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A PATCHWORK OF PASSAGES: ON THE NATURE OF IMITATION
IN GALILEO'S ALPHABET AND PAINTING METAPHORS

In the *Dialogo sopra i due massimi sistemi del mondo*[1], Galileo in the
guise of Sagredo rebukes contemporary philosophers for the practice of
constructing elaborate arguments based on collecting and combining
passages of Aristotle's works, while blatantly ignoring physical proof to
the contrary on the sole basis of *ipse dixit*. Galileo states that he has a
more authoritative book, one which encapsulates the whole of science
and is capable of representing a unified theory of nature. This book is the
alphabet[2]. Galileo's metaphor of the alphabet illustrates the necessity of
forming scientific theories based on observation rather than analysing
the work of previous philosophers; the metaphor is adapted from Lucre-
tius' *De rerum natura* and indicates Galileo's turning towards the prima-
ry constituents of the material world ahead of the study of texts. Follow-
ing his image of the alphabet, Galileo introduces a further metaphor; he
compares the scientist to a painter forming elaborate works, which are
capable of imitating the finest details of the physical world through mix-
tures of the primary colours. Both these images illustrate the scientist's
search for the building blocks of matter, encapsulated by letters and pig-
ments respectively; however, both also emphasize the aesthetic nature of
the scientist's work. This paper seeks to demonstrate that, far from rep-
resenting the ideal image of the scientist forming his theories from the
careful observation of the material world, Galileo alludes to and synthe-
sizes numerous philosophical and literary sources and thus enacts the
very practice of the Aristotelian philosophers that he begins by criticiz-
ing. There is, however, a key difference in his approach, Galileo cloaks
his imitations and seeks to form a new structure from the texts which he
incorporates. It will be argued that Galileo is here responding to a series

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[1] Hereafter *Dialogo*, frequently known by its English title, *The Dialogue Concerning
the Two Chief World Systems*.

[2] For ease of phrasing it will be assumed throughout that the position of Sagredo is
largely indicative of that of Galileo.

of aesthetic works on poetic imitation, which he utilizes to strategically distance himself from the ideas being expressed and by extension any suspicion of heresy; such aesthetic works utilize the dialectic of similarity and difference to provide a middle ground for the expression of original ideas, while simultaneously cloaking this originality. On the other hand, it will also be argued that such metaphors betray Galileo's close association of the craftsmanship, of the scientist and that of the artist, where discovering and making tangible the underlying order of matter is fundamentally a creative activity, and where the scientist not only reveals, but invents the profound beauty in nature.

Towards the beginning of the second day of the *Dialogo*, Simplicius argues that the whole of knowledge is contained in the works of Aristotle and that one can demonstrate every facet of human knowledge by having a grasp of the entirety of his philosophical thought and the ability to combine passages of his texts that are distant from each other. Sagredo in response uses a series of layered metaphoric images to deride Simplicius' statement:

> Ma, signor Simplicio mio, come l'esser le cose disseminate in qua e in là non vi dà fastidio, e che voi crediate con l'accozzamento e con la combinazione di varie particelle trarne il sugo, questo che voi e gli altri filosofi bravi farete con i testi d'Aristotile, farò io con i versi di Virgilio o di Ovidio, formandone centoni ed esplicando con quelli tutti gli affari de gli uomini e i segreti della natura. Ma che dico io di Virgilio o di altro poeta? io ho un libretto assai piú breve d'Aristotile e d'Ovidio, nel quale si contengono tutte le scienze, e con pochissimo studio altri se ne può formare una perfettissima idea: e questo è l'alfabeto; e non è dubbio che quello che saprà ben accoppiare e ordinare questa e quella vocale con quelle consonanti o con quell'altre, ne caverà le risposte verissime a tutti i dubbi e ne trarrà gli insegnamenti di tutte le scienze e di tutte le arti[3].

> *My dear Simplicio, since having things scattered all over the place does not disgust you, and since you believe by the collection and combination of the various pieces you can draw the juice out of them, then what you and the other brave philosophers will do with Aristotle's texts, I shall do with the verses of Virgil and Ovid, making a patchwork of passages and explaining by means of these all the affairs of men and the secrets of nature. But why do I speak of Virgil, or any other poet? I have a little book, much briefer than Aristotle or Ovid,*

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[3] *Dialogo* 121; *Opere*, VII, 135. Translations adapted from Drake 1967.

in which is contained the whole of science, and with very little study one may form from it the most complete ideas. It is the alphabet, and no doubt anyone who can properly join and order this or that vowel and these or those consonants with one another can dig out of it the truest answers to every question, and draw from it instruction in all the arts and sciences.

Sagredo rebukes Simplicius for the practice of forming arguments by collecting and combining pieces of Aristotelian texts, divorced from their original context. He compares this to the literary practice of writing centos, poems composed by splicing together lines, half lines or passages of other poems. Sagredo states he will observe a similar practice with the works of Virgil and Ovid and use them to illustrate the secrets of nature, emphasizing the literary character of such an approach and its distance from scientific reasoning. He then says that he has a more authoritative text than either Aristotle or the Latin poets, capable of representing through its combination and ordering the most complex aspects of the natural world, the alphabet[4]. It has been recognised that in this passage Galileo is alluding to and adapting the alphabet analogy from Lucretius' *De rerum natura*, where changes in the position and sequence of letters between words correspond to the way in which atoms can be reorganized and recombined to form different compounds. Lucretius argues that all things are formed from atoms combined in a limited number of ways, in the same way that the multitude of words in a given language are formed from the letters of the alphabet.

