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NATURAL ORDER AND MATHEMATICAL IMAGINATION. THE USE OF QUOTING *SAPIENTIA* 11–21 IN ORESME'S WORKS*

Abstract. Nicole Oresme quotes four times the passage from *The Book of Wisdom* (*Wisdom of Solomon*) or, in the *Vulgate*, *Sapientia* 11–21 (*omnia in mensura et numero et pondere disposuisti*), in several works covering his whole career. It goes to show the importance he gives to that passage: the order of nature arranged by God limits natural potencies within boundaries from which harmony follows, and at the same time it marks for man the path to perfection. But the human mind can know the natural order only to a certain degree of probability, as it results from *De commensurabilitate*. After all, it makes it possible to glimpse a more varied and complex order that one can imagine. Thus harmony results from a wise mixture of rationality and irrationality. From the point of view of his use of the passage of *Sapientia* 11–21, the skeptical Oresme appears as a scholar in search for a new synthesis, beyond that of mediaeval philosophy.

Keywords: natural order, mathematics, probability, celestial motions, incommensurability.

1. Introduction

Nicole Oresme is considered as a distinguished late mediaeval scholar, among other things, for his idea of cosmic order. It has been considered as such since the publication of Duhem and Maier's pioneering works, and he has

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* Originally this paper should have been published as a part of a collection of studies devoted to the use of *Sapientia* 11–21 in the history of Mediaeval philosophy by Giulio D'Onofrio & Diego Campi, who unfortunately could not achieve their plan. Prof. Robert Zaborowski kindly invited me to consider the possibility of publishing it in *Organon*. I thank him and two anonymous reviewers for their useful advices and remarks.

turned out to be really quite a unique scholar since the publication of the critical edition of Oresme's questions on the *Physics*[1].

Among modern scholars, Stefano Caroti, Jean Celeyrette, Stefan Kischner and Max Lejbowicz, specialists in Oresme's thought, as well as Henri Hugonnard–Roche and Jeannine Quillet, who all have published articles about some aspects of the Norman master's natural philosophy, agree on considering the use of *imaginary cases* the key feature of Oresme's researches on motion. Such cases aren't ordinary events, but they are included in natural philosophy because they are not *impossibilia simpliciter* (a contradiction following from them), but *impossibilia secundum quid* (only an infinite potency, such as the divine one, can fulfil them), or *in respectu* (they can hardly be achieved by a finite natural potency).

Between the end of 80s and the beginning of 90s of the last century, Hugonnard–Roche made up in several articles about the so–called *physics of imaginary cases* the most detailed analysis of Oresme's contribution on that subject[2]. The way the Norman master treats imaginary cases is influenced by Nicholas of Autrecourt's thought[3]. Oresme considers those cases as inseparable parts of the whole theory of motion, because they are based on premises which are naturally false, but don't entail contradictions. Their consequences would come true if the course of natural events were different from the real one, and it isn't necessary to assume God's intervention while explaining what happens in such events[4].

According to Hugonnard–Roche, the Norman master moves away from Buridan's position on the same topic: Buridan doesn't accept the possibility of a different *natural* order beside the real one (an *unnatural* event could only be the result of a miracle), while Oresme separates a natural philosophy *secundum cursum naturæ*, which is about what really happens, from a natural philosophy *secundum imaginationem*, where the premises of hypothetical demonstrations are imaginary cases, either *impossibilia secundum quid* or *impossibilia in respectu*:

> *Ce 'possible à ymaginacion' ainsi qu'Oresme le nomme dans le* Livre du ciel et du monde*, caractérisé tout simplement comme n'impliquant pas contradiction, marque la nouvelle limite du domaine contenant les objets dont peut traiter la physique. Le possible supranaturel, dont Buridan réservait la connaissance aux théologiens, se trouve donc introduit dans la*

[1] See N. Oresme, *Questiones super Physicam (Books I–VII)*.

[2] See H. Hugonnard–Roche, *Analyse sémantique* ... & H. Hugonnard–Roche, *L'hypothétique et la nature* ... .

[3] See C. Grellard, *La théorie de la croyance de Nicole Oresme*, pp. 213–214.

[4] See H. Hugonnard–Roche, *Analyse sémantique* ... , pp. 138–142 & H. Hugonnard–Roche, *L'hypothétique et la nature* ... , pp. 168–172.

> *physique par Oresme, sous la forme de cas possible 'a ymaginacion'*.[1]

The physics of imaginary cases, an *hypothetical physics* turns out to be the result, to use Hugonnard–Roche's incisive phrase, of a *dé–théologisation* of late medieval natural philosophy. Such a *déthéologisation* is matched to its *dénaturalisation*[2]. The so–called *false possible cases* (*secundum quid* or *in respectu*) are about properties of things which don't exist naturally parted from the bodies to which they inhere (space, time, size, degree of intensity of qualities, etc.). Such measurable properties of physical beings exist just as mathematical abstractions; if they were *things*, they wouldn't conform to the *ratio generalis corporum*[3].

Oresme develops the physics of imaginary cases in his early works, especially in the commentaries on the *Physica* and on the *Sphere*, as well as in the French translation with a commentary of Aristotle's *On the Heavens*, better known as *Livre du ciel et du monde.* The physics of imaginary cases is strictly joined to the wide use of mathematics in the field of natural philosophy, which turns out to be the distinctive trait of Oresme's method. Jean Celeyrette explains it as an extension of the Aristotelian physics, that founds on more solid grounds (the mathematical ones) the physics *secundum cursum naturæ*:

> *Les principes mathématiques sont infiniment (et il* [*scil*. Oresme in his *Questions on* the Physics] *donne à ce terme un sens mathématique puisqu'il introduit plus loin des 'degrés d'évidence') plus connu (*evidentia*) que les principes physiques. Et c'est ce corollaire qui lui permet d'expliquer que, comme le dit Averroès, les mathématiciens sont dans le plus haut degré de certitude et que les physiciens les suivent mais de loin.*[4]

Nicole Oresme was not alone in his age in employing imaginary cases in natural philosophy. As it is well known, the famous 1277 *condemnation of Averroism* had already grounded on theological principles the critics of Aristotelian natural philosophy. During the 14th century from such a condemnation several attempts to go beyond some of the basic principles of Aristotelian physics followed, towards a radical rejection of several mainstays of the theory of motion[5]. But the Norman master combined the use of imaginary cases with a mathematical analysis of motion more frequently than all the other masters.

Oresme moves far away from the basic principles of Aristotelian physics since his early questions on the *Physica* as regards the concept of *place*. He

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[1] H. Hugonnard–Roche, *Analyse sémantique* ... , p. 142.

[2] See Hugonnard–Roche, *L'hypothétique et la nature* ... , p. 172 & p. 177. See also J. Quillet, *Enchantements et désenchantement* ... .

[3] See H. Hugonnard–Roche, *L'hypothétique et la nature* ... , pp. 172–173.

[4] J. Celeyrette, *Le statut des mathématiques dans la* Physique *d'Oresme*, p. 101.

[5] Among many articles and essays about the impact of the 1277 condemnation on late mediaeval natural philosophy, see J. Sarnowsky, *God's Absolute Power* ... . See also F. Zanin, *Francis of Marchia,* Virtus derelicta ... , esp. pp. 83–85.

doesn't see it as the *the outermost (external) limit of the including body*, but indeed as the space a body occupies. From this idea of *place* it follows that void could exist in nature, even if it results as *naturaliter impossibile*, given the laws of nature in effect that actually rule the world. The void is actually the distance between bodies, and it could exist in nature (*secundum cursum naturæ*), if there were a force that could produce it. Anyway, it exists outside nature, as does the unlimited space surrounding the universe occupied by God[1].

The departure from Aristotelian natural philosophy involves the concept of *time*, too. Oresme sees it as independent from the duration of natural things: in fact, inspired by the way Boethius explains God's eternity in *The Consolation of Philosophy*, the Norman master defines eternity as *duratio rerum tota simul*, and consequently he separates eternal beings from created temporary things (existing in time, whose duration is *successiva*)[2]. Oresme infers that before creation there was time, even if without a sequence of events, as well as there is a place in the extracosmic space, even if without any body there:

> *Distinguendum est de tempore ut prius, unde, si capiatur proprie, aliqualiter potest sic describi: tempus est rerum duratio successiva. Dico 'successiva' ad differentiam eternitatis, quia omnes philosophi in hoc conveniunt, quod eternitas est rerum duratio tota simul. Ex quo sequitur quod si non sit aliqua successio nisi per motum, quod tunc duratio non esset tempus, nisi motus esset. Tunc sit conclusio quod, licet tempus*

