Juliane Küppers

Framing Newton's *Principia*: The Three Versions of Edmond Halley's Lucretian Ode and Newton's Reception of Lucretius' *De Rerum Natura*

1 Introduction

Readers of the first edition of Isaac Newton's *Philosophiae Naturalis Principia Mathematica* (1687) began their perusal in an elevated state of mind that did not result only from the work's ground-breaking nature.¹ Their receptivity was also shaped by a dedicatory ode written by the *Principia*'s first editor Edmond Halley in the style of the ancient Roman poet Lucretius. It was placed – after Newton's own *Praefatio ad lectorem* – right before the main text. In the second and third edition (1713 and 1726), the ode was revised by its editors, significantly so by Richard Bentley and to a much lesser extent by Henry Pemberton. Its placement was changed to a less prominent position among the other paratexts. The different versions of the ode created different personae for the *Principia*'s author – and thus gave its readers different approaches to the scientific work – depending on its specific historical and natural philosophical context. This paper analyses the revisions in detail and discusses Newton's own relationship to Lucretius' *De rerum natura* in his writings throughout the timespan of the *Principia*'s first three publications. I argue that not only can the changes to the ode be explained by historical circumstance and through the influence of the *Principia*'s second editor Bentley – as is the focus of the study by Albury² and one

¹ Earlier versions of this paper have been delivered at the Neo-Latin Colloquium of the Freie Universität Berlin, the Doctoral Seminar of the Humboldt-Universität zu Berlin, and the Technical Traditions workshop of Harvard University's Department of the Classics during a visiting fellowship. I am thankful for helpful comments made by Bernd Roling, Ramunė Markevičiūtė, Michalis Sialaros, James Zainaldin, and Patricia Marechal. I am especially indebted to Mark Schiefsky who made me aware of Volkmar Schüller's edition of Newton's scholia to Propositions IV through IX Book III of the *Principia*, and who provided me with many helpful remarks that helped turn a mere curiosity about the three versions of Halley's ode into this paper.

² Albury, William R. "Halley's Ode on the *Principia* of Newton and the Epicurean Revival in England." *Journal of the History of Ideas* 39.1 (1978): 24–43, deals with the reception of Epicurean philosophy and the Lucretian didactic poem *De rerum natura* in seventeenth-century England. He briefly goes over some revisions to the ode; his main focus, however, lies on the historical background of this reception and other examples of Epicureanism and Lucretian poetry under the

of Schliesser's³ main arguments. The revisions also reflect the complex relationship to Lucretius' work on Epicurean natural philosophy in Newton's own writings on concrete scientific issues, particularly in the (unpublished) scholia to the *Principia*, as well as in Query 31 Book III of the *Opticks*, and in the *General Scholium*.

1.1 The versions of the poem in the first three editions

Poem 1st edition, 1687, Edmond Halley⁴

EN tibi norma Poli, & divæ libramina Molis,
Computus atque Jovis; quas, dum primordia
rerum

Pangeret, omniparens Leges violare Creator
Noluit, æternique operis fundamina fixit.
Intima panduntur victi penetralia cæli,
Nec latet extremos quæ Vis circumrotat
Orbes.

Sol solio residens ad se jubet omnia pronò
Tendere descensu, nec recto tramite currus
Sidereos patitur vastum per inane moveri;
Sed rapit immotis, se centro, singula
Gyris.

Jam patet horrificis quæ sit via flexa Cometis;
Jam non miramur barbati Phænomena Astri.
Discimus hinc tandem qua causa argentea
Phœbe
Passibus haud æquis graditur; cur subdita
nulli

Poem 2nd edition, 1713, edited by Richard Bentley⁵

(Revisions in *italic*)

EN tibi norma Poli, & divæ libramina Molis,
Computus en Jovis; & quas, dum primordia
rerum

*Conderet, omnipotens sibi Leges ipse Creator
Dixerit, atque operum quæ fundamenta locarit.*

5 Intima panduntur victi penetralia Cæli,
Nec latet, extremos quæ Vis *circumrotet* Orbes.

Sol solio residens ad se jubet omnia pronò
Tendere descensu, nec recto tramite currus
Sidereos patitur vastum per inane moveri;
10 Sed rapit immotis, se centro, singula gyris.

*Hinc patet, horrificis qua sit via flexa Cometis:
line 12 deleted*

Discimus hinc tandem, qua causa argentea
Phœbe

Passibus haud æquis *eat*, & cur subdita nulli

Stuart Monarchy and the later reign of Mary II and William of Orange after the Glorious Revolution.

3 Schliesser, Eric. "On reading Newton as an Epicurean: Kant, Spinozism and the changes to the *Principia*." *Studies in History and Philosophy of Science* 44.3 (2013): 416–428, explains how other aspects of the *Principia*, not only the ode, could be read as Epicurean, how several changes to the second edition of the work were made, as regards content, in order to neutralise this possible accusation, and that the intent of Newton's *General Scholium* was possibly a charge against Spinozism, not necessarily Epicureanism.

4 Isaaci Newtoni Philosophiæ Naturalis Principia Mathematica. Londini 1687.

5 Isaaci Newtoni Philosophiæ Naturalis Principia Mathematica. Cantabrigiæ 1713.

Hactenus Astronomo numerorum fræna recuset: Cur remeant Nodi, curque Auges progrediuntur. Discimus & quantis refluam vaga Cynthia Pontum Viribus impellit, dum fractis fluctibus Ulvam Deserit, ac Nautis suspectas nudat arenas; Alternis vicibus suprema ad littora pulsans.	15	Hactenus Astronomo numerorum fræna recuset: Cur <i>remeant</i> Nodi, curque Auges <i>progrediantur</i> . Discimus, & quantis refluam vaga Cynthia Pontum Viribus <i>impellat</i> ; <i>fessis</i> dum fluctibus ulvam Deserit, ac nautis suspectas nudat arenas; 20 <i>Alternisve ruens spumantia</i> littora pulsant.
Quæ toties animos veterum torsere Sophorum, Quæque Scholas frustra rauco certamine vexant Obvia conspicimus nubem pellente Mathesi. Jam dubios nulla caligine prægravat error Queis Superum penetrare domos atque ardua Cæli Scandere sublimis Genii concessit acumen. Surgite Mortales, terrenas mittite curas ⁶ Atque hinc cœligenæ vires dignoscite Mentis A pecudum vita longe lateque remotæ. Qui scriptis jussit Tabulis compescere Cædes	25	Quæ toties animos veterum torsere Sophorum, Quæque Scholas <i>hodie</i> rauco certamine vexant, Obvia conspicimus; nubem pellente Mathesi: <i>line 24 deleted</i> 25 <i>Quæ superas</i> penetrare domos, atque ardua Cæli, <i>NEWTONI auspiciis, jam dat contingere Templâ.</i> Surgite Mortales, terrenas mittite curas; Atque hinc cœligenæ vires cognoscite Mentis, A pecudum vita longe <i>longeque</i> remotæ. 30 Qui scriptis <i>primus</i> Tabulis compescere Cædes,
Furta & Adulteria, & perjuræ crimina Fraudis; Quive vagis populis circumdare mœnibus Urbes Auctor erat; Cererisve beavit munere gentes; Vel qui curarum lenimen pressit ab Uva; Vel qui Niliaca monstravit arundine pictos Consociare sonos, oculisque exponere Voces; Humanam sortem minus extulit; utpote pauca Respiciens miseræ solummodo commoda vitæ. Jam vero Superis convivæ admittimur, alti Jura poli tractare licet, jamque abdita cœcæ Claustra patent Terræ, rerumque immobilis ordo, Et quæ præteriti latuerunt sæcula mundi. Talia monstrantem mecum celebrate Camænis, ⁷	35	Furta & Adulteria, & perjuræ crimina Fraudis; Quive vagis populis circumdare mœnibus Urbes Auctor erat; Cererisve beavit munere gentes; Vel qui curarum lenimen pressit ab Uva; Vel qui Niliaca monstravit arundine pictos Consociare sonos, oculisque exponere Voces; Humanam sortem minus extulit; utpote pauca <i>In commune ferens miseræ solatia vitæ.</i> Jam vero Superis convivæ admittimur, alti 40 Jura poli tractare licet, jamque abdita <i>diæ</i> Claustra patent <i>Naturæ</i> , & rerum immobilis ordo; Et quæ <i>præteritis latuere incognita sæclis.</i> Talia monstrantem <i>justis</i> celebrate Camænis,