The alphabet analogy is widespread in the *De rerum natura*, occurring overtly at least five times (1, 196-198; 1, 814-829; 1, 908-914; 2, 688-699 and 2, 1013-1019). Lucretius activates the analogy by instructing his reader to witness atomic restructuring in the transposition of letters between words on the page:

> Atque eadem paulo inter se mutata creare
> ignis et lignum? quo pacto verba quoque ipsa
> inter se paulo mutatis sunt elementis,
> cum ligna atque ignis distincta voce notemus[5].

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[4] For a recent discussion of Galileo's alphabet metaphor, see Hall 2013, 141-147 and previously Calvino 1985 and Bellini 2006.

[5] Lucr. 1, 911-914, tr. adapted Smith 2001.

> *And* [*do you see*] *that these same (atoms) by a small change between each other can make both fires and wood. In the same way the words themselves consist of mutual letters a little changed when we say fire and wood with distinct sound.*

Through the interchange of a number of letters we can easily make *ignis* from *lignum*. In the same way, through reorganizing the structure of the atoms the thing which they form can be completely transformed into a unique and original structure. Lucretius uses his own text to make atomic structure tangible; we see the letters shift and form different compounds.

Galileo's metaphor and the allusion to Lucretius depict the necessity of returning to the study of the building blocks of nature ahead of authoritative texts such as those of Aristotle: *i discorsi nostri hanno a essere intorno al mondo sensibile, e non sopra un mondo di carta* («discourses must relate to the sensible world and not to one on paper»)[6]. Lucretius' analogy however explicitly depends on the letters and words of the text to reveal the invisible behaviour of how the combining and recombining of atoms form different compounds. Sagredo by stating that he will observe a similar practice to that of Simplicius, only with passages from Ovid and Virgil, initially emphasizes that Simplicius' combining of passages from Aristotle is at its heart a literary activity. There is, however, a fundamental crux in Sagredo's reasoning: in turning to the metaphor of the alphabet, Sagredo engages in the self same practice, with the key difference that he cloaks the allusion to Lucretius. He turns to a text which itself combines the modes of poetry and natural philosophy in order to indicate his movement away from the study of texts to the material world, effectively demonstrating the contrary, that the natural philosopher must engage in the activities of the poet. What lies beneath the metaphor of the alphabet is not just the atomic print of nature but also that of Lucretius.

There is little doubt why Galileo would not have wanted to refer openly to Lucretius, given his defeat of *religio*, his reduction of the gods to *simulacra*, his contemporary association with Giordano Bruno and his world which is the result of the chance collision of atoms. The allusion mut be cloaked. Shortly following the metaphor of the alphabet, Sagredo describes the practice of alchemists, who never wrote about anything except how to make gold. The alchemist must find a way of expressing

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[6] *Dialogo* 127-128; *Opere*, VII, 139.

their findings without revealing them to the masses; they must instead conceal them «under various disguises». These pseudo-scientists must utilize the dynamics of literary imitation to negotiate their discourse of revealing and concealing. This easily dismissed image of Sagredo self-reflexively demonstrates the same activity which Galileo is engaged in with his use of Lucretius.

Galileo's incorporation of the Lucretian metaphor, however, displays a conceptual complexity that transcends mere disguise, and which is likely responding to a series of works on literary imitation. Galileo's comparison of the practice of the Aristotelian philosophers to the writing of centos follows a similar approach to that taken by Desiderius Erasmus in the *Ciceronianus*, where Bulephorus criticises the interspersing of classical imagery in religious poems and the mismatching of pagan and Christian imagery:

> At pie tractari qui potest, si nunquam dimoveas oculos a Virgiliis, Horatiis ac Nasonibus? Nisi forte quorundam studium approbas, qui fragmentis Homericorum aut Virgilianorum versuum, undique decerptis, et in centonem consarcinatis Christi vitam descripserunt.

> *But how can it be treated devotionally if you never take your eyes off your Virgils and Horaces and Ovids? Unless of course you approve of the efforts of those people who have collected snippets of verses from here, there, and everywhere in the Homeric or Virgilian corpus, and strung them together into a patchwork poem on the life of Christ[7].*

Erasmus uses the form of the *cento*, «patchwork poem», as a derisive image against such poets who use the verses of Virgil, Horace and Ovid in a religious or devotional context. This form of poetry was popular with Christian writers in the late antique and early modern periods. Perhaps the best known example was a fourth century Virgilian cento on the life of Christ by Faltonia Betita Proba[8]. The works which were most widely used to compose centos were those of Virgil in Latin and Homer in Greek. In both the passages from Erasmus and Galileo writing centos

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[7] *Ciceronianus* LB I 1020C / ASD 1-2 701; translation by B.I. Knott from volume 28 of the collected works (Levi 1986, 438).

