classify the different ways that we can abstract from the reality about us. First is abstracting the general from the individual – or what the ancients

⁷ Thomas Aquinas, *Summa theologiae*, I, q. 86, a. 3 in *The Summa Theologica of St. Thomas Aquinas* Second and Revised Edition, 1920; Literally translated by Fathers of the English Dominican Province Online Edition Copyright © 2008 by Kevin Knight. <http://www.newadvent.org/summa/1086.htm#article3>

⁸ Maritain, *Degrees of Knowledge*, 33.

called *physica* – the study of mobile or changeable being. The second is abstraction to the quantity, number or extension which leads to *mathematica* – the study of quantitative being. Thirdly is the abstraction of all sensible or material properties to things that can exist without matter – this is called *metaphysica* – or the study of being as being.⁹

But with regard to the first level of abstraction there are two extremes – an explanatory science which is the philosophy of nature and an observational science which pursues knowledge of lower things where natures are less well known. The philosophy of nature ascends to knowledge of general things such as man, animal, plant and inanimate things and principles and causes. The sciences descend to more and more detail observations through various properties we are able to observe such as gravitation, electricity and magnetism, etc..¹⁰

The philosophy of nature (the 1st order of abstraction) and metaphysics (the 3rd order of abstraction) have more in common with each other in that they pursue the nature of things or to say it another way that “penetrate inside things”¹¹ Mathematics (the 2nd degree of abstraction) is a deductive science that “rules the lower sections of knowing”. The discovery of the possibility of a universal science informed by mathematics rather than philosophy ushered in the age of science with Descartes and Galileo. The idea of a mixed science (i.e. mathematics and natural philosophy) was not unknown to the ancients. There were subjects such as geometrical optics, astronomy and music which used mathematics. The new science revolution was to introduce mathematics to all of natural philosophy and consequently it abandoned the search of the ancients for meaning – i.e. fundamental causes and principles.

⁹ Maritain, *Degrees of Knowledge*, 38-39.

¹⁰ Maritain, *Degrees of Knowledge*, 41.

¹¹ Maritain, *Degrees of Knowledge*, 44.

Maritain says, that the new science “provides truly scientific knowledge and devises wonderful means of utilizing sensible nature (from the point of view of quantity indeed, but not from the point of view of being). It has given up the direct search for real causes in themselves and aims to translate, first and foremost, its measurements of things into a coherent system of equations. In all these ways physico-mathematical science is evidently bound to end up by inserting itself, like a wedge, between pure empirical science and the philosophy of nature and so to rupture the continuity in which the optimism of the ancients delighted.”¹²

This wedge has inserted itself deeply in the modern mind. Whereas the ancients pursued the nature and causes of things, they missed the potential of the observational and mathematical sciences. But as successful as the moderns have been with physics and the other modern sciences, their abandonment of the pursuit of nature and causes has led them to a desert when it comes to having a philosophical basis for such things as morality, law, politics and metaphysics.

Philosophy – a Superior Science: What is the relationship or rather what should be the relationship between science and philosophy? It may seem to the modern man that the sciences do not depend on philosophy for their development. However, philosophy is implicit in the first principles of sciences. Logic, a philosophical discipline, is involved in the use of experimental methods and analysis. Mathematical axioms such as two things equal to a third are equal to each other, are particular to the metaphysical axiom that two things identical with a third are identical with one another. Philosophy, not mathematics, will tell us whether or not irrational numbers are beings of reason or whether non-Euclidean geometries are

¹² Maritain, *Degrees of Knowledge*, 49.

based on Euclidean geometry. Maritain's point is that "philosophy acts as a superior science"¹³ in this way. "The philosopher, if he is to judge the value, limits and subordination of the sciences to each other, must obviously know them from that angle and closely follow their development."¹⁴ There is no formal dependence of philosophy on the sciences but there is a material dependence. Scientific data serve the philosopher in helping him to exemplify his ideas – this is a material dependence. Sciences are formally mathematical and philosophy is formally analytic-synthetic and in this respect they are different and independent in the way they are pursued.

One might think that there could be a continuous combination of science and philosophy of nature. But Maritain points out that this is impossible due the very essences of the two forms of knowledge. The reason for this is that physico-mathematical science is not formally a physical science. Physics is mathematical in its formulation and is verified by conforming the various measurements made to the predictions of the mathematical expressions and the associated definitions. There is no need for the quantities to be real.¹⁵

Yet with the framework of Thomistic philosophy, there is freedom for the sciences to develop independently, however, they need to converse with philosophy. Thomistic philosophy is realistic and provides a justification for the reality of things and our ability to know them. The proper object of the intellect is being. That is where science begins and where we are constantly coming back to as we "loop the loop" between our observations and

¹³ Maritain, *Degrees of Knowledge*, 54.

¹⁴ Maritain, *Degrees of Knowledge*, 54.

¹⁵ For example, in quantum mechanics the psi-function does not have any measurable feature (only the absolute value of psi squared) and mathematically this function extends to infinity – another being of reason. Another example is the spin of the electron – presumed to be analogous to small circulating currents, which follow certain laws such as the Pauli Exclusion Principle.

our ontological understanding – to grasp the nature of being. This process of looping the loop is a way of describing the relationship that should prevail between the philosophy of nature and the sciences.

Mixed Sciences and Empiriometric Sciences:

Turning to empiriometric science, we are dealing with what the ancients and medievals called a mixed science and which they considered somewhat related but not quite on the level of philosophy. In empiriometric science the behavior of objects being studied is cast into mathematical form and the calculations from those expressions are then compared to measurements in the real world. The form of the science is mathematical but the matter is the physical world. The starting and terminating points are observations and measurements. However, the empiriometric science doesn't look into the nature of the things. It is interested in describing the way the things behave. This is what Maritain calls perinoetic knowledge. Maritain says that, "Although it will not constitute a science of physical being as such, nevertheless it will obliquely carry along with it ontological values".¹⁶ It is this aspect of empiriometric science that needs the philosophy of nature in order to properly interpret their results.

Maritain says that science is indifferent as to whether the mathematical entities they use refer to real being or beings of reason¹⁷ because all that matters is the explication that the mathematical formulation provides. St Thomas Aquinas¹⁸ in his commentary on *De Caelo* of

¹⁶ Maritain, *Degrees of Knowledge*, 148.

¹⁷ This is the way things are currently in the sciences in particular in physics. When the philosophy of nature is integrated with the sciences, this indifference will be changed to recognition and will be explicit in the mind of the physicist that a fact or facts that needs to be subjected to further analysis.

¹⁸ Thomas Aquinas, In libros Aristotelis De caelo et mundo exposition THE HEAVENS, translated by Fabian R.Larcher and Pierre H. Conway – Book 1 Lecture 3 , 24: "Consequently, it is not unfitting

Aristotle says that it is not unfitting to use mathematics in natural science as a way of demonstration, for mathematics is an abstraction from the natural world. Maritain says that since mathematics is a higher degree of abstraction, “it is possible to have a mathematical exegesis of the physical real”.¹⁹ Empiriometric science grows because it comes back to the physically real to validate itself and to obtain more observations to advance its understanding.

Two Areas Where Philosophy and Science Interact: There are two ways in which science interacts ontologically (i.e. with philosophy) and both of these ways are inchoate.²⁰ First, science takes first principles from natural philosophy. Science presupposes a philosophy or a pre-philosophy. This substructure may be “rudimentary, unformulated, unconscious” but it is none the less real. Secondly, science requires the ontological to interpret the results that it obtains. Again, this is done in a confused and inchoate manner. It would be much better that science realize its place among the broader science of natural philosophy and submit results to the foundational philosophy on which it is based so that the results can be unpacked from the myriad of assumptions that were made to arrive at the conclusions.

The new physics of relativity and quantum mechanics brought a renewal to physics and a significant change. The new physics “declines to attribute the character absolute to any of the elements of the scientific tableau by nature”.²¹ It gives up “absolute dimensions of bodies, absolute bearings in space and absolute bearing in time (even the existence of an ether), the

for the natural philosopher in his demonstrations to use the principles of mathematics — for the latter is not of a completely different genus but is in a certain way contained under the former”.

¹⁹ Maritain, *Degrees of Knowledge*, 155.

²⁰ Maritain, *Degrees of Knowledge*, 164.

²¹ Maritain, *Degrees of Knowledge*, 165.

absolute character of mass, any system of privileged axes ... or in generalized relativity, of systems of reference having any movement whatsoever in relation to one another.” The new physics looks to achieving a complete geometrization of its mathematical representation. It has given up any ontological pretension and multiplied its beings of reason. The philosopher, on the other hand, knows that there are absolute elements in the world. He doesn't know what they are, but he knows that they exist.