6 The original typesetting indents this line.

7 The original typesetting indents this line.

Vos qui cœlesti gaudetis nectare vesci,
 NEWTONUM clausi reserantem scrinia Veri, 45
 NEWTONUM Musis charum, cui pectore puro
 Phoebus adest, totoque incessit Numine
 mentem:
 Nec fas est propius Mortali attingere Divos.
 Edm. Halley

Vos qui cælesti gaudetis nectare vesci,
 NEWTONUM clausi reserantem scrinia Veri,
 NEWTONUM Musis carum, cui pectore puro
 Phoebus adest, totoque incessit Numine
 mentem:
 Nec fas est propius Mortali attingere Divos.
 Edm. Halley

In the paratext of the third edition from 1726,⁸ its editor Henry Pemberton re-established the original text from the first edition almost completely. Only the fourth verse shows a significant revision so that the relative clause in line 3 and 4 reads: *quas [...] omniparens leges violare creator / noluit, atque operum quae fundamenta locarit*; i. e., Pemberton re-established Halley's *noluit* while keeping Bentley's revisions otherwise intact.

1.2 Prose translation of Halley's poem in first *Principia* edition

Behold the angle of the celestial axis and the balances of the divine mass, and the calculation of Jove; laws which, when he was establishing the origins of things, the all-bearing creator did not want to violate and which he determined as the foundations of his eternal works. The innermost secrets of the conquered heaven are spread out and the force is not concealed that rotates the outermost orbits. The sun – settled on his throne – commands all things to reach downward to him, and on no straight path does he allow the starry chariot to move through the boundless void; but he pulls every single thing in unchangeable rotations, himself in the centre. Now the winding path of the direful comet is evident; now we do not wonder anymore about the phenomena of a bearded star. Here we finally learn by which cause silver Phoebe advances with unsteady strides; why, overcome so far by no astronomer, she bridles at the reins of the numbers; why the nodes return and why the apsides proceed. We also learn with how much force wandering Cynthia urges the ebbing sea, while she deserts the reeds with broken waves and bares the sands that trouble seamen; alternately hitting the highest shores. What so often agonised the minds of ancient sages, what troubles their schools in rough disputes without avail we can see revealed, the cloud dispelled by Mathematics. No longer does error put a

⁸ Isaaci Newtoni Philosophiae Naturalis Principia Mathematica, Londini 1726.

strain on the doubtful with its darkness; the acumen of a sublime mind allows us to enter the palace of the Gods and to ascend to the heights of heaven.

Rise, mortals, leave behind your earthly cares and recognise here <in this treatise> the powers of a mind born in heaven far remote from the life of brutes. He who ordered by written tablets to rein in murder, thievery, adultery and crimes of perjured fraud; or he who advised wandering people to surround cities with walls or who enriched communities with the gift of Ceres or who pressed from the grape relief from sorrows; or who demonstrated how to combine pictures and sounds on a reed from the Nile, and to present voices to the eyes; he elevated the human fate less, providing only a few conveniences for the woeful life. But now we are allowed as guests of the Gods, allowed to treat the law of the heavens, and now the concealed secrets of the hidden earth lie in the open, and the unchanging order of things, and matters that were hidden in past ages of this world.

Praise with me in songs this man who disclosed these things – all of you who delight yourself enjoying the heavenly nectar – NEWTON who opens the shrines of concealed truth, NEWTON who is beloved by the muses, whom Phoebus with his pure heart assists, and enters his mind with all his divine power: No mortal is allowed to come closer to the Gods.⁹

1.3 Discussion of the original and the revised versions of the poem

In his original poem from the 1687 first edition, Newton's editor and publisher Halley emulated a clear model: the first century BCE Roman poet Titus Lucretius Carus. The parallels to his *De rerum natura*¹⁰ (*DRN* from here on) can be assumed to have been obvious to an educated and scientifically interested reader in late seventeenth-century England.¹¹ Halley both refers to Epicurean materialistic

⁹ Translations, if not otherwise noted, are mine, with consultation of Albury (Footnote 2) and Cohen, Bernard/Whitman, Anne. *Isaac Newton, The Principia, The Authoritative Translation*. Berkeley: University of California Press, 1999.

¹⁰ All quoted passages, translations, and other references to the *DRN* in this paper refer to: Titi Lucreti Cari De Rerum Natura Libri Sex. Ed. Cyril Bailey. Oxford: Clarendon Press, 1947. All *DRN* line numberings correspond to this edition.

¹¹ See Haskell, Yasmin. "Religion and Enlightenment in the neo-Latin reception of Lucretius." *The Cambridge Companion to Lucretius*. Ed. Stuart Gillespie, Philip Hardie. Cambridge: Cambridge University Press, 2007. 185–201. See Gillespie, Stuart. "Lucretius in the English Renaissance." *Ibd.* 242–253. See Hopkins, David. "The English voices of Lucretius from Lucy Hutchinson to John Mason Good." *Ibd.* 254–273.

natural philosophy – atomic theory – and also mirrors Lucretian passages in which Epicurus is praised as a clear-sighted philosopher whose importance for the enlightenment of mankind is unique.¹² Several phrases Halley uses are distinctly Lucretian, such as: the *primordia rerum* (line 2), i. e. the atoms (which, in Halley's un-Epicurean reception, were placed in the cosmos by God) which are the building blocks that every material object, organic or inorganic, consists of; or the universe as a *vastum inane* (line 9), an immeasurable void within which the atoms exist and interact. There is even more allusive emphasis in passages in which Newton, in Halley's poem, holds the same role that Epicurus does in the *DRN*: the cloud of ignorance is dispelled by Newton's mathematics (*nubem pel-lente mathesi*, line 23) just as the Epicurean physics presented in the *DRN* dispel the darkness of the fear of the gods rooted in ignorance, e.g. in *DRN* I 146–148 or II 53–61¹³ (from which follows, according to Lucretius, *ataraxia*, complete equanimity or tranquillity of the soul). Halley's poem culminates in positioning Newton as the human being closest to the gods and thus resembles Lucretius in his praise of Epicurus as god-like in the proems to books III, V, and VI of the *DRN*.