[8] Levi 1986, 566, n. 186. For a further example on the subject of Narcissus, which combines both Ovidian and Virgilian material, see Okáčová 2009. On intersecting themes between this paper and Narcissus more generally, see Hardie 2002, 143-172 and Rosati 1976 and 1983.

is acceptable if the form matches the content; they are fine as poetic oddities but should not be the mode of religious or scientific reasoning. Galileo's argumentation follows a similar pattern in the above passage from the *Dialogo*. The form of the cento is used as a means of ridicule, while both Erasmus and Galileo point especially to Virgil and Ovid, Erasmus additionally to Horace. If Galileo is responding to Erasmus in the above passage in the *Dialogo*, then the criticism of the Aristotelian philosophers could well be extended to the practice of the church of using Aristotle as an authoritative text to begin with. Here the mismatch is between the Aristotelian philosophical system, which Galileo seeks to disprove, and the professed ideologies of the church; the close connection between the passages in the *Dialogo* and *Ciceronianus* at the very least display that Galileo's approach owes as much to the tradition of literary criticism as natural philosophy.

Why then, as Sagredo himself asks, does he speak of Virgil or any other poet and what is the significance of his reference to Virgil and Ovid in the context of his criticism of the eclectic practice of other philosophers, who like magpies haphazardly organize their collection of Aristotelian luminosities? It is clear from recent scholarship that both Virgil and Ovid could be clasified as "Lucretian poets", while both could have provided a foil for Galileo's allusion to Lucretius, as the shift from Aristotelian philosophy to Latin epic also creates the middle ground for Lucretius' didactic poem[9]. In drawing the connection between Virgil and Lucretius, Galileo is following in the literary tradition of Petrarch, and stretching back to Macrobius and Servius, of not only identifying Virgil's borrowings from Lucretius but using this to prompt a discussion on ideas of originality and imitation. In the *Rerum familiarium* for instance, Petrarch discusses a line identified in his poem that he had taken from *Eclogues* 6[10]. Despite professing the unintentional nature of his borrowing he concludes by seeking forgiveness on the grounds that Virgil too had stolen from Homer, Ennius and Lucretius. Macrobius in the *Saturnalia* states that Virgil's borrowing's «may even have the appearance of being accidental, since he sometimes skilfully conceals the debt, although at other times he imitates openly»[11]. Galileo in a similar vein uses an overt

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[9] See especially Gale 2000 and Hardie 2009.
[10] *Fam.* 13, 19.
[11] *Sat.* 1, 24, 18

reference to Virgil and Ovid to conceal the far more politically sensitive text he is actually adapting.

What then of Ovid? A similarly rich practice of drawing parallels between Ovid's works and that of Lucretius is clearly evident from the early manuscript tradition of the *De rerum natura*. This was likely sparked by Ovid's praise of «divine Lucretius» in the *Amores*[12]. There is, however, a far more striking connection which can be drawn between the *Metamorphoses* and Lucretius' alphabet analogy, one which in many ways corresponds with Galileo's adaptation of the analogy in the *Dialogo*. Lucretius' alphabet analogy displays how the combining and recombining of atoms in a limited number of compounds serves to create unique and original structures through the reconstitution of a basic set of primary constituents; this in turn leads to the infinite variety and complexity of the physical world. A clear parallel can be drawn with the practice which Simplicius is rebuked for immediately prior to the alphabet analogy, namely how the combining and recombining of various disconnected passages of Aristotle can be used to demonstrate all things that can be possibly known. In other words, the allusive structure of the text functions in the same ways as the alphabet analogy, albeit that the constituents which are reorganized are whole passages rather than letters. The criticism which is aimed at Simplicius is not the practice of reconstitution itself, but its restriction to the works of Aristotle. Ovid in a similar vein adopts the dynamics of reconstitution from Lucretius' analogy and transfers this to the level of intertextual allusion; Galileo's «patchwork of passages» could serve as a succinctly apt description of the *Metamorphoses*, as Ovid composes his poem by combining and recombining allusions to different texts and, crucially generating new bodies of meaning from the remains of previous discourses. Galileo adapts Lucretius' analogy in a strikingly similar manner; Hall has observed that the «"great practice on the texts of Aristotle" that Galileo soundly dismissed in the *Assayer* is a parallel act to recombining the alphabet to create new words according to Sagredo's analogy. The possibilities of dismantling and rebuilding exist with the smallest elements of the linguistic structure, in this case letters, but continue through to entire portions of texts»[13]. There is then a competing set of images encapsulated in the metaphor of the alphabet:

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[12] *Am.* 1, 15, 23-24. For a discussion of this passage and its significance in terms of the early modern reception of Lucretius, see the discussion by Palmer 2014, 109.

[13] Hall 2013, 143.

overtly it indicates that through the study of the primary components of matter it is possible to create an original discourse that is not dependent on reworking the material of others; however, the very image used to express this, is itself a borrowing that portrays textual reconstitution as analogous to the way in which the structures of reality are formed. In encouraging the reader to look below the surface of the text to the implied image, Galileo causes the reader to enact the process of scientific discovery, of searching for an underlying order in matter, an order which Galileo can write into existence in the language of atoms.