The philosophy of nature concerns itself with very fundamental issues based on common observations which are evaluated philosophically using synthetic-analytical methods, for example that there are real things and diversities in the world, that there are substantial changes, and that the living organisms have activities which originate from the self. However, the experimental sciences have generated a large collection of scientific facts whose meaning need to be clarified philosophically to the extent that these facts can be disengaged from the theories in which they are imbedded. Exposing scientific facts to philosophical analysis is like shining a proper light on them - using philosophical principles and objects. Working from the vantage point of the philosophy of nature, scientific facts are looked at in a way that reveals their hidden assumptions, makes explicit the implications of any beings of reason used and identifies simplifications of various abstractions that were used²². It is through this activity that one can bring a unity to the broader physics (i.e. physica) and a true increase in our knowledge. Maritain was optimistic that this work was about to begin or was even beginning in the years leading up to the Vatican Council.²³

²² Such things as recognizing that physics abstracts all categories except quantity and in many cases even that things are substances; that nothing is not something; the limits to infinity do not really exist. To remember that there is a substance that supports the various fields as gravity, electric and magnetic.

²³ Maritain, *Degrees of Knowledge*, 190-191

While there are distinct differences between the two areas of study, the two sciences call for each other. The natural sciences while exploring the detail nature of the sensible only encounter being and causes obliquely and need to be complemented by the philosophy of nature. Similarly, the philosophy of nature which ascends to the ontological must forego explaining detailed phenomena but calls for the natural sciences to provide that detail. The distinction between the two areas of investigation were not clear to the ancients who did not make the distinction that we are making here – except there existed certain mixed or middle sciences that used mathematics like optics, music and astronomy. Thus the two areas are complementary and seek each other for understanding *ens mobile seu sensible* in sufficient completeness.²⁴

Maritain's recognizes that the philosophy of nature splits into two approaches of the study of changeable being. If we take the definition of the subject matter of natural philosophy as *ens mobile seu sensible* (mobile or sensible being), we can place the emphasis either on the *ens* (being) or the *mobile seu sensible* (the mobile or sensible). In the former case we are interested in studying the being of changeable or sensible things – or what we call the philosophy of nature which looks to the real world with synthetic – analytical methods. In the latter case, we focus on the *mobile/sensible* and consequently we are concerned with the sciences that look to observations and measurements for data and uses empiriological methods. St. Thomas often said that the essence of sensible things is hidden from us because of the matter in which it is hidden.

Maritain sees the relationship between the sciences and philosophy of nature much like the relationship of the body and the soul. There is a synergistic relationship and

²⁴ Maritain, *Philosophy of Nature*, 94-95.

interplay. However, the philosophy of nature (the soul) is independent of the state of development of the sciences (the body). During the years after Galileo the world of the sciences was directed by a “mechanistic metaphysics” and the philosophy of nature was like a “separated soul”.²⁵ Maritain says that this had one major benefit in that during that time the philosophy of nature got rid of many impurities. The impurities he was referring to were in the way the mind would tend to go to the ontological, as was the case with the ancients, rather than to dwell with the detail and come to a more perfect understanding. Of course, on the negative side was the divorce of science from natural philosophy which continues to this day.

Empiriometric Science Models and Myths: Physics strives toward the physically real but in doing so it uses a world of symbols – mathematical and geometrical beings of reason. This can be illustrated by an example. There is a physicist in one room and the observatory in another. The physicist is informed of what is happening in the observatory by radio transmissions. The data comes in to the physicist that the object under investigation leaped to a height 300 times its own height. So in his room the physicist creates a catapult type machine that reproduces this effect. Then he learns that there is a memory effect – that the object remembers what it did in the past and modifies its behavior. The physicist, responding to this new information or “crisis”, would then try to incorporate into his “theory” (say by adding computer memory) some appropriate fixes to address the effect. Obviously, the physicist is creating a model (in this case a mechanical model not a mathematical model) that imitates, which isn’t the real thing, but is founded on the real. Maritain reveals that the actual object in the other room is a common everyday flea. Obviously, the physicist wasn’t

²⁵ Maritain, *Degrees of Knowledge*, 190.

interested in nature of the thing it was investigating only its properties. The physicist was modeling the behavior of the flea based on real data but his model missed many important aspects of the flea.²⁶

Maritain says that we can call the models that the physicist uses myths. The theoretical physicist is looking for the simplest and most elegant way to mathematically explain the reality that is seen. Many times it is this search that leads physicists to postulate the existence of something that is later discovered in the laboratory. So it has the power to reveal symmetries and other relationships that can lead to new ideas that then lead to new discoveries.

Distinguishing Modes of Defining: In observing any material object there is the beginning of two kinds of knowledge – one that asks about the essence of the thing and it causes (intellectual knowledge) and one that asks for detail information about the thing (sensorial knowledge). As we have already said, the mind, when contemplating this flux of sense experience, can ascend to the ontological knowledge or descend to the details of the observable. Thus there is a division of knowledge – the one called the philosophy of nature and the other – the natural sciences. Maritain talks about St. Thomas and the fact that he saw the philosophy of nature and the natural sciences in one class. He says that at the time, the natural sciences had not “won their methodological autonomy and still constructed their definitions according to the same typical pattern as the philosophy of nature”.²⁷ The Table below summarizes Maritain’s discussion of the difference between the philosophy of nature and the natural sciences. While there are three levels of abstraction and thereby three types of knowledge, within these levels there are specific differences in the object under study or the

²⁶ Maritain, *Degrees of Knowledge*, 174.

²⁷ Maritain, *Philosophy of Nature*, 91.

terminus a quem. In mathematics, there is the distinction between arithmetic and geometry where the one looks at discrete quantity and the other continuous. In the table, the distinction in the first level of abstraction shows that there are two distinct sciences – the philosophy of nature and the natural sciences.

Table 1: Philosophy of Nature and Natural Science Comparison of Activity: The complementary yet independent view of the ascendancy and descendancy of knowledge in the sensible sciences.

Knowledge Area	Movement of the Mind	Subject	Level of Abstraction (terminus a quo)	Mode of Defining (terminus a quem)
Philosophy of Nature	Ascending to the ontological	Looks at being and it causes in the sensible but deals with first and foremost as intelligible; real being attained directly	First order – particular to general	Resolved in intelligible being
Natural Sciences	Descending to the observable	Looks at being but first and foremost in the sensible; real being and causes attained only obliquely	First order - particular to general	Resolved in the observable or measureable and regulated by mathematics- a mixed science

Subalternation: There is a further consideration that needs to be made relative to the empiriological sciences. Empiriology needs to be linked to a deductive science because in deduction is found the most perfect type of scientific explanation and the deductive science to which empiriological knowledge is linked plays a formal and directive role with respect to experience. In scholastic terms we are talking about **subalternation** to a deductive science – mathematics or philosophy. A science is said to be subalternated to another when it derives its principles from this other science. So geometry would be the subalternate science with

respect to (geometrical) optics and arithmetic would be the subalternate science to acoustics for music. Mathematics is the subalternate science with respect to modern physics. Physics will consider and explain things in mathematical terms and be regulated by mathematical principles. From this we see that the object of modern physics is explanation through mathematics and not philosophy. There are many mathematical beings of reason which are consistent with the mathematics and observation but which need careful attention when the results of the empiriometric science are unraveled. Maritain says that the “danger will be great – not inescapable but great, - of mistaking these mathematically constructed entities, *entia rationis* with their foundation in reality, for ontological causes, for *entia realia* explaining the essence of the physical real”.²⁸ However, the empirioschematic sciences (e.g. biology), in so far as it escapes the attraction of mathematics will be attracted to philosophy – the other deductive science.

Cajetan’s Formal Objects and Formal Perspectives: Maritain takes up the distinctions that Cajetan²⁹ taught about formal objects and formal perspectives in discussing the objects of a science and the point of view that the science takes in pursuing knowledge of the object. Cajetan separates three ideas: (1) the thing that one wishes to know about (Maritain calls this the “intelligibility appeal”); (2) the object that is studied in order to come to the desired knowledge (Maritain calls this the “sphere of fundamental intelligibility”); and (3) the way in which one “converses with” the object (Maritain calls this the “objective light” which is how the mind attains the object or the type of abstraction that is used).

In the Appendix we give more detailed examples of what Maritain is saying. In summary, however, his major point is that the formal perspective or the “objective light” has

²⁸ Maritain, *Philosophy of Nature*, 105.

