

SCIENCE AND AUTHORITY IN GIACOMO ZABARELLA

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1. INTRODUCTION

Some scholars have seen the Aristotelian natural philosopher Giacomo Zabarella (1533–89) as a precursor of Galileo, indeed of modern scientific method.¹ Others have insisted that Zabarella’s logical methodology never foreshadowed the Galilean “two new sciences”, let alone modern scientific method.² Both views, regardless of their merits in stirring a healthy historiographic debate, have tended to emphasize the significance of Zabarella’s methodological works, and his role in the history of Renaissance philosophy. An insight by Charles Schmitt, according to which ultimately “Zabarella’s primary motive was to understand, explicate, and substantiate the philosophy of Aristotle”, has inspired the present research.³ As Schmitt and many others have recognized, Zabarella is a fascinating figure for historians of early modern developments in natural science and philosophy. Indeed Schmitt’s most erudite study on the different roles of experience in Galileo and Zabarella speaks volumes about this fascination.⁴

In this paper, my objective is to contribute to the project of re-appraisal of Zabarella, interrupted by Schmitt’s premature death. More specifically, I will argue that, in his practice of natural science, Zabarella achieved a lucid separation between allegiance to reason and allegiance to Aristotle’s authority, within the constraints of the Aristotelian framework. Zabarella, in other words, fully realized that he could freely practise natural science [*scientia naturalis*] according to Aristotle’s mind [*ad mentem Aristotelis*], suspending the question of whether Aristotle’s pronouncements could be reconciled with the truth of the matter.

In the remainder of this section, I will introduce Zabarella’s practice of *scientia naturalis* in relation to the constraint of allegiance to authority, and touch on some fundamental themes that will be developed in the course of the paper. In Section 2, I will survey Zabarella’s forms of allegiance to the authority of Aristotle in *De rebus naturalibus*. In Section 3, I will analyse Zabarella’s *De rebus naturalibus* with the help of examples that illustrate the separation between allegiance to reason and allegiance to Aristotle’s authority. In Section 4, I will draw some historiographic conclusions.

What was Zabarella’s practice of *scientia naturalis*? By *scientia naturalis*, I mean natural science as it was intended by Zabarella himself. It is crucial that we read Zabarella’s definition of the subject of *scientia naturalis* in its own original language.

... in hac tempestate videntur omnes in hac sententia convenisse, quod corpus universe sumptum, quod et coelestia et inferiora omnia complectatur, quatenus

*naturale, hoc est, quatenus habens in se ipso naturam, quae motus principium esse definitur, sit commune subiectum totius scientiae naturalis.*⁵

... in our time everybody seems to have agreed on this opinion, that body, in its broadest meaning, i.e., such that it comprises all things both celestial and sublunary, in so far as it is natural, that is, in so far as it has in itself a nature which is defined as a principle of motion, is the general subject of all natural science.

Thus the subject of *scientia naturalis* is natural body in its broadest possible sense [*universe sumptum*], celestial and sublunary. But Zabarella's practice of *scientia naturalis* was not the culmination of a form of "experimentally grounded and mathematically formulated" inquiry into natural body, according to J. H. Randall's vision of long-standing, "cooperative efforts" in the schools of Padua and northern Italy, starting in the "thirteenth- and fourteenth-centuries", where "there had been worked out the idea of an experimentally grounded and mathematically formulated science of nature".⁶ On the contrary, Zabarella's practice of *scientia naturalis* conformed to a well-regulated set of teaching practices constrained by multiple sources of authority. The production of scientific texts was related to the teaching activities, and the texts were usually the basis of a professor's lectures on natural science in the faculties of arts. Sometimes the texts took the polished form of printed textbooks. Sometimes, indeed often, they lived in the more ephemeral space of oral communication within the classroom. To the latter phenomenon the immense manuscript heritage, mostly lecture notes, still surviving in European libraries, bears witness.⁷

I label the living participants in the teaching practices *scientiae traditores*, teachers and/or deliverers of science. That teaching *scientia naturalis* was constrained by multiple sources of authority, i.e., *authores*, was recognized by Pietro Ragnisco, more than a century ago.⁸ In my view nothing in subsequent, relevant scholarship calls into question Ragnisco's insight. *Authores*, that is, authorities, can be *both* past and contemporary ones. When quoted and discussed by another participant in the teaching practices, any *traditor* becomes an *author*. This duality of teaching and authority has so far been missed in the literature. *Authores* can be virtually enlisted into the teaching community, regardless of their belonging to a profoundly different, past cultural setting.⁹ This diachronic dimension of authority is essential in all respects, I think. *Traditores* do not speak for themselves only. They take responsibility before a whole tradition, which they constantly re-generate, as more and more *authores* become available in the marketplace. In the texts, *authores* are always worthy of being quoted, discussed, accepted, or quite possibly, and quite often, refuted.

It is because of this diachronic dimension of authority that *traditores* such as Zabarella, or Cesare Cremonini (1550–1631), in Padua, and, for example, the Jesuit professors of the *Collegium Romanum*¹⁰ (as shown by Ugo Baldini), could participate in the practices of teaching *scientia naturalis*, regardless of socio-institutional and ideological borderlines.¹¹ This deep unity of intellectual practice also holds true, I believe, in the face of local hotspots of conflict due to competition for the student market.¹²

Zabarella's production of *scientia naturalis* was regulated by multiple sources of

authority: (a) the corpus of Aristotelian writings circulating in the Renaissance (an object of emotional value¹³), (b) reason (to be further qualified in what follows), and (c) a whole host of *authores*. Zabarella and his fellow *traditores* must respond to many *authores*. The articulated summaries/discussions of opinions of *authores*, which historians of medieval and Renaissance thought are so familiar with, bear witness to the uniformity and consistency of this process. In the texts of Zabarella and his fellow *traditores* we discern a sense of responsibility to respond to multiple authorities, back to Aristotle, the author/authority par excellence.

Zabarella's practice, the details of which we shall see in Section 3, consists in mobilizing his allegiance to these multiple authorities, in such a way that reason and Aristotle are set free to compete with each other, though under the constraint that they must always be reconcilable.¹⁴ So what is Zabarella's originality about, in essence?

Zabarella claims that instead of assuming that Aristotle's writings are always the undisputed starting point of inquiry (as, in his view, most *traditores* erroneously do), he will assume that the starting point of inquiry is the *truth of the matter* [*rei veritas*].

*Quamobrem quum ego rem hanc diligenter consideraverim, semperque existimaverim, quaerendam semper esse omnia cuiusque rei veritatem, deinde illa cognita, ad eam, si fieri posset, verba Arist[otelis] trahenda esse, non e contrario, quod multi faciunt....*¹⁵

Thus, since I have considered this diligently, and have always believed that, first of all, the truth of the matter is to be investigated, and afterwards, once that has become known, Aristotle's words should, if possible, be reconciled with it, not the other way round, which many do....

To the truth of the matter Zabarella will conform his interpretation of Aristotle's words as far as possible. It is Aristotle's writings that have to be accommodated to the truth of the matter, not the other way round. Note, however, that although one cannot simply do away with Aristotle's texts, if they seem to be at variance with the truth of the matter, Zabarella boldly asserts that, once the truth has become known, Aristotle's words should be reconciled with the truth, "if possible" [*si fieri posset*], as the above quotation indicates. Indeed, we shall see that Zabarella recognizes that this reconciliation is not always possible (*cf.* Section 3). Thus, an original space is created in which allegiance to Aristotle does not preclude independent reasoning.¹⁶ Let me clarify my use of 'independent'. It all depends on what we mean by 'independence'. Think of Pythagoras's theorem, and the postulates and common notions of Euclidean geometry. You may need all of them to produce the proof of Pythagoras's theorem, and in this sense you are not independent of Euclidean postulates and common notions. Still, it takes a lot of originality to come up with the proof, which is actually quite complex. Would you deny any originality to the mathematician who discovered the Euclidean proof of Pythagoras's theorem? I think not. In the rest of the paper, I hope, it will become clearer what the limits of, and constraints on, this independence are, and why, in the case of Zabarella, this constrained independence

is highly original.

We shall see that when, for example, investigating the physics of *gravitas* and *levitas*, or the status of *species intelligibiles*, Zabarella is above all concerned with clarifying, articulating, and defending Aristotle's pronouncements. But a change in attitude occurs when Zabarella reaches the very limits beyond which (for him) *scientia naturalis* trespasses into the terrain of metaphysics, i.e., for instance, when tackling the question of the eternal mover, discussed by Aristotle in the last book of the *Physics*. Then, the Paduan professor launches into a *naturalization*, i.e., a reduction to principles of natural philosophy and, as we shall see, specific logical methods, of Aristotle's own demonstration of the eternal mover. He believes that, in this way, Aristotle, *qua* natural philosopher, will not be accused of trespassing beyond the limits of natural philosophy.