Galileo concludes the alphabet metaphor by describing how a writer who can correctly understand the language of the universe and wield its letters can achieve the truest answers possible in all the arts and sciences. Galileo immediately establishes a further analogical level by comparing what he has just described to the process by which the painter depicts the infinite variability of the material world by combining the primary colours in different ratios. It is now the visual artist rather than the poet that becomes an analogue for the natural philosopher:

> in quella maniera appunto che il pittore da i semplici colori diversi, separatamente posti sopra la tavolozza, va, con l'accozzare un poco di questo con un poco di quello e di quell'altro, figurando uomini, piante, fabbriche, uccelli, pesci, ed in somma imitando tutti gli oggetti visibili, senza che su la tavolozza sieno né occhi né penne né squamme né foglie né sassi: anzi pure è necessario che nessuna delle cose da imitarsi, o parte alcuna di quelle, sieno attualmente tra i colori, volendo che con essi si possano rappresentare tutte le cose; ché se vi fussero, verbigrazia, penne, queste non servirebbero per dipigne re altro che uccelli o pennacchi[14].

> *Just so does a painter, from the various simple colors placed separately upon his palette, by gathering a little of this with a bit of that and a trifle of the other, depict men, plants, buildings, birds, fishes, and in a word represent every visible object, without any eyes or feathers or scales or leaves or stones being on his palette. Indeed, it is necessary that none of the things imitated nor parts of them should actually be among the colors, if you want to be able to represent everything; if there were feathers, for instance, these would not do to depict anything but birds or feather dusters.*

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[14] *Dialogo*, 121; *Opere*, VII, 135.

Galileo transfers the metaphor from the world of the page to the canvas. The sentiment remains the same: it is necessary to achieve a command and understanding of the primary constituents of the material world ahead of compounds; and that a skilful practitioner can accurately reconstruct the infinite variability of material reality from this limited number of primary constituents. If, however, we begin from compounds, feathers or by extension excerpts from Aristotle, the result will be nonsensical. Much like Lucretius' alphabet analogy, the activity involves the mixing of the primary constituents in different proportions, in this case the basic pigments, to form a countless variety of viable compounds. Why, however, does Galileo deem it necessary to extend his analogy to the visual arts? Much like in the previous metaphor, Galileo distances himself from the false practices of other philosophers by placing himself in the role of artist. The problem, however, is that the painting metaphor, much like the literary allusions to Virgil, Ovid and Lucretius, clearly implies the act of imitation.

Galileo's argumentation at this point has more in common with aesthetics and literary criticism than scientific reasoning. The full implication of Galileo's painting analogy may be deduced by comparing it to a passage from the *Considerazioni al Tasso*, where Galileo distinguishes the approaches and literary merits of Tasso and Ariosto by associating them with two different forms of visual representation:

Uno tra gli altri difetti e molto familiare al Tasso, nato da una grande strettezza di vena e povertà di concetti; ed è, che mancandogli ben spesso la materia, è constretto andar rappezzando insieme concetti spezzati e senza dependenza e connessione tra loro, onde la sua narrazione ne riesce più presto una pittura intarsiata, che colorita a olio: perché, essendo le tarsie un accozzamento di legnetti di diversi colori, con i quali non possono già mai accoppiarsi e unirsi così dolcemente che non restino i lor confini taglienti e dalla diversità de' colori crudamente distinti, rendono per necessita le lor figure secche, crude, senza tondezza e rilievo; dove che nel colorito a olio, sfumandosi dolcemente i confini, si passa senza crudezza dall'una all'altra tinta, onde la pittura riesce morbida, tonda, con forza e con rilievo. Sfuma e tondeggia l'Ariosto [...]; rottamente, seccamente e crudamente conduce le sue opere il Tasso [...]: e questo andare empiendo, per brevità di parole, le stanze di concetti che non hanno una necessaria continuazione con le cose dette e da dirsi, l'addomanderemo intarsiare.

> *His* [scil. *Tasso's*] *narrative more closely resembles a tarsia picture than an oil painting. For, since a tarsia picture is a composite of little varicoloured pieces of wood, which one can never combine and unite so softly that the contours would not remain cutting and sharply distinct from the variety of the colors, it necessarily makes the figures dry, hard, and without roundness and relief. In an oil painting, however, one softly dissolves the contours and passes from one color to the other without abruptness; whence the picture becomes soft, round, forceful and rich in relief. Ariosto shades and models in the round* [...]; *Tasso works piecemeal, dryly and sharply* [...] *and this manner of filling his stanzas, for want of words, with concepts having no cogent connection with what is said or to be said, we will call* intarsiare[15].