²⁹ Cajetan, *Commentary on Ia Pars Summa Theologica*, q.1, art. 3.

a more profound influence on the “*habitus*” or method than the formal object. For example, in metaphysics the formal perspective of abstracting and defining without reference to material is more formative of the science than just the formal object which is *being*. Maritain analyses the empiriometric and the empirioschematic sciences using Cajetan’s approach and shows that the empirioschematic sciences differ from the philosophy of nature only in its formal perspective (i.e. observational versus ontological methods or *habitus*) whereas empiriometric sciences differ in all three levels of Cajetan analysis – i.e. the intelligibility appeal, the sphere of fundamental intelligibility and objective light. This emphasizes that we must carefully distinguish the empiriometric and empirioschematic sciences in looking at the interaction with the philosophy of nature.

Method and Facts: We come to another important question which gets to the heart of the relationship among the various disciplines. It is the whole idea of method.³⁰ What kinds of facts should the philosophy of nature depend upon? A fact is a well ascertained truth. A fact implies discernment and judgment. Facts are not all of equal rank and enter into the hierarchy of knowledge. There are philosophical, scientific, logical, mathematical and metaphysical facts. There are facts that come from common observations which must be submitted to philosophical judgment. Scientific facts provide material for philosophical analysis and judgment. There are two errors that must be avoided in the analysis of scientific facts. First, brute scientific facts are of no use to philosophy. A brute fact is a scientific fact that has not been treated philosophically. The second error is rejecting scientific facts and constructing a philosophy of nature isolated from the sciences. “Now note that this is an inevitable tendency if the philosophy of nature be confounded with metaphysics; for in this case the philosophy

³⁰ Maritain, *Philosophy of Nature*, 140-151.

of nature claims for itself the same freedom with respect to the detail of scientific facts as is possessed by metaphysics.”

There are two sources of data for the philosophy of nature – (1) human, primordial, pre-scientific experience and (2) scientific observations and facts. Philosophy may convert these things into its own by submitting them to the objective light of philosophy.

Philosophical facts must be drawn from the “gangue”³¹ of scientific facts and submitted to the *intellectus agens* to draw intelligible objects from sense experience. From scientific facts it is hard to distinguish between theory and physical fact. Particularly in the case of empiriometric sciences, the disengagement is complex. One must distinguish between mathematical explanation and facts. The mathematical theory must be considered as “essentially provisory and changing opinion”.³²

Change: There is a sense of aging in the acquisition of knowledge. There is change in the philosophy of nature but not “substantial mutation”. Above we find metaphysics which comes down through the centuries basically unchanged. Aristotle’s metaphysics “will never be out of date”. But what about a scientific theory? How long before it is revised or modified extensively? In the hierarchy of knowledge which starts with science and builds to a philosophy of nature and eventually to metaphysics, there is also a law of change and as you go up the ladder there is less and less change with time. However, philosophy of nature needs to draw upon scientific results to confirm its tenets and to complete its understanding. So too, the metaphysics depend on a vibrant and robust philosophy of nature. The philosophy of nature is the “indispensable mediator” as it takes the inferior sciences and

³¹ Gangue is a term used by Maritain taken from mining. It means the material surrounding or mixed with the desired mineral or ore deposit that is desired.

³² Maritain, *Philosophy of Nature*, 150.

brings their results in accord with its principles and supports the knowledge of metaphysics which lies above it.

III. Maritain's Historical Context

A second overview that Maritain gives us is a brief historical perspective of the relationship between the philosophy of science and the sciences. This perspective clarifies where we have been and where we have come. Maritain was hopeful that history was ready for a renaissance of the philosophy of nature.

The Ancients and Abstraction: Maritain reminds us that the intellect was made for being – that when it looks at the world, it seeks *being* but finds *becoming*. To Plato the sensible nature can only be an object of opinion and not a science. There is no philosophy of nature in Plato's system. There are two worlds – the sensible world of becoming and the world of eternal archetypes – a world of mathematics and metaphysics. When he tries to give an explanation of the world, it is myths that he uses. "I think it can be generally said that every attempt to explain natural phenomena by the use of mathematical knowledge alone necessitates the recourse to explanatory myths."³³

It was Aristotle who replaced Platonic ideas with forms –forms which are immanent in things. He said that universals are in the mind. It was Aristotle who separated *physica* from the *metaphysica*. Revisiting the degrees of abstraction – which are important because they defined how we think and gain knowledge - Aristotle and the Scholastics discussed *abstractio formalis* and *abstractio totalis*. The first type of abstraction is abstraction of the *form* from the matter in order to uncover the essence of the thing or the thing 'known in itself'. This abstraction is called typological visualization and proceeds to the actuality in the thing. The second type of abstraction is abstraction of the parts from the whole in order to

³³ Jacques Maritain, *Philosophy of Nature* (Philosophical Library, Inc. New York, NY 1951), 7.

know how the thing “is known to us”. This type of abstraction is called extensive visualization and proceeds to the potentiality in the thing. There are three levels of *abstractio formalis* – the physical, mathematical and the metaphysical. These three levels are distinct and heterogeneous. There is heterogeneity (that is to say generic differences) among them for the three terminate differently – the physical in the sensible, the mathematical in the imagination and the metaphysical in the intelligible.

But also on this first level of abstraction we have *abstractio totalis* which is the abstraction we need for the detailed sciences. The error of the ancients is that they failed to see the need for a science that looks at the detail of phenomena – that there was a need for a science distinct from the philosophy of nature – that would address this detail. For the ancients this was all one science – the philosophy of nature – and that absorbed all other types.³⁴ The moderns would do the exact opposite and absorb (inchoately) the philosophy of nature into the sciences.

Errors in Aristotle’s Science: Maritain reminds us that the fall of the ancient astronomy and physics of Aristotle, which began in the Middle Ages and reached a climax in the time of Galileo, brought down with it the underlying natural philosophy of Aristotle. For the Ancients, there wasn’t a distinction made between the philosophy of nature and the specialized sciences. Since the ancients kept their eyes on the intelligible, all of the sciences were absorbed into the philosophy of nature. Consequently, the errors in Aristotle’s astronomy (e.g. perfect circles and eternal orbits) and in his physics (what keeps an object in motion?) which were found to be false, led to an abandonment of all his work, including his basic philosophy of material change and motion. Since Galileo, this separation of the modern

³⁴ Maritain, *Philosophy of Nature*, 35.

sciences from the work of Aristotle has had 300 or more years to develop independently. The philosophy of Aristotle still provided the underlying principles for modern physics, but they were hidden, confused and implicit (e.g. the principles of non-contradiction and causality, substance, being, accidents, the ten categories and use of analogical methods in the quantification of qualities).

Discovering Science Itself is not Philosophy: The Galileo-Cartesian revolution began a process which continued until the time of Newton and Kant. The new science was thought to be part of the philosophy of nature and was treated as such. It took several centuries for science to become aware of the fact that science is not a philosophy. This was a tragic misunderstanding according to Maritain – the presumed conflict between the old philosophy and the new – “but actually there was on the one hand a philosophy of nature and on the other a discipline which cannot be a philosophy of nature: two sciences which do not fish in the same waters and are therefore perfectly compatible”.³⁵ But the replacement of the old philosophy left the new science with the responsibility of answering ontological questions and since it was mathematical in nature (the second level of abstraction) looking at quantitative being, the answers that it came up with were mechanistic, that is, “in terms of extension and movement”.³⁶

Classical and Modern Physics and Philosophical Principles: Classical physics (i.e. the physics before relativity and quantum mechanics) led to the idea of a mechanistic explanation of the universe. It gave credence to the idea that if one could know the positions and momenta of all things at a particular time, one could (not in reality but in principle)

³⁵ Maritain, *Philosophy of Nature*, 42.

³⁶ Maritain, *Philosophy of Nature*, 42.

compute and therefore know the future of the universe – not only of the world of inanimate matter but the whole world including the organic – including man. This deterministic universe dominated the thinking of classical physics and its empiriological results were taken as an ontology. Then the new physics came along with the idea of relative motion and the uncertainty principle of quantum mechanics. This new physics discarded the old empiriological mechanical “metaphysics” and replaced it with a theory that no longer was thought to be in conflict with human free will since according to some physicists the uncertainty principle allows for a non-deterministic world – yet at the same time brings the real ontological principle of causality into question. Yet Maritain says that the debate between “determinist” mechanics and “indeterminist” mechanics is quite outside the field of philosophical problem. It would be more precise to say that the quantum world of indeterminism is empiriometric knowledge and that according to its formulation and myths the physical world cannot be strictly measured. The contrary idea that the principle of causality is disproven is taking the empiriological directly into the ontological. This is the result of more than 300 years of forgetting the natural philosophy of Aristotle.