This attempt at separating the jurisdiction of the natural philosopher, pursuing *scientia naturalis*, from that of the metaphysician is worth exploring in further detail, although we need to keep in mind that Zabarella never wrote a commentary on Aristotle's metaphysics, an unfortunate lacuna for us. Two important and similar documents survive in which Zabarella expands on the role of the teacher in relation to natural science. The first is an *oratio* read by Zabarella in 1585. The second is a "preliminary discourse" to a course on Aristotle's *Physics*, Book VIII, which had only recently been published.¹⁷ The main thrust of both writings concerns the specific methodology that, according to Zabarella, Aristotle follows in building *scientia naturalis*, and the implications of this fact for the expositors; in other words, what it means for a teacher "to philosophize in an Aristotelian fashion" ["*aristotelice philosophari*"]. For Aristotle is to be considered, says Zabarella, the inventor of "scientific methods" ["*scientificarum methodorum*"].¹⁸ This scientific methodology, Zabarella argues, is particularly evident in the case of Aristotle's *Physics*, Book VIII.¹⁹ Two precepts must be observed in order for the philosopher/teacher to proceed correctly. One is the *convenient order* that must be followed, the other, more important for our purposes here, is the way of philosophizing that Aristotle taught us in the *Posterior analytics*. To illuminate this point further, Zabarella suggests a fascinating analogy with mathematics. *Scientia naturalis* is built as a succession of theorems [*theoremata*]. The way of constructing these theorems is the logic of the so-called *potissimae demonstrationes* [most perfect demonstrations]. (In the final section of this paper, I will come back to this question of *potissima demonstratio* with further details.) These *potissimae demonstrationes* are to be found, Zabarella continues, especially in Aristotle's *Physics*, Book VIII. Thus, Zabarella sees in the logical methodology of the *Posterior analytics* the essence of scientific methodology. It is this scientific methodology focused on *potissima demonstratio* that qualifies the separation of the natural philosopher's activity of constructing *theoremata* in *scientia naturalis* from that of the metaphysician, hence of the theologian. The latter, Zabarella says, starts from wholly different principles, which only Christian doctrine teaches us to be the true ones. As we shall see in more detail in Section 3, the metaphysician can take the natural philosopher's conclusions as givens, and, for instance, investigate the

conditions of the eternal movers, so as to arrive at knowledge of what the eternal movers really are (i.e., knowledge of their essences). But this is not *scientia* constructed on *theoremata* by means of *potissimae demonstrationes*.

Finally, we shall see that when up against one of the most problematic (in his view) of Aristotle's statements about the nature of celestial heat [*calor coelestis*], Zabarella eventually reaches the threshold, *without* crossing it, of a withdrawal of allegiance.

Strategies of allegiance, then, or intellectual brinkmanship, play an important role in Zabarella's scientific practice. In the remainder of this paper, I will narrow my focus on Zabarella's *scientia naturalis* in the light of his mobile allegiance to authorities.

2. ALLEGIANCE IN *DE REBUS NATURALIBUS*

In *De rebus naturalibus* Zabarella collected a number of essays on questions that were current among Aristotelian commentators in his time, as the subtitle indicates.²⁰ The book is composed of twenty-four tracts. The *De rebus naturalibus*, as a *whole*, has received little attention so far, since scholarly interest has tended to focus on Zabarella's logical writings.²¹ In *De rebus naturalibus*, we find Zabarella constantly manoeuvring to relate his investigations on natural science to the various sources of authority that I have mentioned in the introduction, namely, (a) the corpus of Aristotelian writings circulating in the Renaissance, (b) reason, and (c) a host of *authores*.

An illuminating comment by Charles Lohr will serve as the starting point of my discussion of the patterns of promissory obligations undertaken by Zabarella in *De rebus*.

Because the formulation of an independent philosophy dealing with God, the world, and man *sub ratione entis* relieved Scholastic thinkers of the obligation to relate their conclusions to Aristotelian principles, we must distinguish sixteenth-century Scholastic Aristotelianism both from its Medieval predecessor and from the secular Aristotelianism in the arts faculties of the Italian universities. Whereas the Italian Aristotelians were reduced to offering simply an exegesis of the Philosopher's text...²²

I shall try to moderate Lohr's negative conclusion concerning Italian secular Aristotelianism. Does Zabarella really fit Lohr's view?

To answer this question I will quote some relevant excerpts from *De rebus* tracts, where Zabarella states clearly its objectives. This will allow us to discern the promissory obligations that Zabarella puts himself under at the opening of each single tract. These promissory obligations will show that Zabarella does not offer simply an exegesis of the Philosopher's text.

In Tracts 2, 3, 4, 7, 13, 20, 21 and 22, we find an explicit promise of allegiance to Aristotle's opinion, which supports Lohr's conclusion, to the effect that Zabarella qualifies his practice as being simply that of clarifying, declaring, and/or interpreting Aristotle.²³ A typical example is as follows. Zabarella says: "... I thought I would do a good thing if I tried with all my force to explicate the difficult questions concerning this subject [i.e., prime matter] that cause problems to everybody; and, if, by making

public the things which I had excogitated while philosophizing, and setting aside others, I could get closer to the truth, and, if possible, to making Aristotle's opinion on prime matter clearer."²⁴

However, in Tract 1, we find an original illustration of the whole *fabrica* of natural science, presented as an introduction to the subsequent tracts.²⁵ Further, in Tracts 5, 8,²⁶ 10, 15, 17, 18, 19 and 23, we find an explicit affirmation of Zabarella's intention to accede to the truth *by himself*, though often qualified by a *quantum per me fieri possit* [as far as I am able], and delimited by a *iuxta Aristotelis mentem* [according to Aristotle's mind], or similar expressions.²⁷ A typical example is as follows. Zabarella says:

... not to mention others, not only did Pietro Pomponazzi, who very well and most diligently disputed about accretion in two published books, openly confess that he could not find an explanation [of accretion], but he dared to assert that no human could possibly claim that he had an explanation of this thing. Thus, considering all of this, and being compelled by the example and authority of that man, whose judgement I esteem the most, I decided neither to avoid this disputation because of its difficulty, which would have been unworthy of a philosopher, nor to write about it under the delusion that I could attain the whole truth about this, and a perfect exposition, which would have been arrogant and a sign of temerity. Thus, I will strive as much as possible to get close to the truth, and even if I cannot attain it, at least I will have excited others to undertake this investigation....²⁸

Here is another example of Zabarella's intent *ad mentem Aristotelis*. Zabarella says: "We will thus follow this order in our disputation: we will consider what must be thought, according to Aristotle's mind, first of all about the whole soul according to its substance, second of all about the whole soul according to its quantity and extension, and finally about the whole soul according to its faculties."²⁹

The expressions *iuxta Aristotelis mentem* and *ad mentem Aristotelis* mean "according to Aristotle's mind"; and *de facto*, when we look at what Zabarella does, they mean *according to the principles of Aristotle's natural science*. These are rather common expressions in this sort of literature, but also elsewhere. For example, in the manuscript sheets left by Vincenzo Viviani, Galileo's first biographer and pupil, preserved in the Galileo collection at Florence, we find occurrences of the phrase *ad mentem Galilaei*, typically when Viviani is reconstructing Galileo's ideas, in order to answer new questions, and/or clarify questions dealt with by Galileo himself, starting from Galileo's own principles, as expounded in the *Two new sciences*.³⁰

Finally, in Tracts 9, 11, 14, 16 and 24, Zabarella declares that he will consider, or clarify, or dispute on, or simply talk about, the corresponding subject matter.³¹ A typical example is as follows. Zabarella says: "It is so manifest that celestial bodies produce heat in this inferior region, which does not seem to be in need of proof: but doubt arises as to the mode and cause [of this]. ... we set ourselves the task of talking about only the heat produced by celestial [bodies]; thus the question we must

consider now is in which way they do this, not being hot.”³²

Thus we observe three types of promise of allegiance in *De rebus naturalibus*. First, we find an explicit pledge that Zabarella’s main objective is simply to explain Aristotle’s view. In this regard, the corpus of Aristotelian writings circulating in the Renaissance, above all the commentaries by Averroes, is generally authoritative. I call this the *commentator allegiance*. This is the form that submission to the authority of *traditio* takes in Zabarella. Second, we find a promise to accede to the truth by himself *in accord with Aristotle’s mind*. This is the form that submission to the authority of reason takes in Zabarella. I call this the *scientist allegiance*. Third, we find a much less committal attitude to authority, which may indicate that Zabarella had some difficulties in categorizing his own approach, and which, for example, in Tract 11, *De mistione*, takes the form of a defence of Averroes’s views applied to the question at issue. However, the third type can be reduced to the *scientist allegiance*, by looking at the conclusions reached by Zabarella in *De naturalis scientiae constitutione*, the opening tract of *De rebus*. There Zabarella crafts a revealing simile between geometry and natural science, which articulates well what Zabarella’s practice of *scientia ad mentem Aristotelis* ultimately consists in.

The last section of the tract is entitled *De perfectione scientiae naturalis ac de eius ordine*. It remains to be asked, Zabarella says, whether “*perfectam rerum naturalium scientiam ab Aristotele traditam esse*”, i.e., “if natural science has been taught, or delivered, perfect by Aristotle”.³³ To which Zabarella answers that Aristotle’s natural science can be said to be both perfect and imperfect. As to its fabric and *artificium* it can be said to be perfect. As to its matter and the number of things considered it can be said to be imperfect. For there are many things that remained unknown to Aristotle. But in order to attain knowledge [*notitia*] of these things, it would not be necessary to teach, or deliver, a natural science [*non ... tradere naturalem scientiam oporteret*] with a different order or *artificium*. In fact both order and *artificium* would remain the same. Thus, Zabarella concludes, it can be said that Aristotle’s books on natural science play the same role as that played by Euclid’s *Elements* in mathematics. Mathematicians know very well, he continues, that all new theorems can be derived from those in the *Elements*, and this is why Euclid called his books *elements*. All new theorems are contained in the *Elements* at least virtually, or potentially. By the same token, in Zabarella’s analysis, all natural science can be derived from Aristotle’s natural books. In this sense natural science is perfect, at least virtually, or potentially.³⁴ If you learn how to philosophize *ad mentem Aristotelis*, Zabarella seems to say, you will be able to reconstruct the whole of natural science from Aristotle’s natural books.