The editor of the dedicatory poem to the *Principia*'s second edition, the famous classical scholar Richard Bentley, focused specifically on deflecting this notion of Newton as a modern Epicurus-like figure in his aim to spread scientific knowledge.¹⁴ The first four lines of Halley's unaltered poem read: "Behold the angle of the celestial axis and the balances of the divine mass, and the calculation of Jove; laws which, when he was establishing the origins of things, the all-bearing creator did not want to violate and which he determined as the foundation of his eternal works." Bentley's version reads (changes in italic): "Behold the angle of the celestial axis and the balances of the divine mass, and the calculation of Jove; laws which, when he was *creating* the origins of things, the *almighty creator stated to himself*, and *<behold the> foundations that he built for all his works*." Right at the beginning we see a significant revision by Bentley: the creator is not only *omniparens*, but also *omnipotens*, and *with his words* he

¹² Albury (Footnote 2), p. 28, notes that Halley does not expound the details of Epicurean atomism. This certainly would not have been possible in the context of this short dedicatory poem. Halley does, however, clearly allude to specific terminology of Epicurean atomic theory as discussed by Lucretius; and he could expect most of the readers to understand these references.

¹³ *DRN* I 146–148 and *DRN* II 59–61: "Hunc igitur terrorem animi tenebrasque necessest / non radii solis neque lucida tela diei / discutiant, sed naturae species ratioque." – "This terror then of the mind, this darkness must needs be scattered not by the rays of the sun and the gleaming shafts of day, but by the outer view and the inner law of nature."

¹⁴ I do not here examine all changes in the revised version of the poem. Many of the shorter ones are what Bentley considered to be simple emendations of Halley's Latin. See also Albury (Footnote 2), p. 39 n. 60.

created the laws of nature upon which the world was built. In the original passage God is following laws that *already existed* before he even began his work, which was a massive theological problem that Bentley avoided in his version.¹⁵

In the same spirit, I argue, there are changes from five (puzzling) indicative verbs to subjunctive in lines 6, 14, 16, and 18: *circumrotat* to *circumrotet*, *graditur* to *eat*, *remeant* to *remeent*, *progrediuntur* to *progreantur*, and *impellit* to *impellat*. There are two possible lines of argument. I will start with the seemingly more improbable one, namely that Bentley revised these verbs to highlight the impression that the scientific knowledge is not settled; and that these explanations are what might be, not what is sure, because men can only try to come close to God's knowledge on the workings of the cosmos. I am aware of the second possibility: that these changes are just simple corrections of Halley's Latin, because we have an indirect question in lines 14 to 18 initiated by the *Discimus* in line 13. However, that still leaves two questions open. Firstly, the change to the subjunctive *circumrotet* in line 6 is not necessitated by grammar. Here at least my first interpretation can still stand on grammatical grounds, namely that Bentley explicitly did not want to give the impression that the knowledge of the force that rotates the outermost orbits has been settled with certainty. Secondly, if Halley made a grammatical mistake in lines 14 to 18 in using indicative verbs in an indirect question,¹⁶ why *did* he use one subjunctive, the *recuset* in line 15? It seems probable to me that Halley deliberately chose the indicative for the above mentioned verbs even in an indirect question, precisely in order to make a point about these issues, namely that they are now certain knowledge, exactly measured and computed.

The next significant revision is the complete deletion of line 12. Halley's argument, paraphrased, is that a comet's path can now be computed and there is no longer any need to wonder over the appearance of this phenomenon. Bentley eliminated: "Now we do not wonder anymore about the phenomena of the bearded star." An educated reader in the late seventeenth and early eighteenth century would quite possibly have read this line with Lucretius' voice in his head who often started or finished explanations in the *DRN* with *nec mirum*, "it is no wonder". With this, he aimed to free men of fear of signs of the Gods and other divine interventions when in reality there are perfectly natural explanations for movements of heavenly bodies. Bentley seems to have wanted

¹⁵ See Albury (Footnote 2), p. 39.

¹⁶ I highly doubt this given the obvious, basic grammatical rule and Halley's proficiency in the Latin language.

his contemporary readers to wonder still and so to marvel at God's creation, even if the appearance of a comet can now be scientifically described.¹⁷

Another seemingly minor change in the lines 21 to 23 alters an allusion to Newton's importance for the resolution of millennia-old disputes. Halley wrote that the questions that agonised ancient natural philosophers and that still trouble their followers *to no avail* have now been resolved by Newton's mathematical explanations; line 21 refers to the disputes of ancient philosophers, line 22 with the verb in present tense to their contemporary followers. These three lines are the middle of the poem and, together with lines 24 to 26, mark the starting point of the following hymn to Newton as a quasi-divine intellectual liberator of mankind. Bentley changed just one word, *hodie* instead of *frustra*. In the second edition the same verses say: "What so often agonised the minds of ancient sages, what *still today* troubles their schools in rough disputes we can see revealed, the cloud dispelled by Mathematics." Bentley shows, as does Halley, that contemporary natural philosophers still fight the same fights that schools have been having for centuries. He does not, however, accentuate any notion of the previous disputes being futile – which Halley had done with *frustra*. This adverb in the first version emphasises Newton's singular significance for the history of science in the Lucretian tradition of a deified Epicurus. Bentley did not dismiss the importance of other natural philosophers as Halley did for the sake of the poem; this is a further step to separate Newton from Halley's Epicurean allusions.¹⁸

This passage is connected to the next intervention, again a major one: Bentley deleted line 24 and revised the next two lines 25 and 26. Halley's original reads: "[...] the cloud dispelled by Mathematics. No longer does error put a strain on the doubtful with its darkness; the acumen of our sublime mind allows us to enter the palace of Gods and ascend to the heights of heaven." Bentley's version reads: "[...] the cloud dispelled by Mathematics. *To enter the uppermost palaces and to touch the high temples of heaven is now permitted under Newton's guidance.*" The eliminated line 24 is a distinct and almost literal Lucretian thought¹⁹

¹⁷ This line does also refer directly to "one of the most significant achievements by Newton", Schliesser (Footnote 3), p. 423: "the last propositions of the *Principia* provide a (complex) procedure to calculate and predict the orbits of comets. Thus, in the first edition, the *Principia* closes on a series of propositions that in Halley's way of framing them allow one to tame the causes of superstition."

¹⁸ Ramunė Markevičiūtė helped me to work out this point.

¹⁹ See *DRN* III 14–17: "nam simul ac ratio tua coepit vociferari / naturam rerum, divina mente coorta, / diffugiunt animi terrores, moenia mundi / discedunt, totum video per inane geri res." – "For as soon as thy philosophy, springing from thy godlike soul, begins to proclaim aloud the nature of things, the terrors of the mind fly away, the walls of the world part asunder, I see

about how Epicurus lifted the grave error of being unnecessarily afraid of the gods from mankind. An educated contemporary reader in early eighteenth-century England would read Halley's line in this spirit, meaning that Newton too would be an Epicurus-like figure in freeing mankind from erroneous dogmas; not only that, but he would also be God-like in the same sense as Lucretius deified Epicurus. Furthermore, the difference between scaling the seats of the gods in Halley's original – *scandere* – and touching or reaching for the seats of the gods in Bentley – *contingere* – may be subtle, but it is important. In the first reading Newton, after scaling, is amongst them. In the second reading he may touch upon them but does not fully reach them. Lastly, in Bentley's revision only Newton seems to be able to reach for these heights of heaven and guide other men there, whereas in Halley's original the sublime mind of men in general is able to reach these heights of knowledge.²⁰