[1] One can follow Oresme's discussion on the Aristotelian concept of *place* in qq. 4–6 of the book IV of his commentary on the *Physics*, which are devoted to the issues *utrum locus sit quantitas*, *utrum locus sit corpus continens sive locans* and *utrum locus sit spatium interceptum inter latera continentis, quod esset vacuum sit non esset ibi locatum*, respectively, and in q. 7, too (*utrum naturaliter possit esse vacuum in hoc mundo*). See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 443–464 & pp. 465–471. One can find a full analysis of Oresme's theory of place in: S. Kirschner, *Oresme's Concept of Place, Space, and Time ...* , esp. p. 145: *Oresme argued definitely for the non–Aristotelian position that the place of a body is the space filled or occupied by the body. We know of no other Christian mediaeval philosopher who shared Oresme's position*. See also S. Kirschner, *Nicole Oresme on the Void ...* (mostly devoted to Oresme's theory of intracosmic void), esp. p. 248: *We have to bear in mind that Oresme's denial of the existence of a vacuum only refers to the cosmos inside the last sphere. As already mentioned, a central conclusion that Oresme draws in his discussion of the nature of place in his* Physics *is that, beyond the world, that is, outside the last sphere, there exist an infinite void space*. Oresme argues for the same position in his later *Livre du ciel et du monde*, p. 614, quoted by S. Kirschner, *Oresme's Concept of Place, Space, and Time ...* , p. 154, n. 29. About the way God exists in the limitless empty space that surrounds and includes the natural universe, see q. 19 of the book IV of the commentary on the *Physics*, devoted to the issue *utrum omnia sint in tempore*, i.e. N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 552: *Sicut se habet locus ad immensitatem, que est extra celum, ita tempus <ad eternitatem>, sicut patet in quodam libello qui vocatur* Memoriale rerum difficilium*. Unde sicut ipsa immensitas est Deus, in quo sunt omnia, ita ipsa eternitas est ipse Deus, cui nihil est coeternum, quia omne aliud est commutabile et dependens ex ipso. Ideo dicit Hermes quod 'omnia ab eo et in ipso et per ipsum'; et dicit: 'in ipsa vitali eternitate locus est mundi, propter hoc quod non corru<m>petur aliquando semper'*).

[2] For what concerns the discussion on the concept of *time* in Oresme's commentary on the *Physics*, see qq. 16–18 of the book IV (*utrum tempus sit aliquid*, *utrum tempus sit ab anima* and *utrum tempus sit numerus motus secundum prius et posterius*: N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 528–548). See also *Nicole Oresme and the Medieval Geometry of Qualities and Motions*, p. 272. Finally, see S. Kirschner, *Oresme's Concept of Place, Space and Time ...* , p. 146. As regards Boethius' famous definition of *eternity*, see Boethius, *Philosophiae consolatio*, V, 6. Lastly see the analysis of God's eternity made by Thomas Bradwardine in *De causa Dei*: *Thomas Bradwardini archiepiscopi olim Cantuariensis de causa Dei ...* III, c. 27, p. 708.

> *illo modo sit numerus motus, quia per hoc possumus numerare motum quantum ad durationem, tamen cum hoc est mensura eque bene aliarum rerum et duratio. Et etiam magis numeramus tempus illo modo per motum quam e converso, et naturaliter, <quia> secundum ymaginationem videtur esse prius motu.*[1]

Oresme quotes not so often as might be expected in his works the celebrated passage from the book of *Sapientia*, 11–21: *omnia in mensura et numero et pondere disposuisti*. His way of conceiving the spatio–temporal dimension in which physical beings exist compared to the dimension in which God exists can be correctly understood within the framework of a rather peculiar *metaphysics of natural order*: the above mentioned passage of *Sapientia* quoted in different contexts shows his peculiar point of view not only about the relationship between natural and divine order, but also about the correlation between physics and mathematics. To express it more clearly, the way Oresme conceives the relationship between natural and divine order is correlated to the way he mingles physics and mathematics in his theory of motion.

Oresme quotes the passage of *Sapientia* 11–21 at least four times in different works, which were published in different periods of the Norman's career as a scholar and as an ecclesiastic[2]. Following the line of time, the first quotation is included in Oresme's commentary on Aristotle's *Physica*, book I, question 11, the issue of which is *if in natural species* maxima *are possible*. According to the most recent studies, that commentary was composed in the years 1341–1342, when Oresme began his teaching at the Arts faculty at the University of Paris[3]. The second one is included in the treatise *De commensurabilitate et incommensurabilitate motuum celi* (hereinafter: *TDCIMC*), which was written and published, like all of his mathematical treatises, when Oresme was at the Navarre College, at first as a scholarship recipient, then as a theologian, and finally as chancelor (1356–1361). The third quotation is included in chap. 16 of the treatise *De moneta*, probably wrtitten in the years 1355–1356, right before or right after the battle of Poitiers, which brought about a severe political crisis in the kingdom of France. The kingdom was upset by the financial crisis due to the Hundred Years War's costs and to the bad management of State finances, and the Norman philosopher wanted to recommend a solution as he addressed his treatise to the royal court. As a matter of fact, a French version of *De moneta*, the title of which was *Traité des monnaies*, influenced king Charles V's financial reform of 1360[4]. The translation with a commentary of Aristotle's *Politics* is the last work in which the passage from

[1] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 543.

[2] One can find a detailed and updated analysis of Oresme's career as a scholar in: J. Celeyrette & C. Grellard, *Introduction*, pp. 11–20 & M. Lejbowicz, *Nicole Oresme 'spectateur engagé'*.

[3] For Oresme's works' dating it is nearly necessary to consider J. M. M. H. Thijssen, *The Debate over the Nature of Motion* ... & J. M. M. H. Thijssen, *The Short Redaction of John Buridan's Questions* ... . See also J. Celeyrette, *Les Questions sur la* Physique *dans l'œuvre de Nicole Oresme*, pp. 64–66.

[4] See N. Oresme, Bartole de Sassoferrato & J. Buridan, *Traité des monnaies* ... .

Sapientia 11–21 is included, and it is used to debate the problem *what is the better set of rules for a town*. This translation with a commentary is a part of a wide cultural project of Charles V. The king demanded and financed the translations of Aristotle's works in order to make them available for those who didn't know Latin, but needed a *culture for rulers*. As is well known, once having become dean of the court Oresme translated and commented for his king, Aristotle's *Heavens*, the *Nicomachean Ethics* and the *Economics*, in addition to the *Politics*[1]. That work dates back to the period between 1370 and 1377; then he was appointed bishop of Lisieux and as a consequence he left the Parisian court.

The aims, the style and the problems treated in the works, in which the four quotations from *Sapientia* 11–21 (or, to be more precise: five quotations; there's indeed a double reference in *TDCIMC*) are included, show us a wide range of Oresme's ideas about created order and its connection to the divine one. The measure God has put in created beings sets the *maxima* in natural species, it entails the condemnation of such practices as profiting from exchanging currencies, and it forces territorial and demographical limits to the *civitates*, considered as natural organisms. At the same time, the order God set in the Universe is not fully understandable by human mind[2].

The five quotations from *Sapientia* sketch a *metaphysics of natural order*, which sometimes appears inconsistent: on one side, the Norman philosopher states the peaceful confidence in the order not only as set by God in Nature, but also as a general rule for men, on the other side, Oresme expresses in his mathematical treatises an overall scepticism in human intellectual abilities to understand such an order (provided it exists), therefore one can doubt it can be a rule in acting. Mathematics, the rational discipline *par excellence*, is supposed to provide men with the suitable conceptual tools to understand such an order, but it reveals indeed a reality as complex as it can be, for the most part hidden to human mind. Therefore, Oresme's point of view on natural order is a peculiar combination of a mediaeval attitude to synthesis, and the skeptic one that opened the doors to Humanism and its agitations. In my opinion, his idea of natural order should be regarded as an untimely mental effort to achieve a new, more valid synthesis.

2. The Natural Order within the Divine Order

i) The *maxima naturalia* (commentary on the *Physics*, I, qq. 10–11)

Chronologically, the first time Oresme quotes the passage of *Sapientia* 11–21 is in the conclusion of *quæstio* 11 of the first book of his commentary on the *Physics*. The issue is *utrum in qualibet specie sit dare maximum naturale*. Oresme lists four arguments against the existence of any *maximum naturale*. The last one is about man as a natural being: there is no *maximus homo*, because, as much as big a man is, he can grow again *per medicinas vel qualitercumque*

[1] One can find an updated analysis of Charles V's cultural plan and of the role played by Nicole Oresme in: N. Oresme, *Contro la divinazione* ... , pp. 9–21.

[2] See N. Oresme, *De proportionibus proportionum* ... , III, pp. 246–248.

virtus nutritiva[1]. Oresme rejects the fourth argument just mentioned by seven *conclusiones*, according to which there exists naturally a *maximum* in each species: even though the improvement of life conditions makes possible the unlimited growth of the human body, as a matter of fact there is a measure which the body can't reach (a *maximum quod non*)[2]. At that point, when Oresme completes his reasoning for his position and moves on to reply *ad rationes*, he quotes the passage of *Sapientia*:

> *Unde sequitur quod meliorando circumstantias sicut nutrimenti, aeris, exercitii etc. non potest tantum augeri quin possit plus; sed ex hoc non sequitur quod in infinitum, quia non in duplo nec in quadruplo etc., sed est quedam mensura ad quam non potest pervenire, ut dictum est. Nec valet de inflatione aut talibus, quia non est ad propositum. Ideo de primo: 'omnia facta sunt numero pondere et numero etc.'*[3]

It is not so unusual that a *quæstio* treated by Oresme runs out so quickly, because the Norman master typically limits either the number of arguments supporting/refuting a position at the beginning of a *quæstio* or the number of replies *ad rationes* in the end. It is rather remarkable that he solves the arguments that call his position into doubt (*ad rationes*) only by the authority of the Holy Bible[4]. But the role played by the passage of *Sapientia* 11–21 in Oresme's question I, 11 on the *Physics* can be clearly assessed only if this quotation is placed in the whole background of the same question and the previous one.