To sum up, I suggest that we need to distinguish only between two modalities of relation to authority, according to the type of promise of allegiance marking the opening of each essay, i.e., the *commentator* and *scientist* types of allegiance. It is in the intellectual space opened up by the tension between these two forms of obligation that we must look for Zabarella’s originality.

3. *SCIENTIA NATURALIS IN DE REBUS NATURALIBUS*

In this section, I articulate the discussion of the relation between allegiance and natural science *ad mentem Aristotelis* with a progression of four examples, the last of which will show Zabarella unequivocally approaching a withdrawal of allegiance to Aristotle.

Example 1. *The theory of motion of heavy and light bodies.* In *De motu gravium et levium*, Zabarella says, he will limit himself to clarifying the opinions of Aristotle, which have given rise to so many controversies. This does not sound promising if one is interested in knowing whether Zabarella has anything original to say about the essay's topic. Indeed throughout the essay Zabarella defends Aristotle on a number of counts. However, this is not the whole story. In fact, there are at least two strong elements of originality in Zabarella's essay, where we can observe the scientist working *ad mentem Aristotelis*. The first concerns the motion of projectiles, the second concerns the theory of natural place.

The motion of projectiles. At the very end of the first Book of the essay, whose subject is the motion of the four pure elements, Zabarella ventures into an explanation of the cause of acceleration in free fall. He mounts his explanation on the basis of Aristotle's theory of the motion of projectiles. The objective is to show that Aristotle is right when saying that the cause of acceleration is simply the greater gravity of the falling body. But in what sense does the gravity of the falling body increase, Zabarella asks himself? To answer this question he has an ingenious argument based on an analogy with air's peristaltic action on projectiles.³⁵

First, however, Zabarella responds to a number of authorities. Hipparchus, Alexander of Aphrodisias, Simplicius, Thomas Aquinas, and Durandus de Sancto Porciano, are all extensively quoted and refuted.³⁶ But Durandus is the one whose opinion is closest to the truth, Zabarella thinks. The smaller resistance of the medium, he acknowledges, is in fact responsible for the acceleration of falling elements. Durandus does not furnish a cause of this diminished resistance, however. The cause can be discovered by thinking about what Aristotle teaches when attributing the cause of the motion of projectiles to the parts of the surrounding air. It is true that Aristotle's theory concerns violent motion, but, in Zabarella's view, it can be applied also to natural motion. The percussion of the orderly parts of air by the hand throwing the projectile sets them in motion, after which they in turn keep pushing the projectile, though less and less until their action dies out. By the same token, Zabarella says, if the air's action described by Aristotle for violent motion is true, it must also be true for natural motion. In the case of the descending heavy element, the motor, the nature of the heavy element, is constantly attached to it. Thus if no other cause intervenes a heavy element should fall at a constant speed. Yet it accelerates. Why? Because, Zabarella answers, the underlying parts of air are pushed and set in motion by the descending heavy element itself, which therefore will be less and less impeded by them as they are already in motion.³⁷

Finally, why does Aristotle claim that the cause of a falling body's acceleration is decreasing gravity? Gravity, Zabarella argues, can be taken in two senses. In one sense it is a propensity [*propensio*] to a low place. In another sense it can be said to be *gravitatio*, and it is no more than the excess of the *virtus motrix* over the resistance of the medium. It is in this sense that Aristotle's claim has to be intended, and in this sense, Zabarella concludes, it is correct.³⁸

The theory of natural place. A step forward is now taken by Zabarella. So far he has been concerned with pure elements. But in fact we commonly experience mixed bodies all around us in the sublunary universe. Thus, Zabarella claims, the question of the motor of heavy and light bodies must be reformulated in terms of the motor of mixed bodies. I will not follow Zabarella as he argues against a number of *authores*, and their interpretations of the mixed motor. All I need is his personal opinion *ad mentem Aristotelis*. Each mixed body will have to move according to the dominant element present in the mixture, says Zabarella. Since there is in each mixture a dominant element, each mixture has a form of its own, so that one specific natural place in the sublunary universe will have to be assigned to each mixture. This will be done in accordance with the proportion of gravity and levity present in the mixture, determined by the dominant element, so that all mixtures, as well as the four pure elements, will have a definite place at a certain distance from the centre, or from the heaven, according to this proportion. Thus when a mixed body is located outside of the place assigned to it, it will naturally tend to that place. Here is an example. When we see oil floating on water this does not happen because oil will sometime move downwards as when in air, and sometimes upwards as when in water. In fact the nature of oil is unique. Oil floats on the surface of water because that is the natural place for oil to be, for its nature to be preserved. The natural place of oil is in between those of water and air. Zabarella concludes as follows: "There is no difference in this between the elements and the mixed bodies, insofar as they are heavy and light. To each of them a natural place is assigned in the universe, towards which bodies move from all other places, and this is located at a longer or shorter distance from the centre, or from the heaven, according to the [body's] proportion of gravity and levity."³⁹ There can be infinitely many mixed bodies according as the proportion of heaviness and lightness in the mixture can be infinitely varied. Correlatively there will be infinitely many natural places in the sublunary universe according to the distance from the centre (or from the heaven) of the spherical shell assigned to each mixture. Zabarella's sublunary universe is like an infinitely stratified onion, a finely grained universe, a layer for each mixture's natural place. *Scientia ad mentem Aristotelis*, Zabarella avows, though, I submit, quite a jump from the cosmology of *De caelo*.

Example 2. *The status of 'species intelligibiles'.*⁴⁰ Under the guise of an elaborate response to authority, whose ultimate objective is the defence of Aristotle's opinion on *species intelligibiles*, Zabarella the scientist puts forward his views according to the principles of Aristotle's philosophy [*secundum principia philosophiae Aristotelis*].

In Zabarella's words, Aristotle's opinion is that "the intellect is totally unmixed, it does not have any intelligible [species] within itself in actuality, but has all of them potentially, which it receives from external objects".⁴¹ Zabarella's response to the authorities, whose meanderings we cannot follow here, shows many elements that cannot be found directly in Aristotle, I think, but are products of reasoning within the framework of Aristotle's philosophy. Perhaps the one that is most striking is the following *artificium naturae*.⁴² Since it was necessary that within the sensitive part of the soul two capacities [*vires*] could be lodged, one for knowing, one for retaining the images of things, nature did not endow the same faculty, or the same organ, with both. Rather, nature wanted memory not to be endowed with the capacity for knowing, and the latter not to be endowed with that of retaining. Thus the capacity for knowing necessarily knows in actuality those things that it has received. So if fantasy, which is a capacity for knowing, retained the *phantasmata*, and memory, which is a capacity for retaining, knew the images of things stored in it, then, Zabarella concludes, multiple things could be known at the same time. This is totally impossible according to Zabarella. In the same way, the intellect, which is a capacity for knowing, cannot but know one thing at a time. It does not have a retentive capacity like memory, and therefore *species intelligibiles* cannot be impressed on it without intellection [*intellectio*] taking place. In fact intellection is the species itself impressed [*species ipsa impressa*].⁴³ So much for the exegesis, Zabarella style, of Aristotle's position. But there is an intriguing twist.

By interpreting Aristotle as so bluntly separating the natures of active cognition and passive memory, Zabarella faced the question of cognition in the separate state of the soul after life. In the separate state, Zabarella says, it is obvious that the soul cognizes but no longer by receiving *species intelligibiles* from material objects. Thus, he continues, one has to believe that the soul in the separate state will have perennial memory of things, and therefore that memory cannot be distinguished from cognition. This whole question, however, Zabarella argues, is ultimately a matter for the theologians.⁴⁴ We see here the main thrust of Zabarella's Aristotelianism. It is naturalistic in that it tends to define the boundaries of inquiry for the natural philosopher clearly. Zabarella aims at establishing a separate jurisdiction for the natural philosopher.

Example 3. *The proof of the eternal motor.* At the beginning of the fourth essay, *De inventione aeterni motoris*, Zabarella states that he will speak about immaterial substances, i.e., substances separate from matter [*substantiae a materia abiunctae*], according to the principles of Aristotle's philosophy, and only in so far as they concern the natural philosopher. He will say nothing of what divine revelation tells us about immaterial substances, since divine revelation was unknown to Aristotle, and his [i.e., Zabarella's] goal is to interpret Aristotle's pronouncements.