The last significant revision as regards content is the change from *jussit* to *primus* in line 30. I agree with Albury that this small change had a major impact, as it defused a blasphemous argument, namely that Newton's work was more influential for mankind than God's word given to men as the Decalogue on stone tablets; Bentley's revision manages to convey that "it was no longer the source of the commandments that was in question, but only the advice that they be observed."²¹ I disagree, however, with Albury's argument that "the Athenian sage only brought mankind *commoda vitae*. This placed Epicurus, for Halley, on the same level with the founders of agriculture, cities, etc."²² This analysis is misleading since it conveys the reputation that was ascribed wrongly to Epicurus and his philosophy throughout two millennia: that his contribution to mankind was to give licence to enjoy the common cravings of men and pleasures of the body. On the contrary, Lucretius' proems which

things moving on through all the void." And *DRN* V 7–12: "nam si, ut ipsa petit maiestas cognita rerum, / dicendum est, deus ille fuit, deus, inclute Memmi, / qui princeps vitae rationem invenit eam quae / nunc appellatur sapientia, quique per artem / fluctibus e tantis vitam tantisque tenebris / in tam tranquillo et tam clara luce locavit." – "For if we must speak as befits the majesty of the truth now known to us, then he was a god, yea a god, noble Memmius, who first found out that principle of life, which now is called wisdom, and who by his skill saved our life from high seas and thick darkness, and enclosed it in such calm waters and bright light."

20 Moreover, Albury (Footnote 2), p. 40: "In addition, for a believer such as Bentley the offending line may have been seen as suggesting that Newtonian science alone could overcome theological error (Papism, Socianism, etc.), independently of Divine Revelation."

21 *Ibid.*, p. 40.

22 Cf. *ibid.*, p. 36; also, p. 29 n. 15.

mention the *commoda vitae* (DRN III 2) or *solacia vitae* (DRN V 21) also state that these Epicurean gifts to mankind are explicitly *not* like the gifts of other gods such as Ceres or Bacchus, but rather that they are more valuable and precious²³ in that only they can lift the fear from humans and lead to equanimity and tranquillity of the soul, *ataraxia*. I concur, though, that Halley expressed the idea that Newton is to be placed even higher, since scientific knowledge has progressed immensely, precisely through the use of mathematics (a scientific technique or discipline on which Epicurus placed no importance).²⁴ I suggest that Halley, in the passage from line 21 to 38, indicates a scale of appreciation: the common divine gifts to mankind from line 30 to 36 – settlements, winegrowing, writing systems – are on the lower end (they are *pauca [...] commoda vitae*). Then, the mental salvation of mankind through ideas in Epicurean philosophy is much more valuable than these *pauca commoda vitae*; and this salvation from naïve superstition leads directly to Newton's scientific method of understanding and explaining natural phenomena through mathematics, which "elevates the human fate" the most.

As shown in detail in the above passages, Bentley's overall aim in revising Halley's ode was to eliminate all references and parallels to the *DRN* and to Lucretian imagery.²⁵ Particularly verses that opened up problematic theological

23 For example *DRN* V 13–21: "confer enim divina aliorum antiqua reperta. / namque Ceres fertur fruges Liberque liquoris / vitigeni laticem mortalibus instituisse; / cum tamen his posset sine rebus vita manere, / ut fama est aliquas etiam nunc vivere gentis. / at bene non poterat sine puro pectore vivi; / quo magis hic merito nobis deus esse videtur, / ex quo nunc etiam per magnas didita gentis / dulcia permulcent animos solacia vitae." – "For set against this the heaven-sent discoveries of others in the days of old. Ceres is fabled to have taught to men the growing of corn, and Liber the liquid of the vine-born juice; and yet life could have gone on without these things, as tales tell us that some races live even now. But a good life could not exist without a clean heart; *wherefore more rightly is he counted a god by us*, thanks to whom now sweet solaces for life soothe the mind, spread even far and wide among great peoples." [Emphasis mine].

24 Cosmology and astronomy were regarded as two different ways of studying the heavens – cosmology belonging to physics, astronomy to mathematics. Epicurus, in his Letter to Herodotus, explicitly rejects astronomy as the mathematical approach (Ep. Hdt. 79–80). See also Taub, Liba. "Cosmology and Meteorology". *The Cambridge Companion to Epicureanism*. Ed. James Warren. Cambridge: Cambridge University Press, 2009. 105–124, pp. 106 and 110.

25 One might interject that Bentley still left intact distinct Lucretian terms such as the *primordia rerum*, *vastum inane*, and other references to atomism. This, however, was not problematic by 1713, see Albury (Footnote 2), p. 39: "[...] basic postulates of Epicurean physics, atoms and the void, were not rejected by providentialists but reinterpreted in Newtonian terms: the 'weight' of Epicurean atoms, for example, became 'gravitation' in Newton's system, and so on. [...] Accordingly, Bentley had no objection to Halley's use of the Lucretian term for atoms, *primordia rerum*, in the second line of his ode."

questions or even the slightest impression of heresy based on the peculiar theology of the Epicureans and the status Lucretius ascribed to Epicurus had to be changed. Bentley made sure to give the poem the framework of natural theology and make an Epicurean-inspired interpretation unlikely.

1.4 Discussion of historical context

As we have seen in the previous section, the revisions to the ode in the *Principia*'s second edition had one clear aim: to remove all allusions to Newton as being in the role that Epicurus has in Lucretius' *De rerum natura*, namely a deified natural philosopher who, through his teachings, becomes a liberator of mankind. As much as one may today be surprised to find this much pathos in the preface to a scientific work, a dedicatory poem like this was not at all unusual. So why did Richard Bentley (as assistant to the editor of the *Principia*'s second edition Roger Cotes) feel the need to significantly change several of its passages? Albury's overall argument is that the reason for this was historical: 1687 and 1713 saw two completely different attitudes towards Epicurean philosophy (or what was perceived as such). In the mid to late seventeenth century there was a specific interest in Epicureanism that had not existed at the same intensity before 1660 and that would rapidly fall out of favour again after the Glorious Revolution in 1688/89.²⁶ During the Stuart Restoration and especially under King Charles II Epicurean philosophy was a fashion at court, especially in an aristocratic group of royalists called the Newcastle Circle.²⁷ Between 1655

26 See Harrison, Charles. "The Ancient Atomists and English Literature of the Seventeenth Century." *Harvard Studies in Classical Philology* 45 (1934): 1–79, esp. pp. 9–14, 25–26, on the shifting attitudes towards Epicureanism in the course of the seventeenth century. See also Røstvig, Maren-Sofie. *The Happy Man. Studies in the Metamorphoses of a Classical Ideal*. Oslo: Norwegian Universities Press, 1962, vol. 1, pp. 227–310, on the radical change of opinion on Epicurean ethics as a model for the contented English gentleman after the Stuart Restoration.