Galileo compares Tasso's *Gerusalemme liberata* to an intarsia, a mosaic like picture composed of inlayed sections of wood. He then contrasts this with Ariosto's *Orlando furioso*, which he envisages as an elaborately modelled oil painting. Galileo argues that Tasso's work is of a lesser standard because its component parts fail to fully unite and like the intarsia it lacks cohesion. Although the effect of the image is amusing, it fails to surpass the limitations of its medium. In stark contrast Galileo pictures Ariosto's work as an oil painting, where the colours are expertly blended and where the boarders between the constituent pigments dissolve[16]. The image formed is superior, as the painting achieves a rounded realism which extends beyond the two-dimensionality of its medium. Galileo's branding of the works of contemporary philosophers as centos of Aristotle in the *Dialogo* corresponds precisely with his comparison of Tasso's work to an intarsia. The intarsia in this context is the visual counterpart of the cento. The passages fail to fully combine into a new structure, as the patchwork fabric shows its seams. In both the passages from *Considerazioni* and the *Dialogo*, Galileo uses the image of oil painting as the ideal mode of representation. In the *Dialogo* the metaphor is concerned with the effective blending of primary colours to form a coherent whole. In the *Considerazioni* Galileo turns to oil painting to depict the act of blending, where the divisions between the component parts are interfused so as to become indistinguishable. The closeness between the

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[15] Cited in and translated by Panofsky 1954, 17-18; *Opere,* IX, 63.

[16] Hall 2013, 117 states that the image stems from Cicero's *de orat.* 3, 171, where good composition requires the that the junction between words should not be rough or gaping, but *ut tesserulae omnes arte pavimento*, «all like square stones inserted skilfully in pavements» (a poetical quotation from Lucil. *sat.* 2, 84 Marx). For a discussion of the mosaic as a *topos* in Renaissance aesthetics, see MacPhail 2003.

passages, however, allows us to read a similar dynamic at play in the painting metaphor in the *Dialogo*. Galileo may be seen as activating this set of images through self-imitation. The divisions between the old and the new become indistinct as the constituent texts become inseparable from their new instantiation[17].

Galileo, in using visual arts to comment on the act of imitation, closely follows Petrarch, who employs the image of the painter's mixing of colours to inform his discussion of the need to create distance from the object of imitation. He initially contrasts this process with that observed by the painter:

> Curandum imitatori ut quod scribit simile non idem sit, eamque similitudinem talem esse oportere, non qualis est imaginis ad eum cuius imago est, que quo similior eo maior laus artificis, sed qualis filii ad patrem. [...] Sic et nobis providendum ut cum simile aliquid sit, multa sint dissimilia, et id ipsum simile lateat ne deprehendi possit nisi tacita mentis indagine, ut intelligi simile queat potiusquam dici. Utendum igitur ingenio alieno utendumque coloribus, abstinendum verbis; illa enim similitudo latet, hec eminet; illa poetas facit, hec simias. Standum denique Senece consilio, quod ante Senecam Flacci erat, ut scribamus scilicet sicut apes mellificant, non servatis floribus sed in favos versis, ut ex multis et variis unum fiat, idque aliud et melius[18].

> *An imitator must take care to write something similar yet not identical to the original, and that similarity must not be like the image to its original in painting where the greater the similarity the greater the praise for the artist, but rather like that of a son to his father. [...] We must thus see to it that if there is something similar, there is also a great deal that is dissimilar, and that the similar be elusive and unable to be extricated except in silent meditation, for the resemblance is to be felt rather than expressed. Thus we may appropriate another's ideas as well as his coloring but we must abstain from his actual words; for, with the former, resemblance remains hidden, and with the latter it is glaring, the former creates poets, the second apes. It may all be summarized by saying with Seneca, and Flaccus before him, that we must write as the bees*

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[17] Conte 2017, 17-18, in his recent reappraisal of imitation in Latin poetry, has envisaged the dynamics of intertextuality in a very similar way, describing it as an «oscillating dialectic between "before" and "after"», where the «new structure is no longer the previous one, but in a certain sense it still is» and where «every discourse is constructed as a system of differences». Crucially, Conte also highlights that this dynamic is a means of poetic creativity. Indeed Conte uses Ovid's description of Hermaphroditus (*met.* 4, 378-379) as a means of defining this very dynamic: *neutrumque et utrumque videtur* «it has the appearance of neither but at the same time has the appearance of each».

[18] *Fam.* 23, 19, 11-13, trans. by Bernardo 1985, 301-302.

make honey, not gathering flowers but turning them into honeycombs, thereby blending them into a oneness that is unlike them all, and better.

Petrarch is here arguing that the imitator employs a process of «dissimilitude», where the writer is advised to conceal the exact relation between text and model and where the points of resemblance must be sufficiently elusive yet allusive[19]. It is necessary for the reader to be able to identify the range of different models, yet the boundaries between them should be sufficiently dissolved, so that the originality of the new work should not be questioned. Petrarch advocates abstaining altogether from the borrowing of words or phrases. He uses the image of the painter initially in contrast to that of the imitating writer: the quality of the painter's work is tied to its ability to effectively mimic the world it seeks to represent. In this sense, it would appear to be a more apt metaphor for scientific investigation as it seeks to achieve a close approximation of material reality. The painting imagery, however, runs into Petrarch's representation of literary imitation: it is a writer's colour not his words which must be successfully imitated and it is precisely this abstract notion that allows for the resemblances to remain partially hidden. Petrarch, self-reflexively, uses an allusion to Seneca and Horace [Flaccus] to illustrate his point, saying that the imitator should write in the same way that a bee makes honey, blending his sources and creating a unified and homogenous substance where the qualities of the individual flowers can no longer be identified. Petrarch distinguishes the making of honey from the collecting of flowers or pollen. G.W. Pigman states that the «apian metaphor», though «one of the most familiar of all images in writings on imitation» is «the most misleading topos because it is used to present two opposed conceptions of imitation: the poet as collector (following) and the poet as maker (imitation or emulation)»[20]. Petrarch strictly favours only the later and in doing so distorts the very sources he alludes to. Galileo, likewise, captures this opposition in his juxtaposition of the painting and alphabet metaphors; on the one hand, the scientist must seek and