Question I, 10 treats the problem *utrum in qualibet specie sit dare minimum naturale, verbi gratia ut minimus homo et caro vel aliquod tale*. First of all, Oresme presents the arguments against the existence of such a natural *minimum*. Among them, it is worth mentioning that natural bodies are divisible to infinity and the measure of the potency of a natural being exceeding the strength of elements that bring it to corruption is in the same way divisible to infinity in particles exceeding the force of each corruptive element[5]. The arguments

[1] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 78.

[2] One can find a complete review of the late mediaeval debate on the limits of natural potencies in S. Caroti, *Nuovi linguaggi e filosofia della natura …* .

[3] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 86.

[4] One anonymous reviewer observed that my claim is *not correct*. I think that in doing so s/he overlooks the general context of my claim, for it refers exclusively to the *rationes* at the end of the *questio*, the fact I underlines in the next sentence. But for more clarity I want to add that the two questions together outlines the complete position of the Norman master about natural *minima* and *maxima*. Actually, contrary to what the anonymous reviewer claims, I do recognise that Oresme solves the arguments against his position in both questions (I, 10 & 11) almost without any reference to the authority of the Bible, as it is discussed below. Therefore, I do not overrate the importance of that passage in Oresme's work, because my aim is simply to outline the complex way Oresme conceives the relationship between natural and divine order by considering the different contexts in which he uses the passage from *Sapientia*.

[5] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 71.

supporting Oresme's position follow, bringing them from the *Physica*, where Aristotle criticizes Anaxagoras[1], and from *De sensu et sensibilibus*[2].

Finally, Oresme justifies his answer to the critics by some presuppositions: 1) first of all, *natural being* (a composition of matter and form) can mean either a pure element (air, water, earth or fire), or an imperfect inanimate mixed body (wood, stone), or even a perfect mixed animated body (man, horse), or finally a homogeneous or heterogeneous body; 2) then, a *minimum* is meant as an intensive minimum (qualitative *minimum*) or an extensive one (quantitative), as in case of the weakest degree of a quality. Just as Oresme debates the meaning of *minimum*, he rephrases the *titulum* of the question as follows: *utrum respectu cuiuslibet forme sit materia ita parva quod illa forma non posset esse sub minori nec etiam aliqua eiusdem speciei, sicut forma hominis vel aliqua talis*[3], that is to say, if there exists a *minimum quod non* in natural bodies.

Several *suppositiones* follow the above mentioned *distinctiones*. Oresme assumes that a perfect form such as the soul in living organisms is instantly generated, that is to say, it must be admitted that there is a first instant of the existence of such a form, and not a last one, as – according to Oresme's interpretation – Aristotle maintains in book VIII of the *Physics*[4]. Then, the Norman master explains that a perfect form can't exist within a quantity of matter as small as it can be, e.g. a man as small as he can be, or a grain of millet as small as it can be.

After these introductory remarks, Oresme draws his conclusions. First of all, as regards the forms of perfect living being (of a man, of a donkey etc.), he claims that, being generated, they have a natural minimum, in other words a man or a donkey can be generated in some definite quantity of matter and not in a smaller one. According to the second *suppositio*, if there is a first instant when a man exists, there is a minimum quantity of matter in which the form of a man can be introduced, otherwise such a form would be introduced before the generation of a man[5]. Oresme draws a second *conclusio* about the duration of a perfect form from this first *conclusio* and from the second and third *suppositio*: it must be admitted that there exists a certain quantity of matter below which a form can't perform its potencies, but above that quantity the form can in any case exist as long as such a quantity is not too huge or too wide[6].

In order to solve some objections addressed to his position, Oresme maintains that the natural minimum exists when an organism is still living, while in

[1] See Aristotle, *Physica* 187b13–188a4.

[2] See Aristotle, *De sensu et sensibilibus* 449a21–31.

[3] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 72.

[4] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 72. To tell the whole truth, Aristotle claims that there is a first instant when the form doesn't exist. See Aristotle, *Physica* 263b9–26.

[5] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 73: *Probatur, quia cum embryo cres<c>it et disponitur, tunc introducitur forma; et est dare primum instans in quo est homo per tertiam suppositionem, igitur illa materia est minima in qua potuit introduci. Consequentia tenet, quia, si posset in minori, tunc prius fuisset introducta, quia agens erat approximatum, quod est contra positum.*

[6] See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 74–75.

a corpse a form can exist below whatever quantity of matter. In that case, the perfect form turns into an imperfect one and the organism keeps the name it has when it was living only in an equivocal way (*equivoce*):

> *Iste conclusiones sunt ad intentionem Aristotelis contra Anaxagoram, qui ponebat generationem fieri per segregationem. Et tunc caro et os et talia possunt stare sub materia quantumcumque parva, ut patet in textu, quod est falsum, quia caro et os habent formas <per>fectas dum caro est viva; sed, si sit mortua, tunc non est dare minimam, quia tunc est forma im<per>fecta et non est caro nisi equivoce.*[1]

Finally, the Norman master highlights how different is the way imperfect forms exist. They are generated not according to a natural minimum, but gradually, according to the different parts of matter in which they are introduced. Their duration in time depends on their strength, which makes it possible for them to overcome the resistance opposed by other forms. After such introductory remarks, Oresme maintains that imperfect forms don't have any natural minimum, neither *simpliciter* nor due to the resistance of the contrary, their corruption being achieved gradually, as it is proved by the way warmth or whiteness changes. However, Oresme points out that imperfect forms never exist as separated from the whole being, that has a natural minimum, of which they are accidents[2].

In the following question (I, 11), Oresme debates the problem of if there is a minimum for any natural species, and for or against such a hypothesis he makes use of many arguments included in the previous question. Those for the hypothesis, which appear in the second part (*Oppositum patet*) are just the same ones brought from the *Physics* and *De sensu et sensato* mentioned above[3]. The answer to the issue of the *quæstio* begins with a distinction between four kinds of natural beings, from the imperfect to the perfect ones. At the lowest level one finds the *entia naturalia multum imperfecta*, such as relations or *insensible* accidents, as proportions or equivalences (Oresme informs us that someone thinks they are not really *res*, but only *modi rerum*). The *entia naturalia minus imperfecta* are accidental forms that correspond to sensible qualities (warmth, coldness and everything that is caused by the action of a substantial form). Raising towards the top of the hierarchy of beings, at the third level there are the elements and the *mixta imperfecta* or *inanimata*. Finally, at the top one finds the *entia naturalia perfectiora*, *sicut sunt res animate etc. ut homo, bos etc.*[4]

In his answer, Oresme follows the scale of the four degrees of beings. The *entia naturalia multum imperfecta* don't have a natural maximum, e.g. the *inequalitas* between two terms of a proportion can increase or decrease forever

[1] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 76.

[2] See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 76–77.

[3] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 79.

[4] N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 79.

more by the increasing or the decreasing of the quantity of just a term or of both of them[1]. Even health can improve forever more (to be perfectly healthy is to be infinitely more healthy than the one who is only partially healthy). Oresme points out for this reason that even if a perfect health can't be achieved (he means a permanent harmony between humours) *in istis inferioribus*, the hypothesis that a perfect living organism can exist must be admitted, otherwise Nature would make possible something which would never be fulfilled[2]. Finally, the Norman master adds a list of arguments about the speed at which alterations happen, which can itself increase or decrease forever more, even if in Nature there is an impassable speed, that of the last sphere of the Universe. In that list of arguments the *imaginary cases*, which are considered as the *brand* of Oresme's natural philosophy, are used. They correspond to events considered as possible if certain feature of natural beings are meant as abstracted from the things to which they usually belong[3].

Moving on to the accidental forms, the Norman master claims that they can't increase forever more, neither in extension (there is no infinite natural body), nor in intension (natural forms act according to a maximum degree). That is the evident result if one considers what Aristotle say in *On generation and corruption*. It is not clear what the passage is to which Oresme refers, maybe chap. 7 of book II, where Aristotle maintains that if a natural form exist in its perfect condition in a body, it reduces its contrary to the pure condition of potentiality without mixing with it[4]. No specific question is devoted to such an issue in Oresme's commentary on *On generation and corruption*, but he quickly hints at it in question 15 of book II, where he debates the problem *utrum quodlibet corruptibile habeat determinatam peryodum sue durationis*. It is necessary to consider the material substances which have a contrary to find a solution. In Oresme's opinion, such substances are corrupted only by their contrary. As long as the contrary doesn't act on them, they last without any limit, otherwise they would be corrupted by themselves, by a violent alteration due to the substance itself, which is naturally impossible[5].