27 On the Newcastle circle, the chaotic political situation and religious turmoil, and the search for intellectual and social order and stability, see Lewis, Eric. "Walter Charleton and Early Modern Eclecticism." *Journal of the History of Ideas* 62.4 (2001): 651–664, esp. pp. 651–652. See also Kroll, Richard W.F. "The Question of Locke's Relation to Gassendi." *Journal of the History of Ideas* 45.3 (1984): 339–359, esp. pp. 344–345: "[...] a wider circle of writers associated with the Cavendishes did in fact begin to publish. Walter Charleton's justly famous *Physiologica-Epicuro-Gassendo-Charletoniana* (1654) and *Epicurus's Morals* (1656) were substantial attempts to show that Epicurus provided a scheme for understanding the natural world and that he was not necessarily hostile to Christian belief, if the appropriate adjustments were made along Gassendist lines. Moreover, John Evelyn produced in 1656 his edition of Lucretius, *Essay on the First Book of T. Lucretius Carus de Rerum Natura*."

and 1660, the author and translator Thomas Stanley published three volumes of his *History of Philosophy*, giving Epicurus a bigger part than Plato and Aristotle combined. In earlier decades, Lucretius' beautiful poetry had certainly been lauded, but scholars, poets, and other intellectuals had for the most part strictly distanced themselves from atomism, and (sometimes wilfully) misunderstood the Epicurean pursuit of pleasure as chasing common *hedonai*. Now, under Charles II, openly evoking Epicurean and Lucretian images was perfectly acceptable and even fashionable. Halley in his poem even mastered the art of charming the court with his poem on Newton and subtly criticising the superficial treatment of Epicurean philosophy by the aristocracy. He wrote that Newton had done much more for mankind than just provide *commoda miserae vitae* (line 38), distinguished Newton as closest to being godlike – and not the Stuart king – (line 48), and even depicted the biblical Decalogue as inferior to Newton's *Principia* (lines 30–31). Despite all these controversial references, with his poem Halley managed to make Newton's work an even more fashionable talking point at the quite liberal court.²⁸

With the Glorious Revolution of 1688, Stuart absolutism came to an end. The following monarchs William of Orange and Queen Mary strongly opposed Epicurean philosophy and Lucretius' *DRN*, especially the refutation of Providence; they specifically justified ending the Stuart monarchy by being preordained to take the throne.²⁹ As Albury argues, this unfavourable atmosphere towards central Epicurean teachings made it necessary for Bentley to remove or revise passages that could be deemed heretical.³⁰ I concur with his evaluation of how this historical context formed the background for significant changes in the dedicatory poem of the most influential scientific work in the early eighteenth century. However, as Schliesser argues, this general historical framework is not the full explanation of why the poem was changed to a physico-theological one – it was a personal necessity, too. Newton himself appointed Bentley as assistant to his second editor Roger Cotes,³¹ and he did this knowing full well that

²⁸ Albury (Footnote 2), pp. 36–37.

²⁹ Schliesser (Footnote 3), p. 424.

³⁰ Albury (Footnote 2), pp. 40–41. Although these main political circumstances had not changed by 1726 when Henry Pemberton published the third edition of Newton's *Principia*, Albury argues that the intellectual disputes from the change of the Stuart Restoration to the period after the Glorious Revolution were so far removed by 1726 that Pemberton could restore almost everything of Halley's original without a Lucretian interpretation being the most evident one.

³¹ Editor Roger Cotes, in his preface to the *Principia*'s second edition, makes very clear how it should be read: "Extabit igitur Eximium Newtoni Opus adversus Atheorum impetus munitissimum praesidium: neque enim alicunde felicius, quam ex hac pharetra, contra impiam Catervam

this would mean significant changes to the ode of his friend Halley.³² In a letter exchange from 1692, Bentley had shown himself to be bewildered by the openly Lucretian allusions, now at a perilous time to be an Epicurean. Shortly before, the influential Bentley had prevented Halley from becoming Professor of Astronomy at Oxford in 1691.³³ Newton seems to have had no other choice than to actively make sure, with Bentley as an editor, that an Epicurean reading of the poem, and, much more importantly, hence the *Principia* itself, was made as unlikely as possible.³⁴

In the following section, I retrace the complex relationship of Newton himself during these tumultuous times to Lucretius' *DRN* and Epicurean natural philosophy in general within his own writings in the scholia to the *Principia*, the *General Scholium*, and in Query 31 of the *Opticks*. My aim is to show that what occurred in Newton's overall relation to Epicurean sources was not an about-turn from an Epicurean framing under the Stuart monarchy (as the first

tela deprompseris. Hoc sensit pridem, & in pereruditis Concionibus Anglice Latineque editis, primus egregie demonstravit Vir in omni Literarum genere praeclarus idemque bonarum Artium fautor eximius Richardus Bentleius, Saeculi sui & Academiae nostrae magnum Ornamentum, Collegii nostri S. Trinitatis Magister dignissimus & integerrimus." – "Therefore Newton's excellent treatise will stand as a mighty fortress against the attacks of atheists; nowhere else will you find more effective ammunition against that impious crowd. This was understood long ago, and was first splendidly demonstrated in learned discourses in English and Latin, by a man of universal learning and at the same time an outstanding patron of the arts, Richard Bentley, a great ornament of his time and our academy, the worthy and upright master of our Trinity College." Transl. Cohen/Whitman (Footnote 9), pp. 44–45.

32 Albury (Footnote 2), pp. 38–39 writes that Bentley "was allowed by Newton to assist Roger Cotes in bringing out a second edition of the *Principia* in 1713". On Newton's strained early acquaintance with the "powerful and dangerous interlocutor" Bentley, see Schliesser (Footnote 3), pp. 424–425.

33 Schliesser (Footnote 3), pp. 419 and 424, particularly 419: "I argue that a considerable number of these changes might have been motivated by Newton's desire to prevent an Epicurean reading. In particular, I argue that Newton would have every reason to be alarmed by Bentley's attribution of Epicureanism to Newton. Bentley was powerful politically and he prevented Halley from obtaining a Professorship at Oxford a year before the correspondence with Newton." And 424: "So, when Newton received letters from Bentley with the repeated suggestion that a central part of the *Principia* sounded like Epicureanism, he would have had every reason for concern. Bentley could be dangerous to him."

34 Ibid., p. 424b, also convincingly challenges a common notion in Newton scholarship: that Newton helped elect Bentley for the Boyle lectureship. "There is no evidence that prior to his exchange with Bentley, Newton had a positive view of Bentley." Albury had, like many others, supposed that Newton was likely involved in Bentley's appointment, see p. 38. I also think it rather implausible, given the treatment of Newton's friend Halley in 1691, that Newton would recommend the man responsible for it to the prestigious Boyle lectureship in 1692.

edition's poem seems to indicate), to, twenty years later, a providentialist framing and strict rejection of Epicurean natural philosophy after the Glorious Revolution (as appointing Bentley to significantly change the poem seems to indicate), but rather a careful separation of Epicurean physics from Epicurean theology.

2 Newton on Lucretian passages and Epicurean themes

The *DRN* was an important text for Newton as for many other influential natural philosophers before and physicists after him.³⁵ There is very good textual evidence for Newton's direct reception of Epicurean natural philosophy as described in Lucretius' writings – from the same period, the early 1690s, when he became acquainted to Bentley who would later change or, more specifically, “de-Lucretianise” Halley's ode. Several scholia, originally intended as additions to Propositions IV to IX, Book III, in later editions of the *Principia* (but ultimately never published) were collected by David Gregory, a Scottish mathematician and astronomer and a contemporary of Newton.³⁶ Newton prepared these

³⁵ As Newton writes in the preface to his first edition of the *Principia*, his hope is to come closer to giving a mathematical account of the attractive and repulsive forces between the particles of matter: “Utinam caetera Naturae phaenomena ex principiis Mechanicis eodem argumentandi genere derivare liceret. Nam multa me movent ut nonnihil suspicer ea omnia ex viribus quibusdam pendere posse, quibus corporum particulae per causas nondum cognitae vel in se mutuo impelluntur & secundum figuras regulares cohaerent, vel ab invicem fugantur & recedunt: quibus viribus ignotis, Philosophi hactenus Naturam frustra tentarunt. Spero autem quod vel huic Philosophandi modo, vel veriori alicui, *Principia* haec posita lucem aliquem praebeant.” – “If only we could derive the other phenomena of nature from mechanical principles by the same kind of reasoning! For many things lead me to have a suspicion that all phenomena may depend on certain forces by which the particles of bodies, by causes not yet known, either are impelled toward one another and cohere in regular figures, or are repelled from one another and recede. Since these forces are unknown, philosophers have hitherto made trial of nature in vain. But I hope that the principles set down here will shed some light on either this mode of philosophizing or some truer one.” Transl. Cohen/Whitman (Footnote 9), pp. 28–29. See also: Gillespie, Stuart/Hardie, Philip. “Introduction.” *The Cambridge Companion to Lucretius*. Cambridge: Cambridge University Press, 2007. 1–15, p. 9.

