

St. Albert the Great and Robert Grosseteste on the nature and causes of comets

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journals.sagepub.com/home/jha**William Crozier**

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Abstract

Addressing a subject which has received very little attention, this article explores the interpretations of comets offered by St. Albert the Great (c. 1190–1280) and Robert Grosseteste (1168–1253). It shows how, despite *prima facie* convergences between the two 13th-century bishops concerning the nature and causation of comets, there are nonetheless several previously unobserved subtle differences between them. For Grosseteste the celestial bodies (i.e. the stars and the planets) are the primary, and indeed sole, efficient causes of cometary phenomena, serving to draw up rarefied matter to the upper atmosphere whereupon it is inflamed as it is assimilated to the celestial nature itself. For Albert, by contrast, while the celestial bodies may help to stir up combustible vapours within the atmosphere, and at times precipitate their ascension to the heavenly vault by means of their motion and conjunction, it is not always the case that a comet arises as a result of the direct efficient causality of the celestial bodies.

Keywords

Celestial vault, comets, planets, Robert Grosseteste, St. Albert the Great, stars, vapours

Introduction

In his commentary on St. Matthew's Gospel, the German Dominican bishop, St. Albert the Great (c. 1190–1280), makes the following remark: 'the whole world is theology for us, because the heavens proclaim (*enarrant*) the glory of the Lord'.¹ Albert's interest in the nature of the heavens – that is to say, the nature of the stars, the moon and the planets,

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and their respective celestial spheres – is well attested and has been studied in relative depth by noted historians of science, including P. Duhem and E. Grant.² One important aspect of Albert's thought about the heavens has, however, been largely overlooked. This is his thinking on the nature of one of the most spectacular events within the night sky, comets. Perhaps a partial explanation for this is the fact that Albert's thought on comets is not to be found in his principal work on the heavens – namely in his commentary on Aristotle's *De caelo*. Instead, it occurs in his commentary on the latter's *Meteora*, written sometime 1254–1257.³ As we will see, for Albert – just like Aristotle, and indeed most medievals – comets are not celestial phenomena; rather, they are meteorological ones. Comets occur, so the thesis goes, when earthly 'vapours' ascend through the atmosphere and congregate beneath the vault of the lowest celestial sphere, namely that of the moon, whereupon they ignite and become visible. This article looks at what Albert has to say on the nature and causes of comets. In particular, it explores how his thinking relates to that of his English contemporary and fellow bishop, Robert Grosseteste (1168–1253), and how there are some subtle, though nonetheless important, differences between their views.⁴ Surprisingly, very little has been written on Albert's thinking on comets and no extended comparison of his thought with Grosseteste's has been produced. Indeed, little has been written on the medieval theory of comets in general.

Composed during the 1220s, Grosseteste's little treatise on comets, *De cometis*, postulates that comets consist of 'sublimated' (*sublimata*) earthly matter which, upon reaching the celestial barrier, is 'inflamed'.⁵ As for Albert, so for Grosseteste comets are caused by the ascension and ignition of terrestrial vapours. What is notable, however, is that the two bishops have subtly differing interpretations of the precise causal role which the planets and fixed stars play in the generation of comets. For Grosseteste, the sublimation of earthly vapours occurs solely as a result of the direct causal agency of the celestial bodies, with the latter acting like magnets drawing up these combustible fumes. For Albert, by contrast, a more complex picture is the case. While he affirms that the celestial bodies do indeed stir up different types of vapours within the atmosphere and do, under certain circumstances, contribute to the ascension of these to the celestial vault, thereby causing a comet's generation, he nonetheless follows Aristotle in noting that comets often arise independent of any direct celestial agency. The celestial bodies, so he tells us, play an integral role in producing the vapours needed for a comet's generation. However, it is not always the case that the ascension of these vapours occurs as the result of the direct causal agency of a celestial power. To this extent, for Albert, there are times when the stars and planets function at the level of dispositive causes, merely creating the material conditions needed for the creation of a comet, but yet are not directly involved in the latter's generation itself.