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[1] See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 79–80: *Quantum ad primum, sit prima conclusio quod ubi tales relationes etc., verbi gratia ubi inequalitas potest augeri vel diminui in infinitum per <augmentationem vel> diminutionem aliquorum terminorum, tunc nullus est terminus in augmentatione seu diminutione accidentium seu denominationem consequentium aliquam inequalitatem. Patet statim, ex quo denominationes sequuntur inequalitatem que augetur et diminuitur in infinitum, ut patet exemplo: sit enim* a *linea dupla ad* b*, et* b *augeatur usque quod sit equale* a *vel econverso. Tunc illa inequalitas diminuitur in duplo, in quadruplo et sic in infinitum.*

[2] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 80.

[3] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 81.

[4] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 82; the passage of *The generation and corruption* comes from Aristotle, *De generatione et corruptione* 334b.

[5] See N. Oresme, *Questiones super de generatione et corruptione*, p. 296: *Omnis talis alteratio que est ad corruptionem est ab extrinseco. Probatur primo de simplici elemento, quod non potest se alterare violente, sicut ignis frigefacere se; et sic intelligitur dictum Commentatoris secundo* Physicorum *commento primo, scilicet quod non invenitur aliquod corpus simplex quod alteretur ex se. Similiter dico de mixto quia, sicut prius patuit, mixtum non habet in se qualitates contrarias, sed unam mediam. Secundo, quia nihil disponit ad suam corruptionem primo, quia omne ens naturaliter diligit se permanere.*

Accidental forms, such as warmth or coldness, have a natural maximum, and that means that they can naturally reach a degree of intensity, that is equivalent to the best condition (*in optima dispositione*) in which they can exist. Such forms determine the secondary ones (flavour, sound etc.)[1]. Here Oresme uses mathematical imagination as a conceptual tool to separate a mathematical analysis of physical events from a physical one. He raises the doubt that a sound can increase in intensity, turning acute forever more by gradually shortening a vibrating chord. This is mathematically but not physically possible: as a matter of fact, there isn't any available instrument on which a chord as short as it can be could vibrate. Oresme's position about the distinction between mathematically and physically *possible* is based on Aristotle's and Averroes' opinions. He quotes the Commentator's one, who maintains that in local motion speed can increase *in itself* beyond any limit, but not as the speed *of a moving body*:

> *<Licet> hoc sit ymaginabile mathematice, tamen non est naturaliter possibile, quia contingit devenire ad cordam ita parvam quod eius medietas non potest resonare, nec esset aliquid naturale quod posset eam percutere. Et per hoc patet solutio secundi argumenti, quia negatur quod raritas sive subtilitas augeatur in infinitum. Et ad Aristotelem quarto huius dico quod, licet mathematice subtilitas quantumlibet augeri <possit> per ymaginationem, tamen non in corpore naturali; et similiter dicit Commentator sexto huius, quod non repugnat motui locali in quantum huiusmodi velocitari in infinitum, tamen bene in quantum motus talis corporis.*[2]

Climbing the scale of natural beings, Oresme turns to inanimate substances, e.g. natural elements, and claims that by their nature they can increase extensively to infinity (for example, fire can gradually spread all around, if a combustible is added). However, *simpliciter et absolute*, there is a highest limit to such an increase, which is equivalent to the *optima dispositio* of a natural element, which is achieved when no external element unsettles such a condition. It is not the nature of the element, but rather the *ratio universi* that opposes its increasing to infinity:

> *Est dare aliquam mensuram ad quam non potest attingere, sed bene citra; patet, quia impossibile est esse combustibilia infinita, immo tota materia mundi est finita. Etiam, si ignis augetur comburendo aliquid, tunc materia occupat maiorem locum in igne quam in alio elemento* [...]*; cum una materia non possit occupare plus quam infima sphera lune, impossibile est quod omnia convertantur in igne<m>, adhuc*

[1] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 82.

[2] N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 82–83.

> *supposito quod essent ita breviter combustibilia sicut stuppa.*[1]

At the end of the question Oresme debates what *perfect things* are (like living substances), and takes man as an example of such substances. The single man cannot grow to infinity, because a limitless increase in size would be opposed to his peculiar (substantial) form. In fact living substances are defined by a certain shape and a certain quantity, otherwise there would be no distinction among individuals of the same species. Under certain circumstances, any living substance can improve its way of living, therefore it is not possible to maintain that it reaches *simpliciter* and *optima dispositio*, but at the same time, as it approaches to its perfect condition, its way of existing will be equivalent to such a *dispositio*, the distinguishing feature of which is a *debita mensura*; compared to it aberrations like gigantism or dwarfism can be defined[2]. Finally, there is a measure not only in natural things, but in artificial ones, too; it turned out to be evident by the case of the tower of Babel, that it couldn't stand a long time because of its enormous size, or by that of a town, that should be neither too big nor too small, as Aristotle and Vitruvius claim[3]. At the conclusion of the question, where Oresme puts an end to the debate and replies *ad rationes* above mentioned, the passage of *Sapientia* 11–21 is quoted.

ii) The order of nature is the measure of human praxis (*De moneta*, XVI; Aristotle's *Politics* VII, 9)

The second passage where *Sapientia* 11–21 is quoted in Oresme's works is chap. XVI of the Latin treatise *De moneta*[4]. The Norman master wrote it when he became Bachelor of Theology at the Navarre College, and where he was appointed chancellor in 1356. It has been mentioned above that Oresme wrote a French version of the treatise, too, as at the time he was a member of the royal council, being the dean of Rouen cathedral[5].

The passage of *Sapientia* 11–21 is mentioned as Oresme turns to consider the issue *quod lucrari in mutacione monete est innaturale*. The Norman master maintains that earning on the changing value of currencies is a peculiar example of injustice as such, in fact it is unnatural, since *injustice is somehow against nature*[6]. Some riches multiply, like seeds from which cereals grow, while it is

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[1] N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 83–84.

[2] See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 84–85.

[3] See N. Oresme, *Questiones super Physicam (Books I–VII)*, pp. 85–86: *Unde non convenit sic facere domum quantumcumque magnam, immo posset esse nimis magna, sicut docet Vitruvius in libro de* Architectura*; et patet de illis qui fecerunt turrim in Babilonia, unde videtur quod aut Deus aut natura non potuit pat tantam magnitudinem. Consimiliter civitas habet mensuram, et potest esse nimis magna, sicut dicit idem Vitruvius et Aristoteles in quinto* Politice.

[4] See *The* De moneta *of Nicole Oresme and English Mint Documents*, pp. 25–26.

[5] See *The* De moneta *of Nicole Oresme and English Mint Documents*, pp. x–xii.

[6] *The* De moneta *of Nicole Oresme and English Mint Documents*, p. 25: *Quamuis omnis iniusticia sit quodammodo contra naturam, uerumptamen accipere lucrum ex mutacione monete est quodam speciali modo iniustum innaturale.*

monstrous and unnatural that something which is sterile, like money, multiplies[1].

The Norman master quotes Aristotle and Cassiodorus to further back up his position. Aristotle proves in book I of the *Politics* that usury is against nature, because in its natural use money is a bare tool for exchanges. Therefore, it is unnatural that money produces money, because in that case it ceases to be a tool for exchanges[2]. Cassiodorus describes such a perverted use of money as a perturbation of the order of Nature and of Reason in a passage of his *Variæ* quoted by Oresme: *Talia ergo nature secreta uiolare, sic certissima uelle confundere, nonne veritatis ipsius videtur crudelis ac feda laceracio? Constet prius pondus ac mensura probabilis, quia cuncta turbantur, si integritas cum fraudibus misceatur*.[3] As regards just to that passage of *Variæ*, Oresme quotes the passage of *Sapientia* 11–21, in order to claim that it is forbidden to earn by merely changing currencies or by speculating on the interest on loans. To earn in that way means to ignore divine and natural order:

> *Rursum in libro Sapiencie dicitur quod omnia Deus disposuit mensura, pondere et numero, sed in mutacione monete lucrum non capitur, nisi fraus in istis rebus certissimis committatur, sicut prius declaraui. Ergo Deus et natura derogat, qui sibi ex huiusmodi mutacionibus lucrum captat.*[4]

Oresme translated Aristotle's *Politics* into French with a commentary for the king of France, Charles V, and in the French version it is included the third passage in which *Sapientia* 11–21 is quoted. The translation was completed during the period 1371–1377, when the Norman master was a member of the council of the king. The quotation is in chap. 9 of book VII, which is about the perfect size of a town, an issue debated by Aristotle in chap. 4 of the same book VII of his treatise on politics[5]. Oresme analyzes the passage of the *Politics* in which Aristotle claims that it is very hard, even impossible, that a huge multitude of men be ruled by laws, because no man is provided with prudence and potency such that he is able to rule a multitude of individuals as big as it can be. At the end of chap. 9 he specifies that a huge multitude of men governed by only an authority can't really be a city, but rather *comme une geant ou un grant païz*, which can't be ruled by natural means (*impossible naturelment*)[6]. Therefore, it is necessary to part them in small groups entrusted to different authorities.