³⁶ These scholia have been edited, translated, and extensively commented on in Schüller, Volkmar. “Newton's *Scholia* from David Gregory's Estate on the Propositions IV Through IX Book III of his *Principia*.” *Between Leibniz, Newton, and Kant*. Ed. Wolfgang Lefèvre. Dordrecht: Kluwer, 2001. 213–265.

scholia as evidence to show that ancient philosophers already had a concept of universal gravitation³⁷ – and so as historical support and justification of his own theory. The scholia with references to Lucretian passages are extensive and detailed. They make up a quarter of the entire amount of text in the manuscript and can be found on:

- folio 6r: pag. 408³⁸ Ad Prop. 5. Scholium. (paraphrase of Democritus, passages quoted directly: *DRN* V 91–98, 104–109).
- folio 6v: Ad Prop: VI Scholium. (paraphrases of Lucretius, passages quoted directly: *DRN* I 358–369, *DRN* II 184–198).
- folio 10r: (above citation continues until *DRN* II 205, paraphrases of Lucretius, other passages quoted directly: *DRN* II 216–244).
- folio 10v: (paraphrases of Lucretius and other ancient philosophers – Aristotle, Plato, Leucippus, Democritus, Thales, Pythagoras).
- folio 11r: Ad Prop. VII adde. (paraphrases of Plutarch and Lucretius, passage quoted directly: *DRN* I 984–994).
- folio 11v: (above citation continues until *DRN* I 997, paraphrase of Lucretius).

The following scholia on Pythagoras or Thales contain variants of preceding folios, and so, as regards actual content, the scholia on Lucretius effectively make up about a third of the entire manuscript. The intensity of Newton's treatment of the *DRN* in the scholia is unparalleled in comparison to the other ancient sources discussed there.

The passages from the *DRN* Newton referred to are descriptions of the gravity of the planets as well as the atoms (as the particles of which entire planets consist). In the scholium on folio 6r, to be added to Prop. V,³⁹ Newton summarised Democritus' view that the planets of one planetary system are "heavy toward each other", that "their gravity [is] also extended all over toward the other systems", and that "those that fade away are destroyed by falling into each other." He pointed out that, at the beginning of *DRN* V, Lucretius alludes to this, saying that all seas and lands and sky "one single day shall hurl to ruin; and the massive form and fabric of the world, held up for many years, shall fall

³⁷ Ibid., pp. 213 and 215.

³⁸ The pagination is that of the first edition of the *Principia*.

³⁹ Prop. V is about the gravitation of Jupiter's and Saturn's satellites toward their respective planets.

headlong.” And later: “that all things can fall in with a hideous rending crash.”⁴⁰ On folio 6v to Prop. VI,⁴¹ Newton noted:

That all bodies located around the earth, air and fire as well as the others, are heavy toward the earth and that their gravity is proportional to the quantity of matter of which they consist, was known to the ancients. For Lucretius pleaded for the void as follows: ‘[...] Therefore, we may be sure, that which we are seeking with keen reasoning, does exist mingled in things: that which we call void.’⁴² Lucretius attributes the gravity to the “office of the body” or to nature, which differentiates itself from the non-gravitating void, and concludes from this that the weight is always proportional to the body. He includes all bodies in this argumentation, invisible as well as visible. Then he ascribes gravity to even the atoms themselves, of which all else consists: He teaches that fire and the other bodies which are called light bodies do not ascend of their own accord, but as a result of a force driving upwards, just as wood, which is a heavy body, rises in water: but all bodies are carried downward through empty space.⁴³ (Schüller 2001, pp. 224–225)

After another lengthy citation of *DRN* II verses 184–205, Newton continued on folio 10r:

Although the lighter things, which have more difficulty overcoming the resistance of the air or the water, descend in these fluids more slowly, Lucretius nevertheless teaches that in empty space, where there is no resistance, all atoms, both the heavier ones and those which are less heavy, descend at an equal speed because of the gravity proportional to these atom, <and he teaches this> as follows.⁴⁴ ‘[...] But if perchance anyone believes that heavier bodies, because they are carried more quickly straight through the void, can fall from above on the lighter, and so bring about the blows which can give creative motions, he wanders far away from true reason. For all things that fall through the water

⁴⁰ Transl. Schüller (Footnote 36), pp. 222–225. The passages Newton quotes directly from the *DRN* in the scholia are given by Schüller in Cyril Bailey’s translation (Footnote 10), also used above in section 1.3.

⁴¹ Prop. VI deals with the proportionality of weight to mass (quantity of matter).

⁴² The complete Lucretian passage quoted here by Newton is *DRN* I 358–369 and is a compelling argument for the existence of the void.

⁴³ “Corpora omnia quae circa terram sunt tam aerem et ignem quam reliqua esse gravia in Terram et eorum gravitatem proportionalem esse quantitati materiae ex qua constant Veteribus etiam innotuit. Nam Lucretius pro vacuo sic disputat ‘[...] Est igitur nimirum id quod ratione sagaci / Quaerimus, admixtum rebus quod inane vocamus.’ Lucretius hic refert gravitatem ad corporis officium seu naturam qua ab inani non gravitante distinguitur et inde concludit pond<us> corpori semper proportionale esse: Quo argumento corpora omnia tam insensibilia quam sensibilia comprehendit. Nam et atomis ipsis ex quibus alia omnia constant gravitatem hanc attribuit: Docet enim ignem et corpora alia quae levia dicuntur non spon<te> sed vi subigente ascendere perinde ut lignum quod corpus grave est ascendit in aqua: corpora autem omnia per spatium inane deorsum ferri.”

⁴⁴ The following passage I have omitted here is a detailed argument on the justification for introducing the swerve, the *clinamen*.

and thin air, these things must needs quicken their fall in proportion to their weights just because the body of water and the thin nature of air cannot check each thing equally, but give place more quickly when overcome by heavier bodies. But, on the other hand, the empty void cannot on any side or at any time support anything, but rather, as its own nature desires, it continues to give place; *Wherefore all things must needs be borne on through the calm void, moving at an equal rate despite unequal weights.*⁴⁵ [...]'⁴⁶

(Schüller 2001, pp. 226–229)

Then, he commented on folio 10v:

Lucretius taught this based on the view of Epicurus, Epicurus based on the views of Democritus and older philosophers. For some, who asserted the quality of atoms, thought that the gravity of the bodies was proportional to the number of atoms of which they consist. The others, who believed atoms to be unequal, taught that the gravity <of the bodies> was proportional not to the number of solid <atoms in the bodies>, but to the quantity of the solid <matter in the bodies>. [...]