“To tell the truth, the physico-mathematical universe constitutes a closed world, in which geometrism or mathematicism introduces a pseudo-ontology, a substitute for the Philosophy of Nature and metaphysics”.³⁷

Positivist Interpretation and Reaction: The second phase began in the nineteenth century - the positivist phase - which followed from the time of Kant and continues to the present day. Kant said that science cannot discover the thing in itself and therefore is a science of phenomena which ushered in the age of the positivist. It was the positivist goal to keep science “undefiled” from being, substance, cause and the “why”; to eliminate every

³⁷ Maritain, *Degrees of Knowledge*, 204.

ontological preoccupation; and to avoid the inclination to express as causes “only connections between phenomena”. The non-mathematized sciences were slowly integrated into this ‘phenomenal’ universe and represented not by a deductive mathematics but by schemas or other ‘beings of reason’. Thus the sciences were viewed as providing the only philosophical interpretations, “pretending to take the place of a philosophy of nature”.³⁸ The discipline of the positivist had a useful side effect. It restrained the intellect “which proceeds too quickly to the explanatory cause” and allowed the energies of the scientist to focus on the phenomena and their relations.³⁹ The negative side is that it didn’t allow for any ontological interpretation by anyone inside or outside the field. The reaction against this positivistic notion and the absorption or elimination of the philosophy of nature was seen in the work of Pierre Duhem, Emile Meyerson and by the German phenomenology of Husserl and Scheler.⁴⁰

Pierre Duhem’s view was that empiriometric physics has as its object the pure mathematical representation of phenomena without probing the sources of causality. Physics is a purely mathematical system totally separated from every casual pretension. Duhem was speaking as a physicist. Maritain says that Duhem’s interpretation was useful because it showed that there could be a qualitative view coexisting along with a separate quantitative view.

Emile Meyerson was not a physicist but he was able to see that science requires the presupposition of a thing – a substance. “All science rests upon the unobscured (since the

³⁸ Maritain, *Philosophy of Nature*, 49.

³⁹ Maritain, *Philosophy of Nature*, 53.

⁴⁰ Maritain, *Philosophy of Nature*, 60-72.

nature of this foundation has been denied) but nevertheless solid bed-rock of the belief in being that is independent of consciousness”.⁴¹ Things exist independently of the mind and it is possible for one’s intellectual powers to grasp things. Furthermore, the scientist has “ontological and explanatory preoccupations which enter into the texture of his scientific work”. So Meyerson’s attitude is opposite to Duhem’s. Meyerson seeing that philosophical ideas are hidden within the science and Duhem saying that science with all its mathematics isn’t concerned with philosophy but that a separate qualitative explanation exists alongside the empiriometric. However, both were in reaction to the positivist notions that had taken over the sciences.

German phenomenology presents another reaction to positivism. M. Hans André who combines Thomism and phenomenology and was influenced by Max Scheler reacted against the positivist concept of science and the elimination of the philosophy of nature. The German movement was aimed at restoring the philosophy of nature.⁴² The aim of the phenomenologist, in rejecting a mechanism explanation, was to construct an intuitive science addressing the “essential articulations” of the object. Maritain notes that behind this movement, there isn’t a regulating metaphysics that sets up the frontier between philosophical and scientific understandings. So there is a great danger of confusing their formal objects. He believed that there was a danger in this movement in that science would be made into the philosophy of nature and that this would open the door to irrationalism leading to explanations that were more metaphysical than scientific in character.

⁴¹ Maritain, *Philosophy of Nature*, 63. Maritain is quoting from Antoine A. Cournot, *Traité de l'enchaînement* (Paris, Hachette, 1861), vol. I, p. 264. This quote was taken from Emile Meyerson, *De l'explication dans les sciences* (Paris, Payot 1921); vol.I, p.6.

⁴² Maritain, *Philosophy of Nature*, 71.

A Renaissance for the Philosophy of Nature?: Maritain saw a renaissance in the philosophy of nature taking hold⁴³ as the positivism started to retreat. He saw the future of this renaissance as depending on the efforts of the Thomists who at that time (1951) constituted a growing influence in the revival of the ideas of Aristotle and St. Thomas Aquinas.

In the last years leading up to the Vatican Council II, there was an effort to bring scientists and philosophers together to discuss the bridging of the gap between the two groups. This was the Albertus Magnus Lyceum of the River Forest School, which we will discuss in the next section. However, after the Vatican council much of the effort begun by Leo XIII came to an end and with it the efforts that gave Maritain hope that we were entering a renaissance. Philosophy professor Ralph McInerny said in a talk at a meeting of the Thomist Institute of the Jacques Maritain Center of Notre Dame University in 1997 -

In the quarter of a century or more that intervened between Maritain's *The Philosophy of Nature* and the close of Vatican II, the discussion of the relationship between philosophy and science was carried on by Thomists in a lively fashion. ... The Council had many unintended effects, among them the rapid disappearance of Thomism from Catholic colleges and universities.... there was a precipitous decline among Thomists. *Keynote Speech by Ralph McInerny at the July, 1997 conference of the Thomist Institute* (<http://marita.in.nd.edu/jmc/ti.htm>)

V. Post-Maritain Efforts

The sixty years that have passed since Maritain's published *Philosophy of Nature* have seen some progress toward bridging the gap between the philosophy of nature and the sciences. It is an effort that is in its infancy and not as robust as one would like to see in large part due to the post-Council decline in Thomism in the universities. However, there have been significant steps taken by several physicist-philosophers that deserve mention. The most

⁴³ Maritain, *Philosophy of Nature*, 151-156.

recent advances being done by Rizzi are the most encouraging and give us hope that progress toward Maritain's unification is underway. We begin by discussing the River Forest Group and the effort they made to begin the process of bringing philosophy of nature and the sciences together. We then will talk about the efforts of three physicist-(Thomistic) philosophers - Wallace, Jaki and Rizzi.

The River Forest School – Albertus Magnus Lyceum (1963-1969): In 1963, Father William H. Kane with the help of Frs. Raymond J. Nogar and Benedict M. Ashley established the Albertus Magnus Lyceum as part of the Dominican River Forest School in Illinois whose purpose was to begin a dialogue between philosophers and scientists particularly within the context of philosophy of St. Thomas Aquinas. Ashley summarized the work of the Lyceum in a paper published in 1991⁴⁴. At the time of the Albertus Magnus Lyceum there were several schools of thought regarding St. Thomas' philosophy. There was the French school which consisted of Jacques Maritain and Etienne Gilson; the Louvain Thomists such as Mercier and Renoirte, and transcendental Thomists such as Joseph Marechal and Bernard Lonergan, those who emphasized the Platonic element in Aquinas such as Cornelio Fabro and Albert Little, the strict Thomists observers Reginald Garrigou-Lagrange. But the River Forest school was influenced more by Fathers William H. Kane and Fathers James A. Weisheipl and William A. Wallace and their particular interpretation of St. Thomas.

Looking back on the River Forest School from 1991, Father Ashley listed eight theses that would characterize the thinking of the River Forest philosophers at that time:

⁴⁴ Benedict Ashley, "The River Forest School and the Philosophy of Nature Today", in *Philosophy and the God of Abraham: Essays in Memory of James A. Weisheipl, OP*, ed R. James Long, Papers in Mediaeval Studies 12 (Toronto: Pontifical Institute of Mediaeval Studies, 1991), pp. 1-15.

(1) The source of Aquinas' philosophy was to be based upon St. Thomas' commentaries on the books of Aristotle. It was believed this was superior to the approach of Etienne Gilson who used the *Summa Theologiae* and the commentaries on the *Sentences* and *Contra Gentiles*;

(2) Aquinas should be interpreted as a convinced Aristotelian opposing the tendency to Platonize admitting it only in so far as it is in accordance with Aristotle;

(3) The correct interpretation of Aquinas' philosophy depends on a careful observance of his theory of the order of the sciences such as is discussed in Aquinas' commentary on *De Trinitate*;

(4) It is wrong to distinguish natural science as empirical and philosophy of nature as rational and to treat it as part of metaphysics. Maritain made it clear that the philosophy of nature and metaphysics were distinct. In addition, Maritain drew a distinction between the natural sciences and the philosophy of nature. The River Forest School maintained that it was a single unified science and argued that Maritain's distinction led to his asserting a philosophical imperialism over the natural sciences.

(5) The key to reading Aristotle and Aquinas on natural science is to have a good understanding of the *Organon* especially the *Posterior Analytics*. A common error is to think that for Aristotle science proceeded via logical deductions. In fact he taught that at every level of science new principles must be introduced so that in science there are almost as many principles as conclusions. For example, the principle of inertia or impetus initially proposed by Buridan in the middle ages and used by Galileo and Newton later in the early days of modern physics. These principles we do not come by easily but are evident only after painstaking investigation.

(6) Apparent differences between Galileo and St. Thomas Aquinas are not formal differences but misunderstandings of modern science which developed from the ideological history after Galileo.