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[1] See *The* De moneta *of Nicole Oresme and English Mint Documents*, p. 25.

[2] See *The* De moneta *of Nicole Oresme and English Mint Documents*, p. 26 & Aristotle, *Politica* 1258b4–8.

[3] *The* De moneta *of Nicole Oresme and English Mint Documents*, p. 26. See also Magni Aurelii Cassiodori *Variarum libri duodecim* I, 10.

[4] *The* De moneta *of Nicole Oresme and English Mint Documents*, p. 26.

[5] Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, pp. 287–289. See also Aristotle, *Politica* 1326a26–1327b10.

[6] See Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, pp. 287–289.

Then, the Norman master addresses his attention to the passage in which Aristotle maintains that ruling a multitude as big as it can be is a divine task. In Oresme's opinion, only God's potency can accomplish such a work, in fact such a potency settles the world itself[1]. Aristotle keeps on debating that topic by a general definition of *good*, which concerns everything arranged and determined according to numerousness and size. Just at that point, Oresme quotes the passage from *Sapientia – Omnia numero, pondere et mensura disposuisti* – in order to finally explain Aristotle's opinion: what is good is as such according to its nature[2].

The Norman master points out that measure plays a crucial role in the development of a political community (*cité*), and puts his analysis in the conceptual framework of Aristotelian political thought: a city is a sort of living organism and is ruled, *mutatis mutandis*, by the same laws as natural beings. He quotes the passage of the treatise *On the Soul*, chap. 4 of the book II, in which Aristotle maintains that alteration and growth of a body are due to the soul, because it is the origin and the formal cause of life[3]. Sometimes the nature of a natural being is accomplished in an imperfect way. For this reason, Oresme notices that the Greek philosopher's examples as regards politics are frequently taken from the range of artificial things. It is true that a city is a natural organism, but it is likewise true that sometimes art and prudence rule a city, besides the natural laws that spontaneously *govern* it: *Apres il met exemple des choses faictes par art; car cité est chose naturele, si comme il appert par le secont chapitre du premier, et aucunement artificiele en tant comme par art et prudence elle est adrecié a sa policie.*[4]

It is clear that the quotations of *Sapientia* 11–21 in the treatise *De moneta* and in the French version of Aristotle's *Politics* are joined together by the idea that the natural order settled by God according to *measure, number and weight* is the general rule by which human praxis can be assessed. The way a man behaves has to adapt to such an order, if a man wants to achieve happiness, both individual and social. Such a natural order is placed within a divine one, but while the latter is always provided with beauty and harmony, the former does only sometimes, therefore human mind can't gather the divine beauty. That is

[1] See Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, p. 288: *La divine cognoissance et puissance ordene tout le monde. Mes nulle cognoissance ne puissance humaine ne souffist pour ordener de tous les hommes du monde, si comme il sera apres declaré plus a plain.*

[2] See Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, p. 288: T. [*scil*. traduction] *Item, ce qui est bon est acoustumé estre fait et determiné en multitude et en magnitude ou quantité.* G. [*scil*. *glosse*] *Certain, selon la nature de la chose. Et pour ce di le Sage que Dieu a disposé toutes choses en nombre, en pois et en mesure: Omnia numero, pondere et mensura disposuisti (*Sap. *11–21).*

[3] See Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, p. 288. In the passage mentioned in the previous footnote, Aristotle maintains that alteration and growth are caused by the soul, because nothing grows and develops without nourishment, nothing is felt without taking part in life, and the origin of life is soul. See Aristotle, *De anima* 415b25. Oresme infers out of such a principle that each natural being has a maximum quantity and a measure of its growth. He maintains it in question 11 of book I of his commentary on the *Physica*, in a passage where he uses quite the same lines of the *Soul* to support such a position. See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 83 & Aristotle, *De anima* 416a15–17.

[4] Maistre N. Oresme, *Le Livre de* Politiques *d'Aristote*, p. 289.

exactly what Oresme claims in his treatise *De commensurabilitate et incommensurabilitate motuum celi*, where the passage from *Sapientia* is quoted in order to mark precisely the limits of human knowledge about the divine plan of creation[1].

iii) *Sapientia* between *Aritmetica* and *Geometria* (*De commensurabilitate et incommensurabilitate motuum celi*, part III)

The passage from *Sapientia* 11–21 is quoted twice, which are the fourth and fifth references respectively, in the third part of the famous *TDCIMC*[2]. From a theoretical point of view, this is the most important context among those including that passage. It is used by the personifications of Arithmetic, in order to claim that celestial motions are necessarily commensurable, and of Geometry, which proves that *Sapientia* 11–21 neither rules out that those motions are incommensurable, nor does it contradict the concept of *natural order*.

It is well–known that in *TDCIMC* the Norman master tries to answer to the question if celestial appearances (*configurationes*) recur periodically in the same positions on the heavenly vault. The solution of such a problem is crucial in order not only to determine the world order, but to decide upon the observational grounds of astrological predictions, too. The first and second part of *TDCIMC* are arranged according to the rules of the Euclidean axiomatic method and concern respectively the consequences of the hypothesis of commensurable celestial motions and those of the opposite hypothesis. As Oresmes states it, different celestial motions are commensurable, if in a measurable time interval the ratio either between the values of angles in the centre subtended by the circumference's arcs outlined by the compared motions, or between the number of times of recurring *circulationes* (their coming back to the same point) is equivalent to a rational fraction[3]. The mathematical analysis of celestial motions consists in the study of the ratios of their speeds, in order to calculate when a *configuratio circulationum* recurs. Each speed is a ratio of a motive force to a resistance, then a ratio of speeds is a *ratio of ratios*. As it results in the treatise *De proportionibus proportionum*, it is more likely that such a *ratio of ratios* is irrational rather than rational. Therefore, it is likely that celestial motions are incommensurable.

Oresme widely uses *Bradwardine's law of motion* in his analysis. To explain it in modern terms, in a certain range of time, from t_1 to t_2, the ratio of

[1] According to one anonymous reviewer, the passage of *Sapientia* 11–21 *doesn't play a decisive role* in Oresme's *Tractatus de moneta*, and as regards the use of that passage in *TDCIMC*, which I am going to analyze and discuss, s/he adds: Sapientia *11–21 is not central to the discussion, but only some kind of accessory*. I think that in any event it really doesn't matter if such a passage plays or doesn't play any role in Oresme's position either against some monetary practices or on the commensurability or incommensurability of celestial motions. The general aim of the present paper, as I explain in the introductory footnote, is to show the way Oresme conceives the relationship between natural and divine order from a particular point of way, i.e. the use he makes of *Sapientia* 11–21 in some of his works. From that point of view I agree with the anonymous reviewer: the use of that passage is accessory, which means that the authority of the Holy Bible makes it possible to establish on venerable grounds an original point of view about the general concept of *order*.

[2] See *Nicole Oresme and the Kinematics of Circular Motions*, pp. 284–323.

[3] See *Nicole Oresme and the Kinematics of Circular Motions*, proemium, p. 32, p. 174 & p. 212.

the relative speeds (V_2/V_1) of a moving body is equal to the ratio of the ratio of the motive force to the resistance in t_2 (F_2/R_2) and the ratio of the motive force to the resistance in t_1 (F_1/R_1), that is to say: if $V_2=2V_1$, then $(F_2/R_2)=(F_1/R_1)^2$. To explain it in mediaeval terms, if the speed of a motion doubles or triples, the values of the corresponding motive force and resistance change according to a *dupla* or *tripla* proportion, being a *dupla proportio* a *continua proportio* of three variables, e.g. *x*, *y, z* such that $x:y=y:z$, or $x/z=(y/z)^2$, and a *tripla proportio* a *continua proportio* of four variables, e.g. *x*, *y*, *z*, *r*, such that $x:y=y:z=z:r$, or $x/r=(z/r)^3$ etc.[1]

In the treatise *De proportionibus proportionum*, Oresme terms *irrational ratios* the results of the raising rational numbers both to rational powers and to irrational powers (that is to say, fractional powers). But he considers the first type of ratio commensurable, and the second one incommensurable. As a matter of fact, in the first type of ratio it exists a common ratio between, e.g. A and B, if $A=(B)^n$, and *n* is a rational power, while, if *n* is a fractional power ($n=r/s$), such a common ratio doesn't exist[2]. Oresme proves that, among *n*–ple proportions, from *dupla proportio* to the 101st one, it is more likely that whatever the *proportio proportionum* is taken, it is incommensurable rather than commensurable:

> *Sumantur enim secundum ordinem suarum denominationum 1000 proportiones in genere multiplici sicut dupla, tripla, quadrupla, quintupla, et cetera, usque ad 101am et sint sicut 100 termini ad invicem comparati. Tunc inter huius terminos seu proportiones comparando quemlibet cuilibet sunt 4950 proportiones que sunt proportiones proportionum et illarum 25 sunt rationales et non plures et omnes alie sunt irrationales sicut postea declarabo.*[3]

Therefore, it is probable that celestial motions are incommensurable. But exactly for the reason that this conclusion is only probable, there is no definitive answer to the question asked in *TDCIMC*. Geometry hints at such a conclusion at the end of the third part of the treatise, where Oresme imagines to fall asleep, deprived after his long analysis in the previous books of an answer that satisfies *quod plus appetit intellectus*. Apollo visits him and scolds the Norman master, for dealing with a question that vexes the mind, trying to answer to which is an never–ending effort. Human knowledge is grounded in sensations and, as regards celestial motions, any variations of observations could change the answer to the question: *Are they commensurable or incommensurable?* Oresme should give it up: neither arithmetic, nor geometry can help him to solve the

[1] See T. Bradwardine, *Tractatus de proportionibus*, p. 78.