Thus among the philosophers who would have the body consist of atoms, the view is accepted again that gravity falls to the atoms as well as the constituted bodies and that it is proportional to the quantity of matter in the individual bodies.⁴⁷

(Schüller 2001, pp. 228–229)

45 The emphasis on these two lines is written in Newton's hand all in capital letters. Schüller argues on p. 253 n. 38 that this passage confirmed for Newton that already in antiquity some natural philosophers thought that the acceleration of a body would be the same, independent of its weight – a central tenet of Newton's theory of gravitation.

46 "Et quamvis res leviores quae aeris vel aquae resistentiam difficilior vincant in his fluidis descendant tardius, tamen in spatio vacuo ubi nulla est resistentia atomos omnes tam graviores quam minus graves propter gravitatem sibi proportionalem aequali celeritate descendere, sic docet Lucretius '[...] Quod si forte aliquis credit graviora potesse / Corpora, quo citius rectum per Inane feruntur, / Incidere e<x> supero levioribus, atque ita plagas / Gignere, quae possint genitalis reddere motus: / Avius a vera longe ratione recedit. / Nam per aquas quaecumque cadunt atque aera deorsum / Haec pro ponderibus casus celerare necesse est / Propterea, qua corpus aquae, naturaue tenvis / Aeris haud possunt aequae rem quamque morari: / Sed citius cedunt gravioribus exsuperata. / At contra nulli de nulla parte, neque ullo / Tempore Inane potest vacuum subsistere reij, / Quin, sua quod natura petit, concedere pergat. / Omnia quapropter debent per Inane quietum / Aequae ponderibus non aequis concita ferri'."

47 "Haec Lucretius ex mente Epicuri Epicurus ex mente Democriti et antiquiorum docuit nam quidam aequalitatem atomorum statuantes gravitatem corporum numero atomorum ex quibus constabant proportionalem esse volebant, alij autem quibus atomi inaequales erant, gravitatem non numero solidorum sed q<uan>titati solidi proportionalem esse docebant. [...] Inter philosophos igitur qui corpora ex atomis composuere gravitatem tam atomis quam corporibus compositis competere & quantitati materiae in singulis corporibus proportionalem esse recepta fuit opinio."

On folio 11r and 11v, to be added to Prop. VII,⁴⁸ Newton noted:

Accordingly it is an old view that gravity toward the entire earth originates from this gravity to its individual particles, just as the attractive force of an entire magnet is composed of the attractive forces of the individual particles of which the magnet consists. [...] Therefore Lucretius teaches that there is no center of the universe and no infinite place, but rather infinitely many worlds in infinite space, worlds similar to ours. [...] The strength of the argument is that if the universe were bordered anywhere, then the outermost bodies would not be in equilibrium, because they have no outermost <bodies> toward which they are heavy, but rather strive toward the inner <bodies> through their own gravity. Because they have been flowing together forever, they long since would have accumulated in the center of the whole, so to speak at the lowest point. Accordingly, based on Lucretius' view, each body is heavy toward the matter surrounding it and is carried by the gravity with the superior force to regions where more matter is.⁴⁹

(Schüller 2001, pp. 232–235)

These passages – and the others listed above but not further explicated – show that Newton relied heavily on ancient atomic theory as expounded by Lucretius. He used them as historical precedent for the purpose of justification of his own law of universal gravitation.⁵⁰ As planned during this time, these scholia were to accompany future editions of the *Principia* (though ultimately they were never published).⁵¹ Given this fundamental reliance on Lucretius' writings on the gravity of planets and of matter particles, it seems likely that, some years after he wrote the scholia and before publishing the second edition, Newton preferred to

⁴⁸ In Prop. VII Newton says that gravity exists in all bodies universally. Gravity is proportional to mass (quantity of matter).

⁴⁹ "Igitur quemadmodum vis attractiva Magnetis totius componitur ex viribus attractivis particularem singularum ex quibus Magnes constant sic gravitatem in Terram totam ex gravitate in singulos ejus particulas oriri antiqua fuit opinio. [...] Hinc docet Lucretius nullum esse universi centrum locum infinitum sed infinitos esse in spatio infinito mundos huic nostro similes [...]. [...] Vis argumenti est quod si rerum natura alicubi finiretur, corpora extrema, cum nulla haberent exteriora in quae gravia essent non starent in aequilibrio sed per gravitatem suam peterent interiora et undique ex infinito tempore confluendo jamdudum in medio totius quasi in loco imo jacuissent. Igitur corpus unumquodque ex mente Lucretii grave est in materiam circumcirca positam et per gravitatem praepollentem fertur in regionem ubi materia copiosior est [...]."

⁵⁰ This was not the only central topic of his theory in which he referred to Lucretius. For example, in a fragment on the law of inertia in Newton's unpublished papers he also traced its origins back to ancient natural philosophers and explicitly referred to Lucretius twice. See Johnson, Monte/Wilson, Catherine. "Lucretius and the history of science". *The Cambridge Companion to Lucretius*. Ed. Stuart Gillespie, Philip Hardie. Cambridge: Cambridge University Press, 2007. 131–148, esp. pp. 141–142.

⁵¹ Schüller (Footnote 36), p. 213.

have the programmatic references to the *DRN* deleted solely due to political pressure after the Glorious Revolution, and not necessarily of his own conviction. He clearly drew on the authority of Lucretius' poem to substantiate his own mathematised account of phenomena in physics and astronomy. David Gregory put the following statement by Newton on record in his notes after visiting him in 1694: "The philosophy of Epicurus and Lucretius is true and old, but was wrongly interpreted by the ancients as atheism."⁵²

One could argue now that these texts from the early 1690s are not all that relevant to the changes in the paratexts of the *Principia*'s second edition that was published two decades later in 1713 – after all, by then Newton could have changed his mind on the importance of ancient sources on atomic theory for his own work. The following section, however – one of the most quoted passages of text in scientific history –, in Query 31 of the *Opticks*' second edition from 1718 shows that the profound influence of Lucretius' *DRN* and of Epicurean atomic theory in general is still, by the mid-1710s, evident in Newton's thought:

All these things being consider'd, it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, moveable Particles, of such Sizes and Figures, and with such other Properties, and in such Proportion to Space, as most conduced to the End for which he form'd them; and that these primitive Particles being Solids, are incomparably harder than any porous Bodies compounded of them; even so very hard, as never to wear or break in pieces: No ordinary Power being able to divide what God himself made one in the first Creation. While the Particles continue entire, they may compose Bodies of one and the same Nature and Texture in all Ages: But should they wear away, or break in pieces, *the Nature of Things* depending on them, would be changed. Water and Earth composed of old worn Particles and Fragments of Particles, would not be of the same Nature and Texture now, with Water and Earth composed of entire Particles, in the Beginning. And therefore that Nature may be lasting, the Changes of corporeal Things are to be placed only in the various Separations and new Associations and Motions of these permanent Particles; compound Bodies being apt to break, not in the midst of solid Particles, but where those Particles are laid together, and only touch in a few Points.⁵³ [Emphasis mine] (Newton 1718, pp. 375–376)

⁵² Ibid., p. 214, referring to Newton's Correspondence III 334 No. 446.

⁵³ Newton, Isaac. *Opticks: Or, A Treatise of the Reflections, Refractions, Inflexions and Colours of Light. The Second Edition, with Additions*. London 1718. Newton, however, rejected the Epicurean theory of cohesion and conglomeration of atoms: "The Parts of all homogeneous hard Bodies which fully touch one another, stick together very strongly. And for explaining how this may be, some have invented hooked Atoms, which is begging the Question; [...]" *Opticks*, pp. 363–364.