(7) The natural philosophy of Aquinas and Aristotle provides a foundational analysis for the natural sciences. There are serious flaws in the intelligibility of the findings of science which generates a very confused world-view. For example, physics suffers from a lack of clarity in regards to such terms as space, time, matter and energy.

(8) The task of revising modern science on the basis of its original foundations cannot be evaded by a flight to metaphysics or theology. The philosophy of nature's flight to metaphysics and its disconnect from the sciences has had negative impacts on both disciplines.

Maritain drew distinctions between science and philosophy but he maintained that there was a unity between the two based on the 1st degree of abstraction. However, historically they became separated. Maritain called for a reuniting of the two by first separating the philosophy of nature from metaphysics and then reestablishing the philosophy of nature as a discipline in its own right and then finally uniting it to the natural sciences so that the natural science will have a firm foundation and a means for interpreting their findings ontologically. Aristotle's foresight into the development of *scientia* in general allows for their being additional principles upon which to base further sciences yet to be discovered.

Most of all the River Forest Dominicans took issue with Maritain saying that "natural philosophy as Aquinas conceived it cannot deal with the kind of topics which interest modern

science”⁴⁵. The significance of the change and radical impact that Galileo and Descartes had introduced was not sufficiently appreciated by the River Forest Group. Their position was that it was a misunderstanding. Galileo and Descartes introduced something very new and different from what had gone before. Maritain had a better understanding of mathematics and was correct in saying that the new methods (of modern science) were not anticipated by Aristotle or Aquinas because the new science was subalternated to mathematics as its deductive science and not philosophy.

Maritain’s says that the modern sciences provide by themselves only an oblique look at the real world or real being. It must submit its empiriological results or facts for philosophical analysis in order to understand what it can tell us about the causes, principles and nature of the world. Overcoming the prejudices that modern man has against ancient and medieval philosophy is a tremendous barrier to doing this however. Especially with the common folklore that Galileo fought against the ideas of Aristotle and won. The truth of the matter is that modern science owes its existence to work of Catholic philosophers in the middle ages. The revolution that Descartes and Galileo brought was the discovery that one can use mathematics as a means of representing scientific facts and that there is another subalternate method to the sciences.⁴⁶

The task of properly interpreting empiriological facts is heavily impeded by Kantian ideas that have infiltrated Thomism, like transcendental Thomism, and is rooted in the denial of the proofs of the existence of God. Metaphysics depends on natural philosophy to justify

⁴⁵ Ashley, *The River Forest School and the Philosophy of Nature Today*, 7.

⁴⁶ It has taken until now to realize that the facts obtained in this fashion need to be united with the philosophical facts that are obtained outside of the sciences. Catholic universities need to again become more involved in science research and education and begin to make an impact on bringing back the philosophy of nature.

its very existence. It is the certainty of the existence of God and the immateriality of the soul that results from the philosophy of nature and of human nature (i.e. Aristotle's *Physica* and *De Anima*) that calls for metaphysics which literally means "beyond physics". Without these two philosophical facts there is no need for metaphysics and the philosophy of nature would be the highest science.

Maritain and the River Forest School agree that the natural philosophy of Aristotle/Aquinas provides the starting point for establishing a solid ground for interpreting the results of the natural sciences. Where they appear to disagree is precisely how one should view the relationship between science and philosophy – on the one hand Maritain's position that there are two distinct methods of obtaining knowledge – the philosophical and the scientific and the view of the River Forest group, particularly Fr. Kane⁴⁷, who maintains that philosophy of nature and the sciences are all part of a "single unified science whose object, scope and method are not formally distinct from that of modern natural science."⁴⁸

Post Vatican Council II changes led to the dispersal of the philosophers of the Albertus Magnus Lyceum and also closed the Pontifical Faculty of Philosophy at the River Forest School. Thus this embryonic attempt at advancing the realistic philosophy of Aristotle and St. Thomas was brought to an end. The movement that Maritain had anticipated of a new

⁴⁷ William H. Kane, *Approach to Philosophy: Elements of Thomism*, The Thomist Press, Baltimore, MD (1962).

⁴⁸ In a sense they are both correct. If you look at the current situation, there is a distinction between the empiriological and the philosophical. The world of modern physics is its own preter-real world where beings of reasons are seen as real and there is little explicit recognition of the fundamentals of natural philosophy. So on this point, Maritain is correct and the multiple distinctions he draws are valid. On the other hand, if you want to say what the modern sciences should be in the ideal situation, you would say that natural science is one thing not two disciplines practiced separately but integrated so that the basic principles of *physica* are part of the method of doing science and well ingrained in the mind of the scientist. On this point, Kane is correct and in another sense so is Maritain because he called for an intimate relationship between the philosophy of nature and the sciences.

integration of natural philosophy with the empiriological sciences now became dormant. The members of the Lyceum moved on to topics in the history of science or ethics. Exceptions to this included Fr. William Wallace who continued his work in natural philosophy and made valuable contributions to the demonstrative regress and showing how scientists can come to certain knowledge.

William A. Wallace: William A. Wallace is a Dominican priest with advanced degrees in physics, philosophy and theology⁴⁹. He has authored many philosophical articles for the Catholic Encyclopedia (1967) and has pursued research in the medieval and Renaissance science. He has translated and researched documents by Galileo and has investigated Galileo's use of Jacopo Zabarella's methodology of demonstrative regress⁵⁰. Wallace's consideration of demonstrative regress is important in his work for it is how science reaches certainty in its findings. Wallace's work was done in the years from 1960 to the present time.

In his book, *The Modeling of Nature*, Wallace takes issue with Maritain's account of the relationship of philosophy of nature with science. He says that Maritain has taken a tacit acceptance of the positivist view of science "which effectively rules out the possibility of the scientist's attaining any certain and causal knowledge, that is, ontological knowledge"⁵¹. In a footnote, Wallace quotes Fr. Charles DeKoninck saying that Maritain would erect a

⁴⁹ William Wallace degrees: Manhattan College, New York, B.E.E., 1940; The Catholic University of America, M.S. (Physics), 1952; Dominican House of Studies, Washington, D.C., S.T.B., 1952; S.T.L., 1954; University of Freiburg, Switzerland, Ph.D. (Philosophy), 1959; Th.D. (Theology), 1962. Honorary: Providence College, Providence, RI, D.Sc. 1973; Molloy College, New York, NY, D.Litt. 1974; Manhattan College, New York, NY, L.H.D. 1975; Fairfield University, Fairfield, CT, L.H.D. 1986 from <http://www.innerexplorations.com/philtext/ww.htm>.

⁵⁰ William A. Wallace, *The Modeling of Nature: Philosophy of Science and Philosophy of Nature in Synthesis* (The Catholic University of America Press, Washington DC, 1996) 300.

⁵¹ Wallace, *The Modeling of Nature*, 226.

“frontier” between natural philosophy and modern science.⁵² This is quite revealing of the way Maritain’s work was read by other philosophers and scientists. Maritain was interpreted to say that his analysis leads to a division (frontier) between scientists and philosophers – a divide in which only philosophers could come to certain knowledge and not scientists. I think that Wallace’s and others’ reading of Maritain is too severe. Maritain was looking for a resuscitation of the discipline of natural philosophy which had been lost – either by being excluded from consideration by positivism or by being included into metaphysics by Neo-Scholastic Thomists. With its resuscitation the philosophy of nature was to be reunited to the modern sciences as a body is united to its soul.

Maritain does little in the way of saying how science and the philosophy of nature should interact or relate with each other. He makes the comment that the relationship should be like the body to the soul but doesn’t make this metaphor concrete by saying how the two disciplines should interact. It is only toward the end of the book, *Philosophy of Nature* that Maritain discusses this most important topic saying only that he was looking for a renaissance of the philosophy of nature due to the retreat of positivistic influence and he envisioned scientists as beginning to see the need for philosophy for “a deeper understanding”. So, Maritain was not outlining in particular how this would happen; only that he was hopeful that it would happen. But it seems clear that for this revival to occur philosophers and scientists would need to work together or what is even better for those practicing the modern sciences to become educated in the philosophy of nature so that it is integrated into their thinking from the beginning of their efforts as we will see is the point of view of Rizzi.

⁵² Wallace, *The Modeling of Nature*, 227.

Also, Maritain discusses the difference between empiriometric and empirioschematic sciences, saying that the empirioschematic is much closer to the philosophy of nature because it doesn't use mathematics as an intermediary representation. The more significant problem Maritain encounters is with the empiriometric sciences (e.g. physics). However, Maritain believes that one can derive philosophical facts from empiriometric facts, however, with much careful work.