[2] See N. Oresme, *De proportionibus proportionum* ... I, p. 160.

[3] N. Oresme, *De proportionibus proportionum* ... III, pp. 246–248. Also ch. IV, p. 302: *Propositis quibuscumque duobus acquisibilis per continuum motum quorum proportio sit ignota verisimile est illa esse incommensurabilia. Et si plura proponantur verisimillius est aliquod alicui incommensurabile fore. Et de duobus temporibus contingit hoc idem affirmare et de quantitatibus continuis quibuscumque.*

problem, and proportions between celestial motions are bound to remain unknown[1].

The Norman master tells Apollo that he doesn't presume to solve the problem through any mathematical proof, but human nature has been created in such a way that it craves to know the truth and to fall in depression if it remains in a condition of uncertainty. For that reason, he asks for a conclusive answer from the divine wisdom, in the form of a revelation[2]. At that point Apollo gets an ironical glimpse of the *musas et scientias circumstantes*, and asks Arithmetic and Geometry for reasons supporting a conclusive answer to the question about the ratios of celestial motions. A debate between them begins: Arithmetic claims that celestial motions are commensurable, while Geometry maintains that they are incommensurable. Apollo exhorts them to argue their positions, and Arithmetic takes the floor[3].

The *oratio Aritmeticæ* recalls the opening line of the final part of Thomas Bradwardine's *Tractatus de proportionibus*, where the right law of the change of speed is proved: the well–led mind lets the fog of ignorance disappear and reveals the truth in its whole brightness[4]. Arithmetic highlights that incommensurability would deprive perfection to the Universe, it would reduce the beauty of Heavens, and finally it would ruin mankind which would remain ignorant about the proportions of celestial motions. Even if Arithmetic admits that it isn't suitable for mathematical disciplines to debate about goodness or value, it is evident that some shapes (the circle, for example) and some numbers (e.g. 3) are better than others, as Aristotle and Pythagoras maintain. The hierarchy among shapes and numbers is grounded on some ratios between the magnitudes they are made up of. We tend to consider rational proportions as *digniores* than the irrational ones almost by natural inclination[5].

Celestial motions are the better and the more beautiful ones in Universe, therefore they must be linked by rational ratios. Beautiful and harmonious things always come out of some kind of proportion between the elements which they consist of. That is valid at the lower level of knowledge, that is to say of sensibility: if something amuses the sight, the hearing, and the taste, it means that such a thing is made of rightly mixed elements. Even more so is it valid in the Heavens. Irrational ratios are unsuitable for our minds, and once again even more so for the celestial intelligences that move the Heavens: if they moved

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[1] See *Nicole Oresme and the Kinematics of Circular Motions*, pp. 284–286.

[2] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 288: *Si itaque per inventionem nostram multa scire non possumus, oro ergo ut hoc unum dubium per vestram doctrinam mihi de benigna gratia reseretur.*

[3] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 288.

[4] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 288: *O veritatis actor eterne et defensor invicte te decet erroris efflare nebulas et obscuras ignorantie mentis tenebras effugare ut studiosis ingeniis veritatis splendor irradiet ipsius que sinceritas equitate tui iudicii patefiat divina auctoritate fermata ne quisquam ulterius de mundi mensura sapiat seu audeat affirmare de dignis rebus indigna.* See also T. Bradwardine, *Tractatus de proportionibus*, pp. 110–112: *His igitur ignorantiae nebulis demonstrationibus flatibus effugatis, superest ut lumen scientiae resplendeat veritatis. Scientia autem veritatis ponit quintam opinionem, dicentem quod proportio velocitatum in motibus sequitur proportionem potentiae motoris ad potentiam rei motae.*

[5] See *Nicole Oresme and the Kinematics of Circular Motions*, pp. 288–290.

celestial bodies irregularly, they couldn't be admired. The harmony among celestial intelligences comes from the creator of the Universe, who would behave as a bad architect (one who doesn't fulfil his work according to the plan in his mind), if he didn't ensure order in the Universe. Just at that point of the *oratio Aritmeticæ*, Oresme quotes the passage from *Sapientia* 11–21:

> *Et si irrationalis proportio nostro disconvenit et displicet ingenio quomodo ponemus intelligentias motrices vitam ducentes optimam tam inamena et tristabili disparitate movere que tamen in agitatione et plausu orbium summo gaudio delectantur? Nam et si quis faceret horologium materiale nonne efficeret omnes motus rotasque commensurabiles iuxta posse? Quanto magis hoc opinandum est de architectore illo qui omnia fecisse dicitur numero, pondere, et mensura? Nulla autem incommensurabilia sint numeris mensurata.*[1]

It is remarkable that in the final lines of the above quoted passage, Arithmetic claims that one can't find incommensurable magnitudes among numbers, that is to say discrete quantities, which are its specific topic, while continuous quantities make up the field of geometry. It is an important passage from a historical point of view, because it reminds us that, even if the concept of *real number*, and that of *non–countable* sets of numbers are far away from being precisely defined in the late Middle Ages, the distinction between discrete quantities, considered by arithmetic, and the continuous ones, treated by geometry, is clearly outlined and should be taken carefully into account, in order to avoid considering as merely rhetorical means (that is to say, used for practical purposes) the *orationes* of Arithmetic and Geometry.

The Norman master quotes Plato and Boethius besides the passage of *Sapientia*. Both think that there can't be incommensurability in the Universe, where bodies are made of primary elements originally made according to perfect proportions. Aristotle is quoted by Oresme, too, because he highlights that disharmony in natural phenomena is always the clear proof of their separation from a divine condition, to which celestial bodies are close. Finally, Oresme quotes Jordanus de Nemore, who regularly used mathematics in natural philosophy in his studies on the change of weight in bodies, and that would be totally useless, if the world weren't ruled by some ratios of proportionality between its primary elements[2].

There follows a long section of the *oratio* in which Arithmetic initially clarifies that the mundane music couldn't be played, if there weren't any ratio of proportionality among sounds. Then she turns to the celestial music played by the spheres in their motions: their motions have to be commensurable, if they produce such a harmony that human ears can't perceive, which is however

[1] *Nicole Oresme and the Kinematics of Circular Motions*, pp. 290–292.

[2] See *Nicole Oresme and the Kinematics of Circular Motions*, pp. 294–296.

animo intelligibilem mente capabilem[1]. Such a music wraps everything up: it is directly caused by the motion of the heavens, but its distant, and original cause is the soul of the world, that gives life to everything according to Macrobius[2].

Finally, Arithmetic turns to consider the possible consequences of the incommensurability of celestial motions. It would make astrological predictions impossible, because *non erit* [...] *inter mathematicas numeranda*[3]. It would be even impossible to measure time, which is, according to the famous Aristotelian definition, *the number of change* [i.e. motion] *with respect to before and after*, or, *materialiter* meant, the number of the motion of the more external sphere, which comes periodically back to the same appearance in the Heavens at the end of the so–called *Great Year*. If astrological predictions were really impossible, the mere idea of a divine order in the Universe established by God would be called into doubt:

> *Si est ita, nullus poterit umquam aspectus precognoscere, coniunctiones predicere, previdere effectus. Ymo latebit astrologia omni evo incognita ac etiam inscibilis ut probatum est ante; non erit igitur inter mathematicas numeranda. Et si velocitates celi sunt incommensurabiles et inscibiles, cur mundi opifex 'os homini sublime dedit celumque videre iussit et erectos ad sidera tollere vultus'?*[4]

Once Arithmetic's speech is concluded, Geometry's *oratio* for the incommensurability of celestial motions starts. First of all, Geometry notices that the *oratio Aritmeticae* is *verborum prodiga, sententie parca* and for that reason it makes no sense to reply point by point to her rival. A brief answer is enough[5]. Geometry maintains that the magnificence of the heavens shines with great strength, because celestial motions are indeed partly commensurable, partly incommensurable, i.e. because they are more variable than one usually expects. As a matter of fact, each circular motion results from a mixture of both regularity and irregularity: it is varied in each of its parts, uniform in the order of time. To sum up, beauty results from variety: just as in a song variations make the melody sweeter, and in painting different shades make a picture more pleasant than only one colour uniformly applied on the whole painted canvas, in the same way the mixture of elements on Earth is better than any pure element

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[1] *Nicole Oresme and the Kinematics of Circular Motions*, p. 298.