Also, Newton attempted to mathematise atomic theory in other writings on optics and chemistry during the course of his career.⁵⁴ Moreover, the mere fact that Newton in his *General Scholium* on the *Principia* famously rejected “feigning hypotheses” on processes in nature that are in themselves not observable, but thought at the same time that the atomic theory, unprovable by observation, was the most probable,⁵⁵ shows his commitment to what he learned from Lucretius’ *DRN* and other ancient and early modern texts on atomic theory.

It could be argued as well that mathematics as such, and the application of mathematics in the study of physical phenomena – and so Newton’s whole approach – are inherently un-Epicurean.⁵⁶ However, as is implied above in the passage from his own preface to the first edition, Newton professed his hope that with scientific progress the mathematisation of the physical world might one day even lead to the proof of atomic theory. In conclusion, it seems implausible that Newton himself, of his own accord, strictly rejected all Lucretian imagery in Halley’s ode in general, as the revised version might seem to indicate.

Nevertheless, due to the politically and philosophically hostile atmosphere towards what was perceived as the consequences of all teachings of Epicureanism, Newton needed to keep his work out of a potential conflict in which he could not risk taking sides. Thus, the position he takes in the same Query 31 is clearly opposite to the Epicurean theory of the gods (and its denial of divine providence). If we examine this together with the passages discussed above, we may conclude that Newton considered the insights gained from descriptions of Epicurean physics to be distinctly separate from the theology, arguing for providentialism.

Now by the help of these Principles, all material Things seem to have been composed of the hard and solid Particles above mention’d, variously associated in the first Creation by the Counsel of an intelligent Agent. For it became him who created them to set them in

⁵⁴ Johnson/Wilson (Footnote 50), p. 142: “[...] first attempts to quantify atomic phenomena. The mathematisation of the atomic theory is notable in some sections of Newton’s optical and chemical writings and in his *Principia*, which contain a mathematical derivation of Boyle’s gas law: Newton assumed the existence of particles in his derivation, but refrained from mentioning the atomic hypothesis in this essentially mathematical work.”

⁵⁵ See Wilson, Catherine. “Epicureanism in early modern philosophy.” *The Cambridge Companion to Epicureanism*. Ed. Stuart Gillespie, Philip Hardie. Cambridge: Cambridge University Press, 2009. 266–286, p. 272: “Though Isaac Newton in turn professed disdain for hypotheses concerning unobservable processes that did not admit of experimental or mathematical demonstration, he followed Gassendi, Descartes and Boyle in giving a stamp of approval to corpuscularianism in Book 3 of his *Principia*, and in the last Query of the first Latin edition of his *Opticks* (1706).”

⁵⁶ See footnote 24.

order. And if he did so, it's unphilosophical to seek for any other Origin of the World, or to pretend that it might arise out of a Chaos by the mere Laws of Nature; though being once form'd, it may continue by those Laws for many Ages. [...] Also the first Contrivance of those very artificial Parts of Animals, the Eyes, Ears, Brain, Muscles, Heart, Lungs, Midriff, Glands, Larynx, Hands, Wings, Swimming Bladders, natural Spectacles, and other Organs of Sense and Motion; and the Instinct of Brutes and Insects, can be the effect of nothing else than the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies.⁵⁷ (Newton 1718, pp. 377–379)

He had already spelled out the same argument a few years earlier in the *General Scholium* that was appended to the second (1713), and later also in the third edition (1726) of the *Principia*:

This most elegant system of the sun, planets, and comets could not have arisen without the design and dominion of an intelligent and powerful being. And if the fixed stars are the centers of similar systems, they will all be constructed according to a similar design and subject to the dominion of *One*, especially since the light of the fixed stars is of the same nature as the light of the sun, and all the systems send light into all the others. And so that the systems of the fixed stars will not fall upon one another as a result of their gravity, he has placed them at immense distances from one another. He rules all things, not as the world soul but as the lord of all. And because of his dominion he is called Lord God *Pantokrator*.⁵⁸ (Cohen/Whitman 1999, p. 940)

He closed this passage on God's works with:

This concludes the discussion of God, and to treat of God from phenomena is certainly a part of natural philosophy.⁵⁹ (Cohen/Whitman 1999, p. 943)

Here, in the treatment of the origin of particles and thus the whole cosmos at the end of the *Principia*, Newton explicitly rejected the theological implications of Epicureanism as described by Lucretius. Thus, here too he separated the theology

⁵⁷ Newton: Opticks (Footnote 53), pp. 377–379.

⁵⁸ "Consilio et dominio solo Entis intelligentis, elegantissima haecce Solis et Planetarum compages oriri potuit. Et si stellae fixae sint centra similium systematum, haec omnia simili consilio constructa suberunt Vnius dominio: praesertim cum lux fixarum sit ejusdem naturae ac lux solis, & systemata omnia lucem in omnia invicem immittant. Et ne fixarum systemata per gravitatem suam in se mutuo cadant, hic eadem immensam ab invicem distantiam posuerit. Hic omnia regit non ut anima mundi sed ut universorum Dominus et propter dominium suum Dominus Deus παντοκράτωρ dici solet."

⁵⁹ "Et haec de deo, de quo utique ex phaenomenis disserere, ad philosophiam naturalem pertinet."

of Epicurean atomic theory from its physics, by which he was influenced – and which he had once even planned to use as justification for his own theory of gravitation, as shown above in the section on the scholia.

3 Conclusion

In the present study I have argued that, to explain the changes to Halley's ode to Newton's *Principia*, the historical context is certainly an important aspect, but this approach lacks an account of Newton's own relation to Lucretius' *DRN*. This is provided by the present paper. It has shown that Newton's own treatment of Epicurean philosophy is more complex than an interpretation that directly ascribes the different versions of the ode, and thus the paratextual framing of the *Principia*, solely to external circumstances: i. e., ascribing the openly Lucretian ode to the Stuart monarchy, and the physico-theological reading to the tumultuous period after the Glorious Revolution. Newton's own writings – about the *DRN* in the scholia and about general notions and concepts of Epicurean natural philosophy in other works mentioned here – show a careful separation of Epicurean physical theory and theology. They also reflect, in general, an intense engagement with, reliance on, and sympathy for the ancient source.

This sympathy for Lucretius' *DRN* (and Halley's original ode) can be substantiated by the fact that in the *Principia*'s third edition of 1726, almost everything⁶⁰ – even the seemingly blasphemous passage starting in line 30 – was changed back to Halley's original by its editor, the scholar and physician Henry Pemberton (whom Newton had called *vir peritissimus*, a man of highest expertise, in his preface to the third edition). By then the ideological turmoil around Epicureanism had settled down; not every slightly suspect theological implication needed to be carefully avoided. This version in all its Lucretian glory would become the highlight of early modern poetry about natural philosophy as the paragon for countless other poems, even forming its own genre,⁶¹ on scientific progress and praise of natural philosophers in the following decades.

60 I. e. everything besides the abovementioned line 4, so Pemberton's revision reads: "*quas [...] omniparens leges violare creator / noluit, atque operum quae fundamenta locarit:*" instead of Halley's original: "*quas [...] omniparens Leges violare Creator / Noluit, aeternique operis fundamina fixit.*" The notion that matter is eternal (described here as some sort of pre-divine building parts of the world) seems still to have been too unorthodox, even though it had been possible to change everything else back to the original.

61 See Hopkins (Footnote 11), and Albury (Footnote 2), p. 41.