Stanley L. Jaki: Fr. Stanley L. Jaki (1924-2009)⁵³ was a physicist and also a theologian, holding doctorates in both fields. He did his physics dissertation at Fordham University on experimental cosmic ray physics. He studied extensively the history of science and philosophy. He is an excellent example of the physicist-philosopher that we have been talking about as necessary to bring together natural philosophy and the modern sciences. Fr. Jaki has written many books and articles on a great variety of topics related to physics and the other sciences. Among his accomplishments is bringing to the fore the following important ideas: (1) the significance of Gödel's theorem to philosophy and science; (2) the work of Pierre Duhem with regard to medieval history of science and the philosophy of science; and (3) the history of the growth of science in various cultures. His seminal work published in 1966 was entitled the *Relevance of Physics*, which discussed the limitations of science at a time when physicists were not quite ready to discuss the topic⁵⁴.

Gödel was a mathematician who published a paper in 1930 that basically showed that within a system that is at least as complex as arithmetic, the consistency of the system can

⁵³ S. L. Jaki received a STD in Systematic Theology from the Istituto Pontificio di S. Anselmo in Rome in 1950. He received a PhD in Physics from Fordham University in 1957. From www.columbia.edu/cu/augustine/arch/jaki/cv96.

⁵⁴ S. L. Jaki, *A Mind's Matter: An Intellectual Autobiography*, William B. Eerdmans Publishing Company (2002), p. 29.

not be proven within the system. The significance of this mathematical result took several decades to be understood and is not widely known even today among physicists. Fr. Jaki was the first to recognize its significance for science, particularly the empiriometric sciences like physics and in particular for those who were optimistic that a theory of everything could be discovered in physics that would explain why everything is the way it is. In 1976, Jaki was on a panel at a conference in which the famous physicist Murray Gell-Mann was also a panel member. Gell-Mann was a Nobel-laureate physicist who worked on a theory of quarks based on a group theory approach to explaining the elementary particles known at that time. Gell-Mann said that he was hopeful that in a few months, he and perhaps others would find a complete theory of the elementary particles. Fr. Jaki informed him that he would not be successful because of Gödel's theorem. Gell-Mann was taken aback by this since he had never heard of Gödel. However, two months later it was clear that Gell-Mann had heard what Fr. Jaki had told him and that he had changed his mind about finding such a complete and self-explanatory theory.⁵⁵

Gödel's theorem to the idealist philosopher simply seemed to say that you couldn't prove the truth of a system of ideas and therefore that all systems of ideas (i.e. idealist philosophies) were not fundamentally about truth. But to the realist philosopher, Gödel's theorem was a reminder that the validity of an idea or system of ideas is found in its conformance to reality. For physics this means that the mathematical system that it develops to explain phenomena finds its validity in the fact that it must conform to experimental and observational data (i.e. the real world). Physical theories do not find their truth in mathematics but the truth is found in how it agrees with experimental data.

⁵⁵ S. Jaki, *A Mind's Matter: An Intellectual Autobiography*, p. 7.

Fr. Jaki elevated the work of the physicist, Pierre Duhem, who was also a pioneer in the philosophy and history of science. Maritain referenced Duhem extensively in his books that we are focusing on in this thesis. Duhem did extensive work on medieval and ancient history of science which was mostly lost in his time (among the anti-Catholic prejudice that existed in France and among physicists) and which sadly continues into our times today. His multi-volume work was called the *Le System du Monde*. Duhem also made significant contributions to the philosophy of science (and to science itself) and Jaki's writings about him brought out these contributions.

Fr. Jaki did not advertise himself as a Thomist but his writings indicate that indeed that was his bent. He admired Maritain and was familiar with his book *Degrees of Knowledge*. In 1987, he published an article entitled "Maritain and Science"⁵⁶ in which he praised Maritain for his recognition of the beauty of the New Physics (the physics of the 1930's) and at the same time his courage in saying to a world totally taken in with the excitement of the new physics that empiriometric physics is not the whole of knowledge and in particular that science was a "diminished knowledge". Fr. Jaki is known for saying a similar thing, i.e. that science is a limited knowledge⁵⁷. This was the conclusion of his famous book, *The Relevance of Physics*. It was a witness that was given to world that worshiped science and was not in the mood to consider such things as limits. Both Maritain and Jaki spoke against the rising tide of scientism of which represented the majority of the information that arrived to the layman in the name of science was indeed not science at all

⁵⁶ S. L. Jaki, "Maritain and Science", in D.W. Hudson and M.J. Mancini (eds.), *Understanding Maritain: Philosopher and Friend* (Macon, Ga: Mercer University Press, 1987), pp.183-200; reprint of 1984(2).

⁵⁷ S. L. Jaki, *A Mind's Matter: An Intellectual Autobiography*, p. 29.

but only ontological meanings that attached themselves to the science without philosophical analysis. It takes a lot of courage “to state that there would be no opposition between faith and science if science were to be of philosophical ‘good faith’”.⁵⁸

Fr. Jaki’s experience as a physicist and his deep interest in the history of scientific ideas, compounded by his rigorous research, enabled him to see what other physicists were unable to see. The purpose of his gaining a doctoral degree in physics was to provide him one of the foundations on which to articulate his message that “physics, this quantitatively most exact of all sciences, is both enormously relevant and also most irrelevant at the same time.”⁵⁹

His work in the history of science showed that the sciences did not develop in other civilizations but only within the Catholic culture of Europe. He discussed all of the major civilizations and found that science was “stillborn” in every culture due to a lack of fundamental beliefs necessary to allow science to develop. Science developed in a Catholic civilization due to the existence of the following ideas: (1) the world exists and is independent of us and is orderly; (2) we can understand it; (3) we should have no aversion to observing nature and working with it⁶⁰. Medieval men were fond of quoting the bible – “God has ordered all things by measure, number and weight”. It was believed that the universe is rational, predictable, intelligible and measurable. These ideas which were imbedded in the Catholic mind and culture enabled the development of the modern sciences.

⁵⁸ S. L. Jaki, *Maritain and Science*, p.199.

⁵⁹ S. L. Jaki, *A Mind’s Matter: An Intellectual Autobiography*, p. 26.

⁶⁰ As summarized in Rizzi’s *Science before Science*, p. 187.

Anthony Rizzi: A major contribution to the integration of philosophy of nature and science is the work of physicist, Anthony Rizzi. Rizzi⁶¹ is himself a physicist of some renown having made original contributions in the area of general relativity⁶². He is writing text books for the college level called *Physics for Realists* which explicitly demands the anchoring of physics in reality and the fundamental physics of natural philosophy.

He picks up the work of Maritain and carries it forward. His fundamental work is the book, *The Science Before Science*⁶³ which lays out the need to reintegrate the fundamentals of science (philosophy of nature in the Aristotelian and Aquinas traditions) into the training of scientists, particularly physicists. The science that comes before the modern sciences is the foundation laid by Aristotle and found in his works the *Physica* and the books of the *Organon*. He uses Maritain's ideas found in his *Degrees of Knowledge* and *The Philosophy of Nature* to demonstrate the differences in how Descartes, Einstein and Aristotle look at the world and calls Maritain the greatest philosopher of the 20th century. He quotes Jaki and Wallace often and understands the contributions that they have made.

Rizzi has also written two textbooks for college level courses in Mechanics and Electricity and Magnetism and has authored many original articles in *Integra Physica*, a journal of the Institute for Advanced Physics (IAP). He adopts the perspective of Maritain and lays out an approach for how the revitalization and the reintegration of the philosophy of

⁶¹ Dr. Rizzi received a BS in Physics from the Massachusetts Institute of Technology (MIT); later he received his MS from University of Colorado and a Ph.D. in Physics from Princeton University.

⁶² In 1997, Dr. Rizzi gave the first definition of angular momentum in general relativity thereby gaining worldwide recognition for his work in theoretical physics. That same year he presented his findings at the international general relativity physics conference held in Jerusalem. A layman's magazine article on Dr. Rizzi's discovery appears in "Science," October 1998, Vol. 282, No. 5387, pg 249.

⁶³ Anthony Rizzi, *The Science before Science* (IAP Press, Baton Rouge, LA, 2004).

nature can be achieved. Rizzi leads the IAP which is accomplishing this task, mostly recently with the publication of the second in the series of college physics textbooks.

His book, *The Science before Science*, is meant to be an introduction to physicists and to thinking persons about the need to reintroduce natural philosophy into today's culture. Scientists are the high priests of our culture and people will only believe something if it is offered to them by the "scientific community" which of course is an ambiguous term since it is difficult to identify "scientific community" with any specific organization. So any individual with scientific credentials (or even presumed scientific expertise) and is sanctioned as politically correct by the culture will be listened to with regard to issues today that require input – even non-scientific issues dealing with morality. This scientism, that is prevalent, is based on an understanding of science and of the world as empiriometric. While most people are not scientists, the mind set that says that the material is all there is and often with the accompanying view that morality is the maximum good for the largest number of people is the "philosophy" that pervades the thinking today.