[2] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 300: *Nunc revertor ad Macrobium qui postea dixit: 'Ipsa autem mundi anima viventibus omnibus vitam ministrat': 'Hinc hominum pecudumque genus viteque volantum et que marmoreo fert monstra sub equore pontus'. Iure igitur capitur musica omne quod vivit quia celestis anima, qua animatur universitas, originem sumpsit ex musica. Hec dum ad speralem motum corpus mundi impellit sonum efficit 'qui intervallis est distinctus imparibus sed tamen pro rata partium ratione distinctus', hec ille.*

[3] *Nicole Oresme and the Kinematics of Circular Motions*, p. 304.

[4] *Nicole Oresme and the Kinematics of Circular Motions*, p. 304. In the above mentioned passage Oresme refers to Ovidius, *Metamorphoseon libri* I, 83–86.

[5] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 310.

taken apart, and the Heavens are more beautiful such as they really are, than if stars were arranged regularly in an unchangeable order[1]. It is at that point that Geometry quotes the passage of *Sapientia* 11–21 replying to Arithmetic, noticing that her rival paid attention only to number as the origin of order in the Universe, while she forgets completely the measure:

> *Sic etiam celorum machina nullo carens decore tali varietate componitur ut corpora numero singulumque eorum pondere, id est magnitudine, motusque mensura constent. Que mensura si esset numeralis frustra videretur dictum numero et mensura. Hec ergo mensura ad continuitatem illam refertur que non potest per numeros dimetiri. Et dum eam comprehendere non possumus ipsam irrationalem et incommensurabilem appellamus. Solet si quidem sepe contingere ut homo subtilis in multa variatione pulchritudinem percipiat cuius diversitatis ordinem homo rudis non advertens totum estimat fore confusum, sicut irrationalem proportionem vocamus quam nostra ratio capere nequit. Et ipsam tamen distincte cognoscit dei ratio infinita et divino conspectui loco suo posita placet celestesque circuitus efficit pulchriores.*[2]

The passage just mentioned plays a crucial role in the present analysis, for two reasons that could help us to get the general meaning and value of part III of the *TDCIMC*, which is considered an ethical text, while its value is indeed mostly theoretical. To begin with, Geometry distinguishes discrete magnitudes, such as numbers, which concern celestial bodies, from continuous ones, which concern the motions of these bodies. From a pre–modern point of view, irrationality doesn't *reside* among discrete magnitudes, but among those continuous, and that makes Geometry a higher mathematical discipline than Arithmetic: all the proportions one can find among numbers, can be found among magnitudes, but not vice versa. And after all, uncountable proportions between magnitudes don't deprive Arithmetic of its beauty and its importance in the study of celestial motions[3]. Only *dei ratio infinita* knows the whole order of the Universe is known in its precise measures[4].

The beauty of the Universe is for the most part hidden to the human eyes because of the limits of the human mind, i.e. for epistemological and not for ontological reasons. The man can't see the whole beauty of the Universe, but

[1] See *Nicole Oresme and the Kinematics of Circular Motions*, pp. 310–312.

[2] *Nicole Oresme and the Kinematics of Circular Motions*, p. 312.

[3] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 312: *Ad hoc autem quod arguit nos sibi facere iniuriam et de primogenitura qua se dicit precellere, respondemus quod nullam mensuram nullam proportionem habet in numeris quam non habeamus in nostris magnitudinibus et cum hoc infinite alie reperiuntur in continuis quarum nulla invenitur in numeris. Habemus igitur quicquid habet et multo plus que ergo est primogenitura sua. Nec etiam proportiones numerales privamus a celo. Sed si cum eis in celo ubi omnia relucent sunt alie nullum inde patitur Arismetica detrimentum.*

[4] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 312.

that doesn't mean that such a beauty doesn't exist. Even Geometry's criticism as to the origins of celestial music is grounded on the distinction between discrete and continuous magnitudes: such a music is produced not by the proportions between the speeds of celestial bodies, but by the quantity of matter of those bodies, or by their forms, or by the air celestial bodies move, that is to say by bodies, which are numerable quantities[1]. Therefore, the harmony of celestial music is due to the *commensuratio corporum*, and not to the *commensuratio motuum*. Finally, Geometry claims that for the same reasons the beauty and the perfection of Universe consist precisely in the variety of its events, which is more suitable to the creative divinity than a monotonous uniformity: the innumerable sequence of ages and of the corresponding astrological configurations delights the soul and shows the greatness of the creator, just as the variety of the modulations of voice in a song gives joy[2].

Geometry has proven that there is no contradiction between the incommensurability of celestial motions and the beauty of the Universe in such a convincing way as Arithmetic has proved the opposite theory, but she proves in an even better way that the incommensurability doesn't entail the total ignorance of man about the celestial motions. An error of a few seconds or even of a few minutes of a degree in calculating the return of a celestial arrangement doesn't make it impossible to foresee such a return at a satisfying degree of accuracy. And after all, *ut ait Plinius 'celi mensura non venit in digitos'*[3]. Geometry adds that in any discipline the intellect is motivated to increase its knowledge by what is left unknown, and such an *awakened* ignorance makes even sweeter the understanding of a subject, and it prevents man from getting arrogant. God alone keeps in himself the secrets of nature, while man deludes himself into thinking himself to be able to catch those secrets at the highest degree of accuracy: *Melius ergo fuit ut de rebus tam excellentibus aliquid esset scitum et semper restaret aliquid ignotum et ulterius inquirendum quod quadam pregustata dulcedine generosos animos a terrenis abduceret et excitato desiderio perhemniter detineret in tam alti negotii venerabili exercitio occupato.*[4]

It is well–known that Apollo's verdict, that should have settled the debate as a divine revelation and for which Oresme has eagerly waited, isn't declared. The worried mind of the Norman master is not satisfied by a conclusive answer. In fact, the dream vanishes, just when the god announces that *processus* [...] *et causas earum visitabimus, inde statim pronuntiabimus in figura iudicii veritatem*[5]. The third part of *TDCIMC* was interpreted for more than fifty years, from

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[1] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 314.

[2] See *Nicole Oresme and the Kinematics of Circular Motions*, p. 316: *Qua propter iocundius atque perfectius videtur et etiam divinitati convenientius quod non totiens repetatur idem sed quod novas et dissimiles prioribus constellationes effectusque varios semper producat ut illa seculorum prolixa series, quam Pictagoras per cathenam auream intellexit, non redeat in circulum sed recte procedat sine fine semper in longum quod tamen non fieret absque aliqua incommensurabilitate motuum celestium.*

[3] *Nicole Oresme and the Kinematics of Circular Motions*, p. 318.

[4] *Nicole Oresme and the Kinematics of Circular Motions*, p. 320.

[5] *Nicole Oresme and the Kinematics of Circular Motions*, pp. 320–322.

Duhem, who analyzed it in his *Système du monde*, to Grant, who edited and translated into English Oresme's treatise in the mid–60s, and Molland, as the best example of Oresme's skeptical attitude towards the human mind's possibilities of understanding the order of the Universe.

More recently, Max Lejbowicz proposed a different interpretation. In a couple of articles about Oresme's *TDCIMC*, he considered the third part both in its cultural value, and in its aim, too[1]. Oresme wrote mathematical treatises in an Euclidean style during the period at the College of Navarre as a cultural choice, because he wanted to emphasize the distance from the method of *quæstiones*, and consequently from the typical university scientific research, by choosing a more rigorous method, and at the same time he marked his distance from a cultural milieu he had left behind from the early 1360[2]. Lejbowicz sees the third part of *TDCIMC* as rather strange, not only in the context of the whole treatise, but also in the evolution of the Norman master's thought. In his opinion its eccentricity is due to the target of Oresme's critics, that is to say astrology, which is criticized in the *oratio Geometriæ* as *techne* and not as *episteme*. He was sure that astral effects are real, but they can't be foreseen using the data about celestial appearances.

However, Oresme was also engaged in the political troubles of the kingdom of France at the time of the most severe crisis following the first phase of the Hundred Years War. He wanted to teach the king to be prudent and not to trust in human abilities to foresee the future, and he glorified for him politics as the most important science, because its aim is to protect the harmony of the *polis* by the only concrete intellectual tool is available to man, that is to say persuasion. To sum up, according to Lejbowicz, the third part of *TDCIMC* has a political, and not an epistemological significance: Oresme seeks to make science work for creating relationships based on the awareness of the limits of human knowledge.