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[19] Pigman 1980, 4, «Dissimulative imagery and explicit advice of dissimulation refer to concealing or disguising the relation between text and model. The doctrines conveyed by these two classes pose serious problems for the interpreter who tries to understand imitations and allusions, because they advise the effacement of resemblance between text and model».

[20] Pigman 1980, 8 includes an extensive list of authors who use the apian metaphor, following Seneca, including Petrarch, Poliziano, Erasmus, Calcagnini, Dolet, Florido, Du Bellay, Sidney, and Jonson (for citations see also Pigman 1980, 8).

collect accurate information from the material world; yet on the other, Galileo consistently employs these images to envisage the scientist as a creator of his world.

Petrarch is for the most part responding to Seneca's letter 84 to Lucilius[21]:

Apes, ut aiunt, debemus imitari, quae vagantur et flores ad mel faciendum idoneos carpunt, deinde quidquid attulere disponunt ac per favos digerunt et, ut Vergilius noster ait, liquentia mella | stipant et dulci distendunt nectare cellas. De illis non satis constat utrum sucum ex floribus ducant qui protinus mel sit, an quae collegerunt in hunc saporem mixtura quadam et proprietate spiritus sui mutent. Quibusdam enim placet non faciendi mellis scientiam esse illis sed colligendi. [...] Quidam existimant conditura et dispositione in hanc qualitatem verti quae ex tenerrimis virentium florentiumque decerpserint, non sine quodam, ut ita dicam, fermento, quo in unum diversa coalescunt. Sed ne ad aliud quam de quo agitur abducar, nos quoque has apes debemus imitari et quaecumque ex diversa lectione congessimus separare (melius enim distincta servantur), deinde adhibita ingenii nostri cura et facultate in unum saporem varia illa libamenta confundere, ut etiam si apparuerit unde sumptum sit, aliud tamen esse quam unde sumptum est appareat[22].

We should be like bees, as the saying goes: first they fly about and choose the flowers best suited for making honey, then distribute what they have collected throughout the hive, and as our poet Virgil says, «let the sweet nectar fill the swelling cells and lucent honey flow». Opinion is divided about bees. Do they merely extract liquid from flowers, which immediately becomes honey, or do they transform what they have collected into that sweet liquid by some intermingling of their own distinctive spirit? For some hold that their expertise is not in making the honey but only in collecting it. [...] Others think that what the bees gather from flowers and tender grasses changes its character when stored away in the hive, by a process that includes some sort of fermentation, if I may use that term, during which the different flavors combine into one. But I digress from the matter at hand. We also must imitate these bees, and taking the things we have gathered from our diverse reading, first separate them (for things are better preserved when they are kept distinct), then, applying the care and ability of our own talent, conjoin those various samples into one savor, so

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[21] The other overt reference is to Hor. *carm.* 4, 2, *Ego apis Matinae | more modoque, | grata carpentis thyma per laborem | plurimum, circa nemus uvidique | Tiburis ripas operosa parvos | carmina fingo*, «I, like the Matine bee that goes gathering enticing thyme by mighty effort, round the groves and banks of Tibur rich in waters, small in size, I shape my painstaking poems» (trans. Kaimowitz 2008).

[22] *Epist.* 84, 2-5; trans. by Graver-Long 2015.

that even if it is apparent where a thing has been taken from, it may yet appear to be different from that from which it was taken.

It is only through turning to Seneca that we can fully understand the complexity of the bee metaphor in Petrarch. By using an allusion to illustrate his concept of imitation, Petrarch actively encourages the reader to identify the points of comparison and divergence between his image and that of Seneca, thus illustrating his theory of imitation and its focus on the dynamics of similarity and difference. Seneca discusses to what degree the bee has a formative role in the process of generating honey: does the nectar itself once extracted become honey or does the bee make honey from the nectar? To what extent is the poet a creator or a collector? In other words, is Seneca's bee an Epicurean or a Stoic? Seneca combines the diverse elements of the *topos*, distinguishing the two key parts of the processes: writers must first collect and separate the diverse flowers, before combining them into a unified whole[23]. The end result must be both the same and different; the sources should be identifiable yet form a new and unique structure. This is precisely the dynamic which we have identified as key to the series of metaphors in Galileo's *Dialogo*. The painting and bee metaphors are also very close conceptually; both involve the mixture of viscous substances in order to create a semi-solidified and stable state. Beeswax was also used as a vehicle for pigments in ancient encaustic painting and was a frequent component of painting mediums in the Renaissance. It is also tempting in the given context to read Galileo's criticism of Simplico's belief that «from the collection and combination of the various pieces [of Aristotelian texts] you can draw the juice (*sugo*) out of them» as derived at least in part from the bee metaphor, where the *sugo* «juice» or «nectar» could perhaps be the