In *De inventione* Zabarella tackles the specific issue of the proof of the eternal movers, given by Aristotle in Book VIII of the *Physics*. Zabarella had already discussed the issue in the logical writings, especially in *De regressu*. There he claimed that in order to discover the eternal movers Aristotle had recourse to *regressus*, and

that this point had been missed by all previous philosophers.⁴⁵ The subject of *De inventione*, however, is not Aristotle's discovery processes, but a host of questions concerning the status of the eternal movers at the crossroads of natural science and metaphysics. The questions are as follows. (1) Whether in order to discover the substances that are separate from matter any means can be used other than motion. (2) Whether separate substances can be proven solely from eternal motion, or also from absolute motion. (3) Whether to demonstrate the eternal movers from eternal motion pertains to the natural philosopher, or to the metaphysician [*primus philosophus*]. (4) Averroes's opinion that to demonstrate the eternal movers from eternal motion pertains to the natural philosopher only (which is also Zabarella's opinion). (5) The error of some wrongheaded Averroists who believe that the proof's "middle" [*medium*, i.e., the middle term of a demonstrative syllogism] of the eternal mover belongs to natural science but the conclusion is metaphysical. (6) That a proof has to be named from the "middle", and that Aristotle never believed that a metaphysical conclusion can be proved from a natural or geometrical middle.

The essay aims at proving that Averroes's opinion is correct, and that it is fully consistent with Aristotle's views. Note that in the whole essay the reality of the eternal motion of the heaven, the basis of Aristotle's argument in Book VIII of the *Physics* (according to Zabarella), is never called into question. Zabarella takes it for granted. So the issue boils down to proving that the eternal motion of the heaven is the sole admissible, *natural* basis for the proof of the eternal movers, and that some Averroists err in believing *both* that a proof may have a natural or geometrical middle and a metaphysical conclusion, *and* (worse) that this was Aristotle's mind. The intellectual heavy lifting, so to say, comes when Zabarella is out to show that the proof of the eternal movers is wholly natural, and more generally that the opinion that a proof may have a natural or geometrical middle and a metaphysical conclusion is not only wrong, it is monstrous, it is a hermaphrodite. "Quod ego monstrum esse arbitror, et Hermaphroditum a doctrina Aristotelica, et ab Averro quoque ipso alienissimum", exclaims Zabarella.⁴⁶ How does Zabarella proceed, then?

First, says Zabarella, it is Aristotle himself in the *Posterior analytics*, Book I, who denies that such a monstrous demonstration is possible; such a thing would hardly be worthy of the name "demonstration". This monstrous demonstration would in fact amount to a forbidden passage from genus to genus. Geometry, for instance, could not prove that there is one science [*scientia*] of contraries, which would be a metaphysical conclusion. So much as far as Aristotle is concerned.

Next Zabarella moves on to show that if the demonstration of the eternal movers proved a metaphysical conclusion from a natural middle, then the demonstration would have to be equivalent to the following "illation" [*illatio*]. In a natural body eternal motion is given therefore substances are given that are separate from matter *per essentiam*. This, in Zabarella's opinion, is nowhere to be found in Aristotle. No wonder, says Zabarella, since this illation is not efficacious, because those immaterial substances have no affinity with motion. In fact what little affinity they have, they have it *qua* eternal movers not *qua* immaterial substances. Between cause and

effect there must be an essential nexus; thus the only possible illation is as follows. Eternal motion is given therefore an eternal mover is given. This, Zabarella claims, is doubtless a natural conclusion, since to consider the mover in so far as it is mover is to consider it as a cause of motion, and this pertains to natural science. The metaphysician, on the other hand, knows that separate substances are movers but does not consider them as such.⁴⁷ But where did the interpretative error stem from that so many philosophers, in Zabarella's view, have made?

The cause of the error, Zabarella concludes, lies in the fact that all philosophers until his time have failed to recognize the demonstrative regress that Aristotle makes use of in the eighth book of the *Physics*. In fact, for Zabarella, the confusions of voices clears as soon as one recognizes that the first movement of the *regressus* process simply leads the natural philosopher to prove the existence of the eternal movers wholly naturally. This of course does not preclude that the metaphysician can take the natural philosopher's conclusion as a given and investigate the conditions of the eternal movers, so as to arrive at knowledge *quid sint*, i.e., knowledge of what the eternal movers are. As Zabarella points out, we see Aristotle himself repeating the natural demonstration of the eternal movers in his *Metaphysics* (Book XII), simply because for didactic as well as expository purposes he needs to present it again, not at all because the demonstration is metaphysical and as such belonging to the *Metaphysics*.⁴⁸

Example 4. *The nature of celestial heat [calor coelestis]*. Here we can finally observe the professor at the threshold of a withdrawal of allegiance to the Philosopher; in other words, when Zabarella definitely shifts from the commentator to the scientist form of allegiance.

That celestial bodies produce heat in the sublunary realm is obvious and, Zabarella says, in need of no proof. The question is how they produce heat according to Zabarella's reconstruction of Aristotle's opinion. Celestial bodies are not igneous, and therefore because of their not being formally hot, but only virtually hot, one has to explain how they produce heat in the sublunary realm. According to Aristotle, celestial bodies warm by motion and by light [*lumen*]. But Aristotle attributes only to the Sun the power to heat by motion, since the Sun is especially suited for this, being placed at the right distance from us and moving at the right speed. Celestial motion, on the other hand, produces heat because it rarefies and thins [*extenuat*] the air underneath. That celestial motion is cause of rarefaction, Zabarella is convinced, can be proved by simple arguments, on which there seems to be little or no disagreement. The hotly debated issue is Aristotle's restricting the power of heating to the Sun, and excluding all of the remaining celestial bodies. This is the sticking point because motion seems to produce heat by attrition in solid bodies, and therefore if celestial motion is to produce heat in the sublunary realm it can do so only by attrition with the outermost layers of the elements.

Now, the latter are in contact with the concave of the Moon's orb, not with that of the Sun. So how can the Sun heat things in the sublunary realm? Can it heat the

Moon's orb first, so that the latter will transmit heat down below? This, Zabarella claims, is impossible because celestial orbs are not elemental and thus incapable of either heating or cooling. No reason thus seems available to explain this phenomenon. In reviewing the whole discussion up until his time, Zabarella notes that Alexander of Aphrodisias suggested two solutions, but both are ineffective. Simplicius and John Philoponus equally failed. Averroes came closer to the truth of the matter but his solution too is ultimately ineffective. Failing to find a satisfactory interpretation of Aristotle's statements on the cause of celestial heat, he humbles himself proclaiming the modesty [*imbecillitas*] of his *ingenium*, and leaving to others the redeeming job of reconciling Aristotle's dictum with the truth of the matter.

*Ego igitur, quum aperte fatear me nullam invenire rationem potuisse, qua sententiam Aristotelis tueamur, quod mihi fortasse ob inscitiam meam, atque ingenii imbecillitatem contingit, defensionem Aristotelis aliis excogitandam relinquam....*⁴⁹

Thus since I could find no reason that might support Aristotle's statement, which perhaps is due to my ignorance, and to the modesty of my intelligence, I will leave to others the job of excogitating a defence of Aristotle....

"Sequitur ut quomodo Coelum suo motu calefaciat, consideremus, quando in sententia Aristot. aquiescere minime possumus."⁵⁰ It remains that we move on!, Zabarella seems to exclaim to himself, since we cannot agree with Aristotle's opinion.

As for himself, he proceeds to mount a quite original investigation of the cause of celestial heat. However, he hastens to beg the reader *not* to construe his decision as an attack on Aristotle.⁵¹ Let us give Zabarella his due, and pay heed to his original theory.

There are three conditions that have to be satisfied for the orb of the Moon to produce heat underneath. The first is that the moving orb is close enough to the sublunary realm, the second that it is solid, and third that it moves fast enough. As for the Moon's orb the first two conditions seem unexceptionable, and in fact can be found in Aristotle, or so Zabarella claims. The third, however, not so. In fact, to Zabarella's mind, Aristotle believed that the motion of the Moon is not fast enough. But, he insists, the Moon seems to move fast, rotating with the whole celestial sphere once every twenty-four hours. So Aristotle should have proved that this speed is not fast enough. We experience that, for example, when iron hits flint-stone, setting fire to the surrounding air. Yet its motion cannot be said to be faster than that of the Moon. By the same token the motion of an arrow through air is not faster than that of the Moon. Yet Aristotle claims that the lead tips of arrows heated by motion melt down. So, in Zabarella's mind, there is no doubt that the motion of the Moon is fast enough to produce heat by attrition. However, the very serious question arises of the terrestrial regions underneath the celestial poles. These regions are known to be cold. Thus either there cannot be fire but only cold body above these regions, which is absurd because no cold body can occupy the place above the sphere of air, or there is indeed fire, where there is little or no celestial motion, which is a prime cause of

heat. How does then Zabarella square the circle? By postulating with Aristotle that all heat in the elements is maintained by celestial motion, he admits that fire above the polar regions cannot be maintained, since there is little or no celestial motion close to the poles. Thus fire is transformed into another, colder element and thus descends by gravity. In fact there is a natural cycle which nature observes. The celestial heat generated especially by celestial light produces vapours which emanate from earth and rise to the sky, where they are transformed into fire by the attrition caused by celestial motion. So in order to preserve an equilibrium nature had to excogitate a way to allow for a global exchange of matter between elemental spheres. This much, Zabarella claims, seems to have been foreshadowed by Aristotle himself in the first book of the *Meteorologica*.⁵²

4. CONCLUSION: AN HISTORIOGRAPHIC REFLECTION

Zabarella has come full circle. He has boldly experimented with *scientia naturalis ad mentem Aristotelis*. He has gone through the cycle of doubting, meditating personal solutions, and risking the failure of reconciliation with the Philosopher. By orchestrating forms of allegiance he has unequivocally (in his view) separated the jurisdiction of the natural philosopher from that of the metaphysician.⁵³

Let us take stock by starting again from an insight by Pietro Ragnisco. More than a century ago, he acutely posed the question as to whether, in the final analysis, Zabarella *really* believed in the eternal motion of the heavens.⁵⁴ Remember that when “naturalizing” the demonstration of the eternal movers Zabarella had not called into question the eternal motion of the heavens. He had taken it for granted as the starting point of inquiry. So, Ragnisco asks himself, if the circular motion of the heavens can *only* be eternal motion, why, for Zabarella, does it need an eternal mover in the first place? In other words, Ragnisco argues, Zabarella would have come close to doubting the need for postulating an eternal mover, thus implicitly renouncing a most powerful argument for the existence of separate substances, hence for the existence of God.