Lejbowicz's interpretation is not completely persuasive. As a matter of fact, it gives too much attention to some passages of the third part of *TDCIMC*, for example the one in which Apollo, after Arithmetic's and Geometry's speeches, exhorts Oresme to give a good measure to the arguing between the personifications of the two mathematical disciplines, and to understand its mere rhetorical value (*Ne, inquit, estimes veram esse discordiam inter istas evidentis veritatis clarissimas genitrices seriose. Enim ludunt et inferioris scientie stilum deludunt*[3]). Lejbowicz completely overlooks, if not even misunderstands Oresme's distinction between the commensurability of quantities of celestial bodies, and the (probable) incommensurability of the measures of their motions. He believes it is an incomprehensible inconsistency in Oresme's theory, while

[1] See M. Lejbowicz, *Argumentation oresmienne et logique divinatoire ...* . See also M. Lejbowicz, *Logique, mathématiques et contre–acculturation ...* & M. Lejbowicz, *Nicole Oresme 'spectateur engagé'*.

[2] See M. Lejbowicz, *Logique, mathématiques et contre–acculturation ...* , pp. 225–229 & M. Lejbowicz, *Nicole Oresme 'spectateur engagé'*, pp. 48–52.

[3] *Nicole Oresme and the Kinematics of Circular Motions*, p. 322.

it is indeed, as it has been previously explained, a crucial distinction based on the difference between discrete and continuous quantities.

It is better to restore the epistemological significance of the third part of *TDCIMC*. And after all, Lejbowicz himself in his final article on the Norman master agreed with Duhem and Quillet[1]: Arithmetic's and Geometry's *orationes* mark the passage to a *désenchantement* of nature and any symbolic references to what is beyond it disappears from nature itself[2]. Such a passage is coupled with an attitude of *moderate skepticism* concerning the abilities of the human mind to understand the laws of the Universe[3].

The awareness of human weakness opens the door to *imaginatio* in the field of natural philosophy, which is actualized by the extensive use of mathematics in that field. There are plenty of *mirabilia* in nature, which shouldn't be considered as the results of perceptive mistakes, but as phenomena which can be known at a certain degree of probability[4]. From that point of view, the distinction between discrete and continuous quantities, on which the Norman master insists, achieves a great value in *TDCIMC* most of all in its final part: the *rationes* between incommensurable magnitudes can be precisely known only by an infinite mind, that is the divine one, which lives in the infinite extracosmic space[5]. Man should be happy with knowing them at a certain degree of accuracy.

3. Conclusion

The way Oresme quotes and uses for his purposes the passage of *Sapientia* 11–21 appears at a first sight incoherent, but such an impression vanishes, as the conceptual content of the third part of *TDCIMC* is carefully considered. The different quotations are connected in the framework of the ethical aim of the whole intellectual work of the Norman master, as Lejbowicz, Celeyrette, and more recently Grellard have maintained[6]. Oresme can certainly be considered

[1] Lejbowicz died in 2015; he published his last work on Oresme in 2014.

[2] See M. Lejbowicz, *Nicole Oresme 'spectateur engagé'*, pp. 60–61.

[3] I dare use the term *skeptic* as regards Oresme's attitude towards the limits of human knowledge. Even after having carefully considered Grellard's warning about the equivocal use of *skepticism* employed in the context of late mediaeval philosophy, I think that, at least in a restricted sense, it portrays Oresme's epistemology. Therefore, the term may be used taking *some precautions*. See C. Grellard, *Y a–t–il une tradition sceptique au Moyen Âge?*, p. 205: *Le recours à la méthode* a posteriori [...] *permet de faire emerger la ou les formes médiévales du scepticisme. Celle–ci se caractérisent par un important recours à Cicéron (et pas seulement à Augustin) et par la défense d'une épistémologie faillibiliste (notre savoir n'est jamais définitif, il est toujours révisable). Dans cette perspective, Jean de Salisbury est sans doute le principal représentant du scepticisme médiéval* [...]. *D'autres formes de faillibilisme, qui ignorent la référence à Cicéron, en particulier au XIV*[e] *siècle (Autrécourt, Oresme) ne devraient sans doute être rattachées au courant sceptique médiéval sans quelques précautions.*

[4] According to Lejbowicz and Quillet, Oresme wrote the treatise *De configurationibus qualitatum et motuum* and some *questiones quodlibetales* in order to explain how to correct those perceptive mistakes.

[5] See N. Oresme, *Questiones super Physicam (Books I–VII)*, p. 463: *Ante mundum Deus poterat alicubi facere mundum, unde illud quod est extra mundum forte est alterius rationis a loco qui est in mundo, sicut etiam est de duratione.* As regards Kirschner's analysis of that aspect of Oresme's natural philosophy see S. Kischner, *Oresme's Concept of Place, Space, and Time ...* , pp. 164–170, esp. p. 168 for the identification of God with the immensity of the extracosmic space and p. 169 for consequently the non–dimensionality of such a space.

[6] See J. Celeyrette & C. Grellard, *Introduction*, p. 20 & M. Lejbowicz, *Argumentation oresmienne et logique divinatoire ...* , pp. 173–176. Even C. Grellard, *Probabilisme et approximation du vrai au XIV*[e] *siècle ...* doesn't

an *engagé* scholar, as it results from the preface of his translation of Aristotle's *Politics*, where he says that *there is no other higher science apart from politics*, and he entirely agrees as to the cultural challenge of the king of France, Charles V, who considers knowledge as a mean to create harmony in the *cité*.

Taking Lejbowicz's opinion as valid, we have to admit that even the use of mathematics in the Norman master's works has an ethical and political meaning, which can partly explain why Oresme's way of thinking seems so eccentric in late mediaeval philosophy. Modern scholars presume that such an extensive use of mathematics is a reaction to the method of *quæstio*, with which the Norman master was dissatisfied and to which he opposed the treatise as the best form of philosophical debate[1]. After the years at the Arts' Faculty in Paris, Oresme regularly wrote treatises besides the translations of Aristotle's works, but during the Parisian years he had stood out for his peculiar style of debating, which combined arguments based on experience with examples taken from mathematics[2]. In conclusion, even the extensive use of mathematics has a political aim: to rebuild knowledge and, at the same time, civil life on new grounds.

However, Lejbowicz's theory should be more carefully debated, because it overlooks the theoretical content of Oresme's theory about the limits of the human mind to know the order God decided to give to nature. I think that by regularly using mathematics in the field of natural philosophy Oresme aimed to fulfil not only ethical and political purposes, but some others of a different kind, too. Such a regular use is really peculiar, and it shows that Oresme was one of a kind as a philosopher. Jordanus de Nemore and the Oxford Calculators restricted the use of mathematics within the limits of specific issues, respectively, science of weights and proportions of speed of motions[3], while Oresme broadened it to so many different aspects of natural philosophy, that the results he achieved lead him to think that the human mind can't finally know the order of the Universe. As Grellard observes, such a skeptical attitude is due to the fact that the exactitude of mathematical proofs, which is ensured by the degree of evidence of their principles and the precision of mathematical method, can be achieved rarely in natural philosophy, more rarely than in imaginary cases. Thus, the essential limits of the human mind compared to the divine one comes completely to light[4].

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realize that the key difference between Oresme, on one side, and in the context of that article, Buridan, and Gerson, on the other one, is that the Norman's *probabilisme* is not merely a rhetorical device but an attitude firmly grounded in the relationship between natural philosophy and mathematics.

[1] See M. Lejbowicz, *Logique, mathématiques et contre–acculturation* ... , p. 215 & pp. 226–229.

[2] About that aspect of Oresme's style, see J. Celeyrette, *L'argumentation mathématique* ... .

[3] About the debate on the relationship between Oresme and the Oxford *Calculatores*, see e.g. E. Mazet, *Richard Swinshead et Nicole Oresme* ... , pp. 105–137 & E. Mazet, *Quelques aspects* ... , pp. 103–129.

[4] See C. Grellard, *La théorie de la croyance de Nicole Oresme*, p. 222: *La plupart de nos connaissances, en effet, ne remplissent pas les standards scientifiques exigés par l'épistémologie médiévale héritée d'Aristote. Il faut donc chercher, non pas l'évidence parfaite qui garantisse la vérité, mais une certitude suffisante, ponctuelle, délimitée et réversible. On peut donner des règles permettant d'identifier les croyances fausses, mais il est plus difficile de déterminer positivement et à priori ce qui doit être cru*.

It turns out from the quotations of *Sapientia* 11–21 a peculiar *metaphysics of natural order*, I mean an idea of the divine order that transcends, supports and directs the natural one in a way that could be summarised as follows:

(1) In the field of Nature, *maxima* and *minima naturalia* make us merely glimpse an order God wanted to give to nature, at such a measure that it should lead human praxis towards the achievement of human happiness.

(2) Beyond that order it is possible that another order exists, but the human mind can't see it.

(3) But thanks to mathematics man can imagine it without contradicting himself and without being forced to keep completely silent. Mathematics allows him to achieve a knowledge of natural events, which is not absolutely valid, but provided at least a certain degree of probability, and at the same time to catch sight of a variety that goes beyond human limits.

(4) What makes Oresme's own position peculiar in late mediaeval philosophy is that it conceives such a variety, which usually appears as disorder, as the tangible proof of God's potency.

Thus, Oresme approaches certain Renaissance philosophers, like Nicholas of Cusa, and moves away from what can be called typical Mediaeval thought.

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