Being a physicist first and a philosopher second, Rizzi is able to bring a perspective to the discussion that has been lacking. He is able to speak as a physicist and give examples from physics that illustrate the abstract notions of Maritain regarding the nature of empiriometric science. While there have been other physicists, like Stanley Jaki and William Wallace, who are scientist-philosophers, Rizzi is unique in that he is first a physicist, who has made unique contributions to the general theory of relativity, and secondly a philosopher who discovered the importance of St. Thomas and Aristotle to the physics that he was engaged in. Rizzi believes that we must educate the physicist (and other scientists) in the fundamentals of Aristotle's *physica* and keep him anchored in the real world. The physicist

is a primarily a realist. He wouldn't be a physicist if he didn't believe there is something outside of himself, and outside of his mind. However, due to the mathematization of physics, there is a tendency for him to live in the preter-real world of mathematics and to think that it is the real world. This is the error of idealism, i.e. thinking that the means by which we know something is the something.

Rizzi says that the explanatory nature of the empiriometric sciences is limited due to the empiriometric beings of reason "so as to coordinate the measurements".⁶⁴ Rizzi continues to explain, "In doing so, it is very hard (if not impossible) to take the beings of reason, "the qualities" and "substances," used by the theory and determine what constellation and interactions of real ontological qualities and substances are truly causing the measurements (including all the valid predictions of the theory) to be as they are". Rizzi points out the wave equation can be used to represent both the behavior of light (for example, in diffraction and interference) and water waves – two complete diverse phenomena having the same equation describing it.

Rizzi brings the ideas of Maritain and applies them to real examples from the sciences. He discusses inertia, time and space, forward and backward time travel, the big bang theory, quantum mechanics and action at a distance and evolution. These examples are the ones he says cause the most confusion and even fundamental doubt about nature and man's ability to understand himself and nature. He brings these in to show the confusion between the ontological and empiriometric and how one would begin to approach the problem of submitting these empiriometric results for ontological evaluation.

Rizzi asks the question as to why has so little work been done in trying to integrate the ontological (that is the real) with the empiriometric (physics). He answers that it requires

⁶⁴ Rizzi, *The Science before Science*, 207.

two very hard things: “a deep understanding of the foundational part of *physica* (science of mobile being)...as well as of empiriometric (modern) physics. It requires understanding what empiriometric science is.”⁶⁵ The empiriometric habit is one that is firmly impressed upon the minds of physicists. Focusing on the teaching students of physics to keep the fundamentals of natural philosophy explicit in their thinking from the beginning will help them in avoiding empiriometric thinking and the ontological errors of the current generation of physicists. Of course, it is also the desire of Rizzi to reach out with efforts for those already trained in physics. His book, the *Science Before Science* is intended for them. Physicists should also read Rizzi’s physics textbooks as they contain many insights into the world of mechanics and electricity and magnetism that come from keeping the fundamental principles of natural philosophy in mind as one does empiriometric science and looks at the real world. For example, the concept of *plana* – that there must be a mass-less material substance that carries the fields – such as gravity, electricity and magnetism. The ideas and insight he has on inertia (or impetus) in mechanics and the A-potential field in E&M and the understanding of the “displacement current” in Maxwell’s equations are just some of the valuable insights that are found in his textbooks and not found in other introductory physics textbooks⁶⁶. His treatment of special relativity is new. He keeps the student anchored to the real and does not allow him to take the easy way out by just learning the mathematics and living in the world of beings of

⁶⁵ Rizzi, *The Science before Science*, 168.

⁶⁶ Rizzi describes impetus as the power (category of quality) activated in a body that moves it at a constant speed in a particular linear direction. It is second nature to the body, because it can be gained and lost without changing the body’s fundamental nature. (Inside cover of *Physics for Realists*, 2008). For magnetic effects which are caused by impetus activated charge (current) produces a new quality in the *plana* (the carrier of the field). The A-field caused in a given region bears a kind of signature of the type of impetus that created it. (page 151, *Physics for Realists E&M*, 2011). The displacement current is not caused by a changing electric field as often taught in physics but caused by a changing charge distribution (page 216, *Physics for Realists E&M*)

reason. I am certain that these insights gained by keeping the fundamentals of the *physica* will lead to advances in physics as a discipline.

Rizzi does not view the philosophy of nature as distinct from the individual sciences rather that the philosophy of nature needs to be the foundational part of the training of the scientist. Rizzi prefers to call the philosophy of nature the *physica* after Aristotle's fundamental work on the subject. He sees that the modern sciences are the tools of this *physica*. In private communication with the author he has said, "The empiriological science is not a separate science, but a tool, a methodological approach belonging to science beyond the basics discovered by Aristotle".⁶⁷

Maritain's detailed synthesis of the philosophy of nature and its relationship to the modern sciences is a pioneering step in the right direction. While Maritain makes distinctions between the ontological and the empiriological, between the formal and material, between the *ens* and the *mobile seu sensible*, the discipline of the philosophy of nature and physics in Rizzi's estimation is one discipline and not two disciplines. Rizzi calls for the unification of the philosophy of nature and modern science into a single pursuit of knowledge and wisdom and he prefers to call this united field of study – *physica*. This work can only be done by trained physicists who know the foundational physics. Rizzi is calling for a reform in the way physics is taught and practiced⁶⁸.

VI: Conclusion

Conticuit Populus Meus Eo Quod Non Habuerit Scientiam - Hosea 4:6

⁶⁷ Anthony Rizzi to Kenneth F. Klenk, Subject: RE: Copy of Ashley Article, personal e-mail (23 August 2011) excerpt.

⁶⁸ Anthony Rizzi to Kenneth F. Klenk, Subject: Maritain and Our Work, personal e-mail (24 September 2011).

What is the cause of this great gap between philosophy and science? Science is a separate and isolated enterprise – it does not converse with its foundational principles found in the philosophy of nature. However, science has become the head of the culture and scientists are the high priests. Unfortunately, scientists are often incapable of doing this job correctly because their knowledge is limited and not grounded in the *physica*. In the process of making empiriological science the head of the culture – we are radically changing our culture in these times. The call to integrate science and the philosophy of nature is an urgent call to take a different road - based on reason – and one that integrates all of our knowledge not just a part of it. Once we have integrated knowledge, we will have taken the first step toward turning the culture around.

Maritain was the first voice who identified the problem and the resulting danger to our culture. He has identified also how we begin to reverse the problem. We must address the problem at its root. The most basic of all the sciences is physics and it is the most empiriometric. Physics is an objective science – one which requires that all hypotheses (whether mathematical in formulation or not) be verified by experiments or observations – i.e. to judge the truth by conformance with reality. Physics however does not explicitly recognize its foundational principles – the *physica* of Aristotle.

Physica provides the principles. Modern physics is an extension or a tool of *physica*. Rizzi says that we must distinguish between the fundamental principles and principles which come later. For example, impetus is not one of the first principles but it is a principle – not as general as those of the foundational principles but still a principle – a principle that is used to further regulate physics or mechanics. The idea of impetus was developed in the middle ages by Buridan and others and received a great leap forward with the work of Newton. Impetus

was an idea that Aristotle had gotten wrong - which only goes to show that even a genius like Aristotle doesn't get everything right.

The thesis will conclude with several thoughts into how Maritain's call can be realized. The effort to follow through on Maritain's call is a difficult one. It requires that persons be educated and experienced in both realistic philosophy and physics in order to achieve results. It requires a return to the realism of St. Thomist that puts the understanding of the sensible at the foundation of all knowledge. It calls for a rejection of the idealist philosophies which dominate our culture and our universities. It is a huge effort and one that seems overwhelming. We have nearly 400 years of divisions to overcome. We must move beyond the rancor and misunderstanding between science and philosophy, recognizing that physics is calling for a foundation from which it can call forth the ontological reality hidden in its theories and revealed in its experimental facts. We must recognize that since Maritain's time the world has taken several steps backwards. Whereas Maritain was optimistic that we were about to enter a renaissance, the rapid decline in Thomism has aborted that reality. The world is much more scientific, materialistic and atheistic than it was just 60 to 80 years ago when Maritain was writing. Physicists particularly need to realize that a broader discipline of natural science, call it *physica*, is necessary. Physics is the most empiriometric science among the sciences but it is closest to the fundamental reality of change and movement and explaining the nature of non-living things. However, the interplay must take place for all the modern science whether empiriometric or empirioschematic.