We can now tentatively answer Ragnisco’s question. In fact I believe that there was no real doubt in Zabarella, at least not in the sense of a deeply felt conflict of conscience between two possible laws of explanation valid in the heavens and on earth. There is no conflict in Zabarella between the *commentator* and the *scientist* forms of allegiance. Zabarella’s conscience has not yet reached the stage of conflict retention. He still enjoys the privilege of being able to lay down his conscience before authority.

Yet we have to concede that reason looms large in Zabarella’s mind. “... first of all, the truth of the matter is to be investigated, and afterwards, once that has become known, Aristotle’s words should, if possible, be reconciled with it.” Zabarella senses the current of change. He looks out onto modernity, advocating his right to appeal more and more to reason, *his* personal reason, as a new forum where the individual decides to what extent allegiance to an authority can be pledged. However, the scientific practice of the moderns will look like quite another thing; in fact, much more like the “experimentally grounded and mathematically formulated science of

nature”, seen by Randall in Zabarella and his fellow *traditores*. Randall’s construction of his argument has never been questioned on its own grounds. In the whole of *De rebus* there are no discernable traces of Zabarella’s applying *regressus* to natural philosophy (though, as we have seen, he puts forward the historical claim that it was *regressus* that Aristotle had made use of in Book VIII of the *Physics*).⁵⁵ Surely, if *regressus* was the innovative methodology that paved the way for Galileo and seventeenth-century mathematical physics, some evidence of its successful application to natural philosophy should have been found in its most prominent proponent. Yet there is none.

So, on what basis did Randall construct his argument? And why has *regressus* been seen as a precursor of modern scientific method? I will answer the first question by suggesting that Randall based his argument on a likely mistranslation of a key passage from Galileo. I will subsequently answer the second question by suggesting that *regressus* has been seen as a precursor of modern scientific method because it has been interpreted anachronistically.

Randall’s analysis. The textual evidence Randall brought in support of an influence of Zabarella’s *regressus* theory on Galileo is, in my view, based on a mistranslation of a key passage from Galileo’s *Two new sciences*. Randall reads Galileo as follows: “The knowledge of a single fact acquired through the discovery of its causes prepares the mind to ascertain and understand other facts without need of recourse to experiments, precisely as in the present case, where by argumentation alone the Author proves with certainty that the maximum range occurs when the elevation is 45°. He thus demonstrates what has never been observed in experience.”⁵⁶ The original is as follows: “... la cognizione d’ un solo effetto acquistata per le sue cause ci apre l’ intelletto a ’ntendere ed assicurarci d’ altri effetti senza bisogno di ricorrere all’ esperienze, come appunto avviene nel presente caso; dove, guadagnata per il discorso dimostrativo la certezza dell’ essere il massimo di tutti i tiri di volata quello dell’ elevazione dell’ angolo semiretto, ci dimostra l’ Autore quello che forse per l’ esperienza non è stato osservato.”⁵⁷

I find myself at variance with Randall’s rendering of Galileo’s passage. Randall translates “effetto” with “fact”, introduces a “discovery of ...”, which is not in the original, and renders the “guadagnata per il discorso dimostrativo ...” with a “by argumentation alone ...”, where the “discorso dimostrativo” — which Randall considers a type of logical demonstration — refers to the mathematical proof just presented by Salviati-Galileo in the preceding text. Finally, in the last sentence, Randall (or the typist) leaves out the “perhaps [forse]”, indispensable to construct the integral meaning of the Italian sentence. Randall’s English version is so close to the Crew and de Salvio translation of the *Two new sciences* passage, that the question arises whether Randall based his analysis on vol. viii of Antonio Favaro’s National Edition of Galileo’s works (as, I think, we must assume given Randall’s referencing the translation precisely to that volume), or he or the typist inadvertently quoted Crew and De Salvio.⁵⁸

The anachronistic interpretation of regressus. In my view, Randall and some of his followers have proposed an anachronistic interpretation of Zabarella's *regressus* theory. By "anachronistic" I simply mean that I find it technically difficult to reconcile with the views of Zabarella and his contemporaries. But I need to substantiate my point.

Take the following recent statement about Galileo's alleged use of Zabarella's *regressus* by William A. Wallace, the major proponent of *regressus* as a precursor of modern scientific method.

The substantial content of MS n. 27 concerns the demonstrative process (*regressus*), a type of reasoning that makes use of two demonstrations, one of the 'fact in itself', the other of the 'reasoned fact'. In his exposition, Galileo refers to these two demonstrations as 'progressions' and notes that they are separated by an intermediate stage. The first progression argues from the effect to the cause, whereas the second moves in the opposite direction, from cause to effect. In order that the process works, it is necessary that the 'demonstration of the fact' comes first, and that the effect is initially more known than its cause, although at the end they must be seen as convertible. The intermediate stage realizes the transition to the second demonstration. As it was explained in Galileo's times, this stage concerns a mental examination of the proposed cause (*mentale ipsius causae examen*), according to the expression used by Jacopo Zabarella (1533–1598). The Latin word *examen* is important because it corresponds to the Greek *peîra*, a word which is in the root of the Latin *periculum*, that is, test, the equivalent of experiment (*experimentum*). The main job of the intermediate stage is the test, to search for and eliminate other possibilities, so as to find the cause that makes that effect be present.⁵⁹

Wallace thinks that the intermediate stage of *regressus*, the *mentale ipsius causae examen*, is experiment. I will try to show the reason for my perplexity with this interpretation.

First of all, Wallace has recourse to etymological analysis, when claiming that "[i]l termine latino *examen* è importante perché corrisponde al greco *peîra*, un vocabolo che è nella radice del latino *periculum*, cioè prova, l'equivalente di esperimento (*experimentum*)". He transforms the *mental examination* [*mentale examen*] into an experiment, by suggesting that *examen* corresponds to the Greek *peîra*, which would be the root of the Latin *periculum*, and that therefore *periculum* — equivalent to *experiment* (according to Wallace) — is what has to be intended instead of *examen*. Here I wonder what a *mentale ipsius causae periculum*, i.e., literally, a mental experiment of a cause, might be. (But, I guess, the notion of *mentale periculum* would have pleased Alexandre Koyré, who thought that Galileo's experiments were thought-experiments.)

Second of all, I confess that I find the equivalence *periculum*/experiment postulated by Wallace difficult to accept. *Periculum* seems to mean *test*, it is almost always to be found in the obscure and idiomatic expression *periculum facere* (approximately, to

do a test, in the sense of verifying if something that is being said is true or not), and does not carry the connotations of *experiment* in the early modern, Galilean sense of controllable experiment and measurement. Charles Schmitt argued long ago that *periculum facere* cannot be construed as the carrying out of an experiment.⁶⁰

My perplexity with Wallace's interpretation is best illustrated by considering how Paulus Vallius (1561–1622) — the very Jesuit professor whom Wallace believes to be the author, or one of the authors, of the manuscripts from which Galileo culled the notes preserved in *MS n. 27*, and to which Wallace refers in the above quotation — construes the intermediate stage of *regressus* in his 1622 *Logica* (the key text that, in an earlier manuscript form, seems to have been one of the sources of *MS n. 27*).

First, Vallius acknowledges that the best treatment of *regressus* is in Zabarella's logical writings (*De hac materia agunt ... et omnium optime Zabarella lib. de regressu*). Second, Vallius connotes the intermediate stage of *regressus* in unequivocal mental terms. "Hanc intermediam intellectus considerationem, aliqui vocant negotiationem intellectus, alii mentale examen, alii meditationem, alii applicationem, et intentionem mentis..." The intermediate stage, Vallius says, is called by some an "intermediate consideration of the intellect", by others a "negotiation of the intellect [*negotiatio intellectus*]", by others a "mental examination", by others a "meditation", and by others an "application, and intention of mind". Here we find no terminological clue that the intermediate stage has anything to do with experience. The expression "negotiatio intellectus" is hard to translate. In classical Latin, "negotiatio" only means "business", "commercial transaction", or a "commercial establishment". However, cognates of "negotiatio" in early modern vernaculars, such as, for instance, English, also mean "a discussion or process of treaty with another (or others) aimed at reaching an agreement about a particular issue, problem" (OED). A meaning similar to the latter is also given for the Italian "negoziare" by the *Accademia della Crusca* dictionary of 1623.⁶¹ Hence my terminological choice, which, as we shall see presently, agrees well, I believe, with how Vallius elucidates the process of *regressus*. Third, Vallius goes on to explicate the intermediate stage of *regressus* and to give some examples, none of which refers to *periculum* or experience.