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[23] Erasmus captures the image: *Apes num ex uno frutice colligunt mellificii materiam? An potius ad omnes florum, herbarum, fruticum species mira sedulitate circumvolant, frequenter e longinquo petentes quod condant in alvearia? Nec statim mel est quod adferunt, fingunt ore visceribusque suis liquorem, ac in ipsas transformatum rursus ex sese gignunt, in quo non agnoscas, nec floris, nec fruticis delibati saporem, odoremve, sed apiculae foetum ex omnibus illis temperatum* («Bees don't collect the material for making honey from just one bush, do they? No, they flit in their wonderful busy way round every type of flower, herb, and bush, often going far afield for the stuff to store in their hive. And what they bring is not honey to begin with. They turn it into a liquid in their mouths and inner parts, and then reproduce it, transmuted into their own substance; in it one recognizes not the taste or smell of any flower or shrub the bee has sipped, but a creation of the bee itself, compounded from all the contributory elements», *Cic.* LB I 1002D / ASD 1-2 652).

sucus of Seneca[24]. It should also not be overlooked that the numerous instantiations of the bee metaphor look towards the proem of *De rerum natura* 3, where Lucretius depicts himself as gathering, not modifying, the wisdom of Epicurus:

> tuisque ex, inclute, chartis,   10
> floriferis ut apes in saltibus omnia libant,
> omnia nos itidem depascimur aurea dicta,
> aurea, perpetua semper dignissima vita[25].

> *And from your pages, illustrious master, like the bees which in flowerful vales sip each bloom, we feed on each golden saying-golden and ever most worthy of eternal life.*

Before concluding it may be worth introducing one further painting metaphor, which appears in one of Lucretius' chief sources and which was formative for the alphabet analogy. Empedocles uses the mixing of pigments to illustrate the creation of the world from the primary elements:

> ὡς δ᾽ ὁπόταν γραφέες ἀναθήματα ποικίλλωσιν
> ἀνέρες ἀμφὶ τέχνης ὑπὸ μήτιος εὖ δεδαῶτε,
> οἵ τ᾽ ἐπεὶ οὖν μάρψωσι πολύχροα φάρμακα χερσίν,
> ἁρμονίηι μείξαντε τὰ μὲν πλέω, ἄλλα δ᾽ ἐλάσσω,
> ἐκ τῶν εἴδεα πᾶσιν ἀλίγκια πορσύνουσι,   5
> δένδρεά τε κτίζοντε καὶ ἀνέρας ἠδὲ γυναῖκας
> θῆράς τ᾽ οἰωνούς τε καὶ ὑδατοθρέμμονας ἰχθῦς,
> καί τε θεοὺς δολιχαίωνας τιμῆισι φερίστους·

> *As when painters adorn votive offerings, men well-learned in their craft because of cunning; and so when they take in their hands many-coloured pigments, mixing them in harmony, some more, others less, from them they prepare forms resembling all things, making trees and men and women and beasts and birds and water-nourished fish and ling-lived gods, first in their prerogatives* [26].

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[24] Hall 2013, 20 discusses the presence of Seneca's works in Galileo's library. Horowitz 1997, 114, «Ancient analyses of bees and flowers are at the bedrock of humanist theory of *imitation*. From Lucretius the humanists repeat *De rerum natura* 3, 10-12 [...] Horace echoes these lines in *Carmina* 4, 2, 27-32, expanding Lucretius' borrowing from one author (Epicurus) to a poet's borrowing from several authors».

[25] Lucr. 3, 10-13; trans. Smith 2001.

[26] Empedocles (frg. DK 23 / Inwood 27) = Simplic. *phys.* CIAG 9, 159, 27, commenting on 187a 21 ff.; ed. and trans. Inwood 2001.

Empedocles visualizes the formation of the infinite variety of the world from different combinations of the four elements by comparing this to the image of the painter using different mixtures of the pigments to represent the forms of all things. Galileo's metaphor in the *Dialogo* is remarkably similar; not only does it use the painting to illustrate the same idea, but it largely follows the same structure; Galileo likewise lists the various elements of the material world that the painter represents, including men, plants, birds, and fish (all that is accept Empedocles' gods). It would be easy to dismiss the striking resemblance between these passages as purely the result of the chance collision of disparate readings that occupy the same conceptual domain. As C. Ham, however, states, Lucretius' alphabet analogy looks towards Empedocles' painting metaphor; both depend upon the same fundamental idea: the infinite variety of the material world is achievable through the mixture (combination and recombination) of a limited number of primary constituents[27]. It would then follow, especially given the highly intertextual nature of the *Dialogo*, that Galileo in seeking out the primary constituents of the discourse would look past Lucretius to his source and place them side by side. Crucially, however, before the discovery of the Strasbourg papyrus, our chief source for this passage from Empedocles was from Simplicius' commentary on Aristotle's *Physics*. Galileo's choice of the name Simplicio for the Aristotelian representative in the dialogue was intended to point to Simplicius, while also playing upon the double entendre of his name. Indeed it would be hard to think of a better example than Simplicius' commentaries of the practice of mismatching various passages from Aristotle with other philosophical texts. If this is the case, then Galileo's final artistic flourish is for Sagredo to use Simplicios' own words against him, in a quotation not from Aristotle, but Empedocles.