We need to recognize that there is a unity inherent in the activity surrounding man's use of the 1st degree of abstraction. The interplay between the detail understanding of nature that we obtain from scientific investigation and the philosophy that we arrive at from our

observations and analysis must be reestablished and become an active discipline. We can no longer afford to have the sciences acting as if they are sufficient in themselves for understanding the full nature of things. Of course, the practitioners of science whose interest is only in explaining the ‘how’ of nature must be formed with the proper education in the foundational ideas of the science – including and most importantly – educated about the limits of the empiriometric and empirioschematic models that they will use in their research. But it is equally important that the disciplines of modern sciences yield up those prominent and mature scientists who have an in-depth appreciation of the full *physica* to work at the level of understanding the ontological implications of the sciences which as Maritain says only obliquely tell us about the real being and principles. We must bring forth from among the scientific community persons who are willing to dedicate themselves to discovering the truth – to unravel and discover this truth from the “gange” of scientific facts and to bring from their work the wisdom that is the basic inclination of all men – as Aristotle so simply said – “all men by nature desire to know”⁶⁹.

⁶⁹ Aristotle, *Metaphysics*, in *The Basic Works of Aristotle*, Richard McKeon, editor (Random House, New York, NY), p. 689.

VIII. Appendix: Cajetan's Areas of Knowledge

Following Thomas Cajetan (1469-1534)⁷⁰, Maritain⁷¹ gives a detailed analysis of the areas of knowledge that we have been talking about to further illuminate the differences and similarities between philosophy of nature and the natural sciences. Cajetan, a Thomist philosopher, gave this analysis in his commentary on the *Ia Pars Summa Theologica*, q.1, art.3. Maritain uses a notation in discussing Cajetan which helps to simplify the Latin constructs that Cajetan uses and we will adopt that language here. In considering an area of study, first and foremost there is present to the intellect something that it wants to know – this is called the Intelligibility Appeal of the thing or area to explore. Secondly, there is the object that the intellect will focus on – the Sphere of Fundamental Intelligibility. Finally, there is the point of view that one will use in looking at what is given in the sphere of intelligibility and that is called the Objective Light. The objective light is the more formative element in defining the *habitus* or the discipline of the science. In Table 2, we list Cajetan's original Latin notation and next to it the notation as used by Maritain to help clarify Cajetan's meanings. Next, we provide the elements for metaphysics, mathematics and the philosophy of nature – the generic fields of study inferred from the 3 levels of abstraction.

To illustrate further the use of this analysis, Maritain (and Cajetan) discuss theology and show that there are several specific areas that results from the way in which it is viewed. Table 3 lists them. The intelligibility appeal and the sphere of fundamental intelligibility are the same but it is the point of view of the objective light that creates different ways of proceeding.

⁷⁰ Saint Thomas Cajetan (1469-1534) was a cardinal of Catholic Church and known for his extensive commentary on the *Summa Theologica* of Thomas Aquinas.

⁷¹ Maritain, *Philosophy of Nature*, 118-140.

Table 2: Metaphysics, Mathematics and the Philosophy of Nature: These 3 sciences are consider in terms of Cajetan’s criteria.

Cajetan’s Latin Notation	Maritain’s Notation	Metaphysics	Mathematics	Philosophy of Nature
Ratio formalis objecti ut res; ratio formalis quae;	Intelligibility Appeal	Being (entitas)	Quantity (quantitas)	Mutability (mobilitas)
Formal object quod	Sphere of Fundamental Intelligibility	Being as being (ens sub ratione entitatis)	Being as quantity (ens sub ratione quantitatis)	Sensible and changeable being (ens sub ratione mobilitatis)
Ratio formalis objecti ut objectum; ratio formalis sub qua	Objective Light – the formative function for the <i>habitus</i> of the science	Without reference to material: (sine omni material)	With intelligible material (cum material intelligibili tantum)	With sensible material but not individual (cum material sensibili, non tamen hac)

Table 3: Theology in Cajetan’s Analysis: Theology has specific areas that it looks at under the Objective Light although the Intelligibility Appeal and Sphere of Fundamental Intelligibility are the same.

Cajetan’s Latin Notation	Maritain’s Notation	Theology		
Ratio formalis objecti ut res; ratio formalis quae;	Intelligibility Appeal	Deity as such- the deep depths of the divine nature		
Formal object quod	Sphere of Fundamental Intelligibility	God as God; (Deitas sub ratione Deitas)		
Ratio formalis objecti ut objectum; ratio formalis sub qua	Objective Light	Lumen divinum evidens – theology of the blessed	Lumen divinum revelans abstrahendo ab evidential aut inevidentia – the divine revealing light considered neither as evident or non-evident	Lumen divinum inevidens – the non-evident divine revealing light – objective of faith

The difference between the philosophy of nature and the non-mathematical empirioschematic sciences is in the objective light or the formal perspective that is used to converse with the subject. This is shown in Table 4. The empirioschematic science has the same Intelligibility Appeal and Sphere of Fundamental Intelligibility – it is how the Objective Light differs – where the science looks at the object (mutability) as a chiaroscuro of things conceived empiriologically. There is an induced intelligibility appeal, i.e. a view of the subject in a second determination for empirioschematic science – phenomena. A phenomenon is not a certain thing or formal object of first determination. It is an aspect of sensible being and so it is secondarily perceived by some sense observation. Secondarily, the

Table 4: Empirioschematic Sciences: Empirioschematic science is similar to the philosophy of nature except in the Objective Light which gives rise to a secondary or induced criteria.

Cajetan's Latin Notation	Maritain's Notation	Philosophy of Nature	Empirioschematic Science (non-mathematical)	
			Primary	Secondary or Induced
Ratio formalis objecti ut res; ratio formalis quae;	Intelligibility Appeal	Mutability (mobilitas)	Mutability (mobilitas)	Phenomenality
Formal object quod	Sphere of Fundamental Intelligibility	Sensible and changeable being (ens sub ratione mobilitatis)	Sensible and changeable being (ens sub ratione mobilitatis)	Mutable being considered from the point of view of the detail of observable phenomena
Ratio formalis objecti ut objectum; ratio formalis sub qua	Objective Light – the formative function for the <i>habitus</i> of the science	With sensible material but not individual (cum material sensibili, non tamen hac)	Sensible being insofar as it is observable; chiaroscuro of empiriological conceptualization	Mutable being seen under the objective light of the mode of defined by sensory operation

sphere of fundamental intelligibility is the collection of observable phenomena and the objective light is mutable being as seen in these observations. Lastly, Maritain looks at empiriometric science and compares it to the philosophy of nature and then provides us a final definition – summarized in Table 5.

Table 5: Empiriometric Science and Final Definition of Philosophy of Nature:
Comparison leading to a final definition of the philosophy of nature.

Cajetan's Latin Notation	Maritain's Notation	Philosophy of Nature	Empiriometric Science	Philosophy of Nature (Maritain's Final Definition)
Ratio formalis objecti ut res; ratio formalis quae;	Intelligibility Appeal	Mutability (mobilitas)	Quantity (quantitas)	Mutability (mobilitas)
Formal object quod	Sphere of Fundamental Intelligibility	Sensible and changeable being (ens sub ratione mobilitatis)	Changeable being (ens mobile sub ratione quantitas)	Ens secundum quod mobile, sub modo definiendi per intelligibilem quidditatem (et non per operationem sensus), seu sub lumine ontologico
Ratio formalis objecti ut objectum; ratio formalis sub qua	Objective Light – the formative function for the <i>habitus</i> of the science	With sensible material but not individual (cum material sensibili, non tamen hac)	Intelligibility of quantitative relations or detail of measurable phenomena	Ontological mode of analysis and conceptualization, a way of abstracting and defining which, the while it refers intrinsically to sensory perception, aims at the intelligible essence.

Here we see that the empiriometric science differs from the philosophy of nature across the board. The Intelligibility Appeal for the philosophy of nature is mutability and for empiriometric science is quantity – a fundamental difference at the very outset. The Sphere of Fundamental Intelligibility is also different – sensible and changeable being in all of its aspects for the philosophy of nature and for empiriometric science – changeable being only as it is quantitative. The Objective Light for philosophy of nature is sensible not individual

matter but for empiriometric science it is twofold – (1) the intelligibility of quantity as related to mathematics and (2) the detail of the measured data as it relates to results of the quantitative understanding.

The new definition for the philosophy of nature, given in the last column of Table 5, is a definition given in light of the discussion we just reviewed. The Intelligibility Appeal is mutability – the change in the world around us. The Sphere of Fundamental Intelligibility is all of mutable being as seen in its intelligible whatness and not in the detail of the sensible observations. The Objective Light is “an ontological mode of analysis and conceptualization, a way of abstracting and defining which, the while it refers intrinsically to sensory perception, aims at the intelligible essence”.⁷²

⁷² Maritain, *Philosophy of Nature*, 140.

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