Vallius argues that by means of this intermediate stage "we see that an effect is always and necessarily connected with the cause, and that to the cause all the conditions of cause apply, and that to the effect all the conditions of effect apply; so, by comparing cause and effect, and by knowing the quiddity of the cause, that cause becomes known to us, and [we know] that the effect depends on that [cause], and in this way we have cognition of the cause by resolution and application of the logical rules, by means of which we know which is the cause and which is the effect".⁶² In sum, according to Vallius, the goal of the intermediate stage of *regressus* appears to be no more than a clarification of the cause-and-effect relationship, gained by means of logical rules and leading to better knowledge of the quiddity of the cause. There is nothing original in Vallius's treatment of *regressus*. Vallius fails to clarify what the intermediate stage of *regressus* consists in, since he only hints at the application of unspecified logical rules. One thing is clear, though. The intermediate stage of

regressus is neither an experiment nor a *periculum*. Indeed, nowhere does Zabarella, on whose treatment Vallius depends, claim that the intermediate stage of *regressus* has anything to do with experiment or *periculum*.

So, neither Vallius nor Zabarella conceives of the intermediate stage of *regressus* as a *periculum*, let alone as an experiment. Indeed, we might ask, how could the mental examination of a cause by means of logical analysis resemble anything like the carrying out of a test, or experiment, with material artifacts? The fact of the matter is that no exponent of *regressus* solved the problem of what the *mentale examen* consists in. On the contrary, as we shall presently see, it was argued in Padua, in Zabarella's time, that the *mentale examen* was an irreducibly irrational stage of *regressus*. This might explain why even Zabarella, the most original of all *regressus* methodologists, failed to make use of *regressus* in natural philosophy. The failure of the intermediate stage of *regressus*, lucidly perceived in Zabarella's time, has gone missing in contemporary historiography, and replaced with experiment.

Around the middle of the sixteenth century, Alessandro Piccolomini (1508–79), a colleague of Zabarella at Padua and the editor of a popular edition of pseudo-Aristotle's *Mechanical questions*, and Francesco Barozzi (1537–1604), a mathematician of Greek origin, became involved in a dispute about the nature of mathematical proof. Piccolomini put forward an acute analysis of what constitutes *demonstratio potissima*, the kind of perfect demonstration that would constitute an Aristotelian demonstrative science. He came to the striking conclusion that mathematical proofs are not *potissimae demonstrationes*, and that therefore mathematics does not conform to the canon of an Aristotelian demonstrative science. Some, Piccolomini tells us, doubt whether *regressus* is at all possible in demonstration, by raising the objection that, since in any scientific process, the direction is from the unknown to the known, and since by demonstration *quia* one knows the cause of the effect, it is wholly unclear for what purpose a demonstration *propter quid* should follow the demonstration *quia*. Others, Piccolomini continues, in order to defend *regressus*, admit the existence of an intermediate stage, called “negotiation”, between the first demonstration *quia* and the second demonstration *propter quid* [i.e., the Zabarellian *mentale examen*].⁶³ But Piccolomini ironically notes that he has always failed to understand what this so-called negotiation is supposed to be, and claims that it is an irrational element that vitiates the whole demonstrative process. “Aliqui ... ut coacti ponant quandam (ut ipsi dicunt) negociationem post primum processum, quam ego ponderans nunquam intellexi, quod sibi vellet. Aut enim illa erit, quidam a priori processus, aut a posteriori, et quidquid detur in obscuras ambages inciderimus, ut cuilibet parum in Logica versato, manifestum esse potest.”⁶⁴ This is the most damning criticism ever levelled at the intermediate stage of *regressus* theory. The intermediate stage, as Piccolomini points out, introduces an obscure, ultimately illogical element in the logical process (“in obscuras ambages inciderimus”). No *regressus* theorist has ever been able to respond to Piccolomini's strictures. It is small wonder, then, that even Zabarella *de facto* abandoned *regressus* in *De rebus*.

In conclusion, Zabarella and *regressus* theory do not deserve credit for

foreshadowing Galileo's novel mathematical natural philosophy. On the contrary, as Ragnisco and Schmitt have intuited, Zabarella does deserve credit for separating his practice of natural science, which owes nothing to *regressus*, from his pledge of allegiance to Aristotle's authority, while working wholly within the Aristotelian framework. One condition of that achievement, which this paper has emphasized, consisted in Zabarella's mobilizing his allegiance to authority, by neutralizing the conflict of conscience between Zabarella the *commentator* and Zabarella the *scientist*.

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2. In my opinion, the most thorough discussion, and clear refutation, of the Randall thesis is to be found in N. Jardine, "Galileo's road to truth and the demonstrative regress", *Studies in history and philosophy of science*, vii (1976), 277–318. Cf. also James B. South, "Zabarella, prime matter, and the theory of regressus", *Graduate Faculty philosophy journal*, xxvi (2005), 79–98, who comes to interesting conclusions even though his focus is still on Zabarella's logical methodology. In South's opinion, "Zabarella's philosophical creativity is better viewed in this light than in any purported imperfect foreshadowing of subsequent thinkers" (*ibid.*, 94), with an obvious reference, I think, to Randall's theses. Cf. Antonino Poppi, *La dottrina della scienza in Giacomo Zabarella* (Padua, 1972), especially pp. 22, 133; *idem*, "Zabarella, or Aristotelianism as a rigorous science", in Riccardo Pozzo (ed.), *The impact of Aristotelianism on modern philosophy* (Washington, DC, 2004), 35–63, originally in Antonino Poppi, *Ricerche sulla teologia e la scienza nella scuola padovana del cinque e seicento* (Soveria Mannelli, Catanzaro, 2001), 125–52; and Charles Schmitt, *L'Aristotelismo nel veneto e le origini della scienza moderna: Alcune considerazioni sul problema della continuità*, in L. Olivieri (ed.), *Aristotelismo veneto e scienza moderna* (2 vols, Padua, 1983), i, 79–103, pp. 95–96. See also Cesare Vasoli, *Introduction*, in G. Zabarella, *De methodis libri quator, Liber de regressu* (Bologna, 1985), pp. xi–xxviii; and Francesco Bottin, *Giacomo Zabarella: La logica come metodologia scientifica*, in Gregorio Piaia (ed.), *La presenza dell'Aristotelismo padovano nella filosofia della prima modernità* (Rome and Padua, 2002), 33–55.
3. Charles Schmitt, "Experience and experiment: A comparison of Zabarella's view with Galileo's in *De motu*", *Studies in the Renaissance*, xvi (1969), 80–138, p. 126. Another recent study which shifts the focus off Zabarella's methodology is Heikki Mikkeli, *An Aristotelian response to Renaissance humanism: Jacopo Zabarella on the nature of arts and sciences* (Helsinki, 1992).
4. Schmitt, "Experience" (ref. 3). Gabriele Baroncini, *Forme di esperienza e rivoluzione scientifica* (Florence, 1992), 39–62, has discussed Schmitt's paper, pointing out reservations about Schmitt's interpretation of some passages by Zabarella. These concerns, however, in my view, do not call into question the substance of Schmitt's conclusions.
5. Giacomo Zabarella, *De rebus naturalibus*, In *Aristotelis libros de anima* (Frankfurt, 1966; facsimile