To conclude with a different perspective, we might consider Albert Einstein's foreword to the *Dialogo*, where he criticizes Galileo for the fact that he does not acknowledge the crucial discovery made by Kepler, that the «true orbits» of the planets are elliptical rather than circular, which Galileo was no doubt aware of and which would have provided him with the definitive proof of Copernicus' heliocentric model for the solar system ahead of all competing theories. Einstein states that this is «a grotesque illustration of the fact that creative individuals are often not re-

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[27] Ham 2013, 49.

ceptive»[28]. If nothing else this paper has demonstrated the contrary. Galileo's series of metaphors and analogies conceal a whole host of allusions to different texts, that operate within the literary practices of *imitatio* and dissimulation, while making them part of the repertoire of his scientific reasoning. If Lucretius occupies a privileged place among the various models identified in this paper, it is because, far from dislocating the literary and scientific, Lucretius smoothes their boundaries until the work of the artist becomes that of the scientist or natural philosopher.

The metaphors of painting and the alphabet are not the only artistic images used by Sagredo in the *Dialogo*; almost immediately after the painting metaphor he envisages the structure that is contained within all things that can be known to the way in which *un marmo contiene in sé una bellissima, anzi mille bellissime statue* («a block of marble contains a beautiful statue, or rather thousands of them»), but, as he states, *il punto sta a saperle scoprire* («the whole point lies in being able to reveal them»). In order to reveal this hidden structure, the scientist must employ the tools of the artist. In his 1612 letter to Lodovico Cigoli, Galileo weighs in on the longstanding debate on the relative merits of painting and sculpture. He favours painting because he states it is further removed from what it seeks to imitate: «For, the farther removed the means by which one imitates are from the thing to be imitated, the more worthy of wonder the imitation will be»[29]. Since painting achieves a representation of three dimensions on a single plane it surpasses sculpture, which he states shares in the relief of Nature. It is a painting's simultaneous similarity and distance from the material world which gives it significance as a medium of representation. Finally he states that «the sculptors always copy and the painters do not. The former imitate things as they are, the latter as they appear; but since things are only in one way and appear in infinite ways, it is enormously more difficult [for the painter] to attain to excellence in his art»[30]. The infinitude of appearances, letters and brush strokes only momentarily coalesce to form an image of reality. The artist in surpassing pure imitation takes

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[28] Authorized translation by Sonja Bargmann ahead of the 1967 edition of Stillman Drake's translation of the *Dialogo*.

[29] *Opere* 11, 340-343, «Perciocché quanto più i mezzi, co' quali si imita, son lontani dalle cose da imitarsi, tanto più l'imitazione è maravigliosa».

[30] *Opere* 11, 340-343, «E quelli imitano le cose com' elle sono, e questi com' elle appariscono: ma perché le cose sono in un modo solo, et appariscono in infiniti, e' vien perciò sommamente accresciuta la difficultà per giugnere all' eccellenza della sua arte».

part in the formation of the world. The scientist who pieces together disparate observations to form a new theory not only contributes to the understanding of the material world but makes it that little bit bigger. In elevating the visual and literary arts, Galileo acknowledges that his world is tied to the infinitude of appearance over the possibility of imitating a singular stable form. He seemingly rejects the position of the detached observer as the world cannot be seen as distinct from its active examination and representation.

Galileo's depictions of the different arts and how they reinterpret the image of the scientist may be read in terms of a tension between realism and constructivism. There can be little doubt that Galileo is concerned with achieving a perspective of the world as he believes it actually to be, one that is in marked contrast to Aristotelian philosophy. Lucretius' metaphor is much more than a thought experiment for Galileo; in the *Saggiatore* he seeks to advance a theory of the fundamental particles of matter and how they relate to the senses. While the structure and train of thought of Galileo's postulation is clearly indebted to Lucretius and the Atomists, especially Democritus, it is also clear that Galileo is seeking the fundamental order in matter that not only lies beneath our world of sensory experience, but gives rise to light itself.[31] Yet the *Saggiatore* also contains Galileo's most famous metaphor of the book of nature written in the language of mathematics. The metaphor, however, is not just illustrative; it is formative. Without such metaphors, we would construct reality in an entirely different way. As D. Kennedy states «from this perspective, scientists create or construct or invent the reality they are ostensibly investigating. Far from language being either a transparent medium or a barrier between us and the world, our sense of the world, in this view, is constituted *in* language»[32]. It is precisely this dynamic which as Kennedy shows is at the heart of Lucretian physics which is crucial to Galileo's reading of the nature of things. The alphabet analogy's intertwining of the structure of language and matter informs not only Galileo's view of reality but his own position in relation to this reality as both its discoverer and inventor.

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[31] On Galileo's atomism see for instance Redondi 1983, especially 14-20, against whom, see Ferrone-Firpo 1986, and more recently Galluzzi 2001, and Shea 2001.

[32] Kennedy 2002, 18.

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