- of edn publ. Frankfurt, 1606–7), 3 (note that numbers refer to columns rather than pagination).
6. Randall, “The development” (ref. 1), 177.
 7. Charles Lohr, *Latin Aristotle commentaries: II. Renaissance authors* (Florence, 1988).
 8. “... la vita di quei professori non era che per la scuola: per essa ed in essa si esauriva la loro vita. La scuola allora era quasi indivisa dalla vita cittadina, era una gran vita; ed un professore restava soddisfatto vivendo in essa. Perciò non vi erano studi che, per per quanto alti e superiori potevano essere, non si riferissero all scuola”, in Pietro Ragnisco, “Giacomo Zabarella il filosofo: Una polemica di logica nell’Università di Padova nelle scuole di B. Petrella e di G. Zabarella”, *Atti del R. Istituto Veneto*, ser. 6, iv (1885/86), 463–502, p. 467. Cf. also *idem*, “Giacomo Zabarella il filosofo: La polemica tra Francesco Piccolomini e Giacomo Zabarella nella Università di Padova”, *ibid.*, 1217–52.
 9. The printing press made it easier for this to happen; for instance, Charles Schmitt has noted that access to Averroes’s commentaries was greatly improved by the printing-press entrepreneurs who made his massive corpus of writings available in the multi-volume Giunti edition of 1550–52. Schmitt, “*L’Aristotelismo*” (ref. 2), 89.
 10. For instance, Johannes Lorinus (1559–1635), Benedictus Pererius (1535–1610), Paulus Vallius (1561–1622), Mutius Vitelleschi (1563–1645), and many others active there at various times in the late sixteenth or early seventeenth centuries. Paulus Vallius’s *Logica*, for example, was influenced by Zabarella most extensively. Indeed the theory of *regressus demonstrativus*, expounded by Vallius in the *Logica*, is appropriated from Zabarella’s *De regressu*, as, on the other hand, Vallius himself acknowledges. Cf. Paulus Vallius, *Logica*, ii (Lyon, 1622), 340–50; and Zabarella, *De methodis* (ref. 2), 145–57. Cf. Edwards, *The logic* (ref. 1), 256ff., for a penetrating analysis of Zabarella’s theory of *regressus*.
 11. Cf. Ugo Baldini, *Saggi sulla cultura della Compagnia di Gesù (secoli XVI–XVIII)* (Padua, 2000), especially 239ff., on the continuity of the teaching of *physica* (i.e., Aristotle’s *Physica*, *De caelo*, *De generatione et corruptione*, *Meteorologica*, *De anima*) within the Jesuit schools, from the sixteenth to the eighteenth centuries. *Scientiam tradere* in the production of these professors, especially before the impact of Galilean mathematical physics, took the typical form of the *commentario*, and that of the *manuale* or *trattato*, the latter two differing only in size, and usually consisting of abbreviated commentaries. The *commentario* contained both explanations of the Aristotelian text and *quaestiones*. In the case of the Jesuit professors we also need to make allowance for a further element of self-regulation to do with the cultural policies of the Society of Jesus. It took the form of an internal censorship articulated at many levels. This phenomenon’s impact on the professors’ production, especially in relation to the regimentation of tendencies to deviate from the Aristotelian norm, has been lucidly investigated by Ugo Baldini. Cf. Ugo Baldini, *Legem impone subactis: Studi su filosofia e scienza dei Gesuiti in Italia, 1540–1632* (Rome, 1992). See especially pp. 75ff.
 12. A battle broke out against the attempt by the Jesuits to establish an independent college in Padua, in competition with the university, during which Cesare Cremonini, professor of philosophy at the university, was called upon to lead the charge against the intruders. Cf. Antonio Favaro, “Lo studio di Padova e la Compagnia di Gesù sul finire del secolo decimosesto”, *Atti del R. Istituto Veneto*, ser. 5, iv (1877/78), 401–535; Léopold Mabilleau, *Étude historique sur la philosophie de la Renaissance en Italie (Cesare Cremonini)* (Paris, 1881), 17ff.; and Cesare Cremonini “Orazione contro i Gesuiti a favore dello Studio di Padova”, in *Le orazioni*, ed. by A. Poppi (Padua, 1998), 53ff., and the Jesuits’ responses, in Maurizio Sangalli, “Apologie dei Padri Gesuiti contro Cesare Cremonini. 1592”, *Atti e Memorie dell’Accademia Patavina di Scienze, Lettere, ed Arti*, cx (1997–98), 241–355. Cf. also Maurizio Sangalli, *Cultura, politica, e religione nella Repubblica di Venezia tra Cinque e Seicento* (Venice, 1999), particularly pp. 187ff., and *Università accademie Gesuiti: Cultura e religione a Padova tra cinque e seicento* (Trieste, 2001). A lot of students,

- according to Poppi, had left the venerable *Studium* for the fledgling Jesuit college.
13. It is hard to miss this emotional investment when reading, for instance, Zabarella's *De rebus naturalibus*, where he repeatedly addresses other *traditores*, who oppose Aristotle's texts, with the verb *audere* (to dare, to venture).
 14. Such an innovative tendency in Zabarella was seen by Pietro Ragnisco, though Ragnisco was ultimately unable to detach his appreciation of the Paduan professor from a precursory interpretation that pointed to the advent of Galilean science. In fact we might say that Ragnisco preceded Randall by more than half a century, though the former was (rightly, in my view) steadfast in always and clearly distinguishing between the two forms of scientific practice. Cf. the still unsurpassed studies by Ragnisco, "Giacomo Zabarella il filosofo: Pietro Pomponazzi e Giacomo Zabarella nella Questione dell'anima", *Atti del R. Istituto Veneto*, ser. 6, vi (1886/87), 949–96; "Giacomo Zabarella il filosofo. Una polemica di logica" (ref. 8); "Giacomo Zabarella il filosofo: La polemica" (ref. 8); and "Da Giacomo Zabarella a Claudio Berigardo ossia prima e dopo Galileo nell'Università di Padova", *Atti del R. Istituto Veneto*, ser. 7, v (1893/94), 474–518.
 15. Zabarella, *De rebus* (ref. 5), 201.
 16. Zabarella, as is well known, was involved in fierce controversies but never accused of withdrawing allegiance from Aristotle (so far as I have been able to ascertain). Cf. Ragnisco, "Giacomo Zabarella il filosofo: Pietro Pomponazzi" (ref. 14); *idem*, "Giacomo Zabarella il filosofo: Una polemica di logica" (ref. 8); *idem*, Giacomo Zabarella il filosofo: La polemica tra Francesco Piccolomini" (ref. 8); and *idem*, "Da Giacomo Zabarella a Claudio Berigardo" (ref. 14).
 17. Cf. M. Dal Pra (ed.), "Una 'oratio' programmatica di G. Zabarella", *Rivista critica di storia della filosofia*, xxi (1967), 286–90; and Dominique Bouillon (ed.), "Un discours inédit de Iacopo Zabarella préliminaire à l'exposition de la 'Physique' d'Aristote (Padoue 1568)", *Atti e memorie dell'Accademia Galileiana di Scienze, Lettere, ed Arti in Padova*, cx/1 (1998–99), 119–27. The first document has already been used, for different purposes, by N. Jardine ("Keeping order in the School of Padua: Jacopo Zabarella and Francesco Piccolomini on the offices of philosophy", in Di Liscia, Kessler and Methuen (eds), *Method and order in Renaissance philosophy of nature* (ref. 1), 183–209). The second, so far as I know, has not been used in relation to Zabarella's natural philosophy (although its editor has published an interesting commentary to the text).
 18. Dal Pra, "Una 'oratio'" (ref. 17), 288.
 19. Bouillon, "Un discours" (ref. 17), 124–5. Cf. E. Berti, "Metafisica e dialettica nel 'Commento' di G. Zabarella agli 'Analitici posteriori'", *Giornale di metafisica*, n.s., xiv (1992), 225–44.
 20. "... quibus quaestiones, quae ab Aristotelis interpretibus hodie tractari solent, accurate discutuntur", cf. Zabarella, *De rebus* (ref. 5), title page.
 21. Parts of the *De rebus* were discussed, for instance, by Schmitt, "Experience" (ref. 3); E. Kessler, in "The intellectual soul", in C. Schmitt and Q. Skinner (eds), *The Cambridge history of Renaissance philosophy* (Cambridge, 1988), 530–4; Baroncini, *Forme di esperienza* (ref. 4); and in the various studies by Ragnisco (refs 8, 14). A study of the massive book as a whole is still lacking.
 22. Charles Lohr, "The sixteenth-century transformation of the Aristotelian natural philosophy", in E. Kessler, C. Lohr, and W. Sparr (eds), *Aristotelismus und Renaissance. In memoriam Charles B. Schmitt* (Wiesbaden, 1988), 89–99, p. 99.
 23. Zabarella, *De rebus* (ref. 5), 133, 231, 253, 307, 541, 856–7, 915, 979–80.
 24. "... aliquid me operae pretium facturum existimavi, si arduas, quae hac de re [i.e., prime matter] existunt, quaestiones, magnasque difficultates; quae negotium facessere omnibus solent, pro viribus explicare tentavero; et ea, quae ipse philosophando excogitare potui, in commune conferens, aliisque expedenda, relinquens, nisus fuero veritatem, et Aristotelis de prima materia sententiam (si possim) reddere clariorem." Zabarella, *De rebus* (ref. 5), 133.
 25. "... in primis Naturalis scientiae naturam, et fabricam a me hoc libello explicatam, tamquam praeludii, ac praeparationis loco cunctis Aristotelicae theoriae studiosis exhibeo." Zabarella, *De rebus*

- (ref. 5), 2.
26. Note that this tract, which Zabarella inserted in the collection upon the request of students and friends, is not about natural science but about a metaphysical question, as he points out (*De rebus* (ref. 5), 367).
27. Zabarella, *De rebus* (ref. 5), 269, 374–5, 435–6, 582, 728, 765, 831, 1007–8.
28. "... ut nunc alios omittam, Petrus Pomponatius, qui duobus a se editis libris diligentissime, et optime de accretione disputavit, non solum se in eius cognitione non acquiescere, palam, et ingenue confessus est, sed etiam asseverare ausus, nullum esse mortalium, qui possit asserere sibi in huius rei intelligentia esse plene satisfactum. Hoc ego considerans, et illius viri, cuius eruditionis atque iudicium plurimi facio, exemplo et auctoritate ductus; neque detrectandam mihi propter difficultatem esse hanc disputationem existimavi, quod pusillanimitas, ac philosophia indignis homini esset; neque eo animo hanc scribendi provinciam suscipere constitui quod me ad plenam veritatis notitiam pervenisse putans, perfectam eius declarationem polliceri me posse considerem, quod quidem arrogantiam fortasse, ac temeritatem prae se ferret: sed ... niterer, quantum per me fieri possit, prope ad veritatem accedere, ac si ipsam non prorsus attingere, saltem ad eam inveniendam alios magis excitare...." Zabarella, *De rebus* (ref. 5), 765.
29. "Hunc itaque ordinem in hac nostra disputatione servabimus: primum de tota anima secundum suam substantiam; postea de tota secundum suam quantitatem et extensionem; ac demum de tota secundum facultates suas, quid iuxta Aristotelis mentem sentiendum sit, considerabimus." Zabarella, *De rebus* (ref. 5), 728.
30. Cf. a fascinating essay "*ad mentem Galilaei*" by Viviani, entitled "Sopra i principii del Signor Baliani". It is preserved at the Biblioteca Nazionale Centrale, Florence, among the folios of Ms. Gal. 74 [Div. 2a – Parte Va, t. 4], a collection of adespota, and can be consulted online, at <http://www.bncf.firenze.sbn.it/>. The attribution of authorship to Viviani was put forward by Raffaello Caverni, who published the writing, in *Storia del metodo sperimentale in Italia* (6 vols, Florence, 1891–1900), iv, 313–14.
31. Zabarella, *De rebus* (ref. 5), 394, 453, 556–8, 684–5, 1043.
32. "Coelestia corpora in hoc mundo inferiore calore producere ita manifestum est, ut nulla probatione indigere videatur: de modo autem et ratione ambigitur. ... de solo calore a coelestibus producto, dicendum nobis proposuimus ... quomodo ergo producant, quum calida non sint, id nobis in praesentia considerandum proponitur." Zabarella, *De rebus* (ref. 5), 556–8.
33. Zabarella, *De rebus* (ref. 5), 131.
34. Zabarella, *De rebus* (ref. 5), 131–2.
35. Zabarella, *De rebus* (ref. 5), 333ff.
36. Zabarella, *De rebus* (ref. 5), 333–8.
37. Zabarella, *De rebus* (ref. 5), 338–341.
38. Zabarella, *De rebus* (ref. 5), 341–2.
39. "Nullum ergo in hoc discrimen est inter elementa et mista, quatenus gravia vel levia sunt; singulis enim assignatus est in mundo locus naturalis, ad quem moventur ex omnibus aliis locis, isque vel magis, vel minus a Coelo remotus pro maiore cuiusque gravitate, vel levitate." Zabarella, *De rebus* (ref. 5), 351.
40. Zabarella, *De rebus* (ref. 5), 979–1006.
41. Zabarella, *De rebus* (ref. 5), 979–80.
42. Zabarella, *De rebus* (ref. 5), 993. *Artificium naturae* is Zabarella's own expression. 43. Zabarella, *De rebus* (ref. 5), 993–4.
44. Zabarella, *De rebus* (ref. 5), 1004.
45. Zabarella, *De methodis* (ref. 2), 151ff.
46. Zabarella, *De rebus* (ref. 5), 260.

47. Zabarella, *De rebus* (ref. 5), 261–2.
48. Zabarella, *De rebus* (ref. 5), 263–4. Cf. *De methodis* (ref. 2), 151ff., where Zabarella explains in detail the stages of the *regressus* method applied by Aristotle to the demonstration of the eternal motors.
49. Zabarella, *De rebus* (ref. 5), 569.
50. Zabarella, *De rebus* (ref. 5), 569.
51. “haec enim dicere volui, non ut Aristotelis sententiam impugnarem ...”, in Zabarella, *De rebus* (ref. 5), 569.
52. Zabarella, *De rebus* (ref. 5), 571–4.
53. In a sense, Zabarella implemented in *De rebus* a programme that he had already put forward in his *De tribus praecognitis*, where he had argued that the opinion is false of those who claim that all sciences are subalternated to metaphysics. For, since the subjects of the sciences are distinguished by their different ways of proceeding, there cannot be any hierarchical subalternation. The metaphysician contemplates *ens quatenus ens*, whereas the natural philosopher contemplates *ens quatenus habens propensionem ad motum*. Giacomo Zabarella, *Opera logica*, 3rd edn (Cologne, 1597), 528. The *Opera logica* was published by Zabarella before the *De rebus*.
54. “Ma lo Zabarella ammetteva l’ eterno moto? ... Qui si trova nello Zabarella, a mio modo di vedere, un contrasto nella sua mente, il quale esprime lo stato cui era arrivata la sua cognizione. Il moto circolare del cielo è solo moto eterno: ma se è eterno, perchè ha bisogno dell’ eterno motore?” Cf. Ragnisco, “Da Giacomo Zabarella a Claudio Berigardo” (ref. 14), 485.
55. The only possible exception is Zabarella’s discussion of prime matter. Cf. Zabarella, *De rebus* (ref. 5), 136–7, and South, “Zabarella” (ref. 2), 87–94, who interprets Zabarella’s investigative path as an instance of *regressus*. Let us note, however, that, for all his methodological acuity, Zabarella never states, in the tract on prime matter, that he is following the stages of *regressus*. In my view, South’s reconstruction is forced and only remotely plausible.
56. Randall, “The development” (ref. 1), 200.
57. Cf. Galileo Galilei, *Le opere di Galileo Galilei*, Edizione Nazionale, ed. by Antonio Favaro (20 vols, Florence, 1890–1909), viii, 296.
58. Cf. Galileo Galilei, *Two new sciences*, transl. by H. Crew and A. de Salvio (New York, 1954; 1st edn, New York, 1914), 276, and Randall, “The development” (ref. 1), 200, fn. 32, where Randall does not acknowledge his appropriation of the Crew and De Salvio translation.
59. “Il contenuto sostanziale del MS n. 27 riguarda il processo (*regressus*) dimostrativo, un tipo di ragionamento che impiega due dimostrazioni, una ‘del fatto in sé’, l’altra ‘del fatto ragionato’. Nella sua esposizione, Galileo si riferisce a queste due dimostrazioni come ‘progressioni’ e nota che esse sono separate da una fase intermedia. La prima progressione argomenta dall’ effetto alla causa, mentre la seconda si muove nella direzione opposta, dalla causa all’effetto. Perché il processo funzioni, occorre che la ‘dimostrazione del fatto’ venga per prima e che l’effetto sia dunque inizialmente conosciuto più della sua causa, sebbene alla fine essi debbano essere visti in modo convertibile. La fase intermedia realizza la transizione alla seconda dimostrazione. Così come veniva spiegata ai tempi di Galileo, questa fase riguardava un esame mentale della causa proposta (*mentale ipsius causae examen*), secondo l’espressione usata da Jacopo Zabarella (1533–1598). Il termine latino *examen* è importante perché corrisponde al greco *peîra*, un vocabolo che è nella radice del latino *periculum*, cioè prova, l’equivalente di esperimento (*experimentum*). Compito principale della fase intermedia è la prova, il ricercare ed eliminare altre possibilità, in modo da ritrovare la causa che fa sì che quell’effetto sia presente”. William A. Wallace, “Galilei, Galileo (1564–1642)”, dictionary entry in *Dizionario interdisciplinare di scienza e fede*, 2003–6; retrievable on-line at: <http://www.disf.org/voci/142.asp>. Wallace’s mention of in *MS n. 27* refers to Galileo’s early notebooks, published in Galileo Galilei, *Tractatio de praecognitionibus et praecognitis* and *Tractatio de demonstratione*, edited by W. F. Edwards

and W. A. Wallace (Padua, 1988). The titles under which Galileo's notebooks were published have been assigned by the editors; they are not Galileo's, and they are nowhere to be found in Galileo's original manuscripts.

60. Schmitt, "Experience and experiment" (ref. 3).
61. Vallius's passage is in his *Logica* (ref. 10), ii, 345. The *Vocabolario della Crusca* says that "negoziare [to negotiate]" is "il trattare che fanno i Principi le cose di stato [the the negotiating that Princes hold about state affairs]". See Accademici della Crusca, *Vocabolario degli Accademici della Crusca*, 2nd edn (Venice, 1623), *ad vocem*. It is difficult to trace the meaning of *negotiatio* in neo-Latin. So far as I have been to ascertain, it seems not to have stably acquired that of negotiation in the *Oxford English Dictionary* sense. However, the present state of our knowledge of neo-Latin does not allow certain conclusions. For example, the *Glossarium mediae et infimae Latinitatis* does not list the OED meaning under the heading of "negotium", to which the reader is referred for "negotiatio" (Charles Du Fresne Du Cange, *Glossarium mediae et infimae Latinitatis* (8 vols, Paris, 1937–38)). However, Thomas Aquinas, in a passage from his *Writing on the Sentences of Peter Lombard* [*Scriptum super Libros Sententiarum*], comes close to the OED meaning of *negotiation*, while speaking of a "rationem negotiantem". Thomas's passage is as follows: "Unde cum negotiatio de his quae sunt ad finem, praesupponat naturalem cognitionem finis, quae sequitur naturalem inclinationem voluntatis in finem; oportet quod habitus perficiens rationem negotiantem de his quae sunt ad finem, praesupponat inclinationem appetitus ad finem ..." (retrievable at the website of the *Archivio della Latinità Italiana del Medioevo*: <http://www.uan.it/alim/letteratura.nsf/Ricerche?Openform>).
62. "... per hanc negotiationem, nos videre effectum esse semper, et necessario connexum cum causa, et illi causae convenire omnes conditiones causae, et effectui convenire conditiones omnes effectus, et ita conferendo causam cum effectu, et cognoscendo quidditatem causae, cognosci a nobis, illam esse causam, et ab ea dependere effectum, et hoc modo haberi cognitionem causae per resolutionem, et applicationem regularum logicarum, quibus cognoscere possumus quae sit causa, et quis effectus". Vallius, *Logica* (ref. 10), ii, 345.
63. Alessandro Piccolomini, *In mechanicas quaestiones Aristotelis, paraphrasis paulo quidem plenior* (Rome, 1547), 81v–83r.
64. Piccolomini, *In mechanicas* (ref. 63), 83r.