While Albert's discussion of comets in his *De meteora* post-dates Grosseteste's *De cometis* by several decades it is important to note that there is little to suggest that Albert had any direct knowledge of Grosseteste's treatise or the general contours of its content. Having said this, some of the positions which Albert critiques concerning the causes involved in a comet's production do share certain traits with the ideas found in Grosseteste's *De cometis* and helpfully serve to situate the latter. For purposes of clarity I shall thus discuss Albert's thinking first and then address Grosseteste's material on the subject.

Albert, Grosseteste and the medieval debate on comets

It is important to note that Albert and Grosseteste were not unique in discussing the nature and causes of comets during the early-to-mid 13th century. The questions ‘how are comets generated?’, ‘how do they move?’ and ‘what do they signify?’ were discussed widely during this period. Thus, besides Albert’s and Grosseteste’s contributions, several other treatises on comets have come down to us from this period. These include a lengthy anonymous text composed in Spain around 1238 and Giles of Lessines’ important *De essentia, motu, et significatione cometarum* – the latter was composed following the appearance of the comet of 1264 and, as even a cursory glance reveals, demonstrates a strong familiarity with Albert’s and Grosseteste’s writings.⁶ Also notable is the fact that the subject of how comets were produced and what they signified often found its way into theological literature of the time. It is thus not uncommon to find some mention of comets in commentaries on the second book of Peter Lombard’s *Sententiae*, which discusses – amongst other things – God’s creation of the celestial bodies and how they serve to govern the pattern of terrestrial life.⁷ Indeed, the subject of comets and their generation was even discussed in the *quaestiones disputatae* conducted by theology masters in the Papal court itself.⁸ It is, however, in the various commentaries and glosses from this period on Aristotle’s *Meteorora* that the most in-depth study of comets is to be found. For example, St. Thomas Aquinas offers a lengthy exposition of Aristotle’s discussion of comets in his *Sententia super meteorora*, while Roger Bacon and Adam of Buckfield both discuss comets in their respective *Meteorora* commentaries.⁹

Aside from the fact that Albert and Grosseteste constitute two of the most well-known scientific writers of the 13th-century – and were both recognized as such during their own day – these two thinkers are worthy of particular consideration because their differing interpretations of how comets are generated helped to shape the debate which was to run throughout much of the later middle ages on this subject. The question of how the celestial bodies draw up the flammable vapours needed for a comet’s generation, and indeed that of other atmospheric phenomena visible in the night sky, – that is, whether it is by means of their motion or by means of some attractive agency – was one which can be detected throughout the literature of the following centuries. For example, in his *Quaestio de aqua et terra*, Dante Alighieri, the famous 14th-century Venetian poet and natural philosopher, states that this question remained unresolved and much-disputed even in his own day.¹⁰ In turn, as already indicated, Albert and Grosseteste are also worthy of our attention because they are the thinkers most frequently referenced, alongside Aristotle himself, by later medieval writers as the leading *auctores* on the subject of cometary generation. Thus, both are frequently quoted in Giles of Lessines’ extensive *De essentia, motu, et significatione cometarum* and Gerard of Silteo’s *Summa de astris*, both of whom, like Albert himself, observed the great comet of 1264. Similarly, a much neglected late-13th century *Meteorora* commentary, once thought to be by the celebrated Scottish Franciscan friar, Bl. John Duns Scotus, repeatedly quotes Albert concerning the nature and signification of comets.¹¹

Aristotle, comets and the celestial vault

In order to understand Albert's and Grosseteste's thinking on comets properly, it is necessary to offer a few brief remarks on the medieval understanding of the structure of the cosmos itself. Following the cosmologies articulated by the Ptolemaic and Aristotelian schools, the medieval mind maintained that the earth stood at the centre of the universe and was, as Grosseteste's *De sphaera* explains, surrounded by a series of transparent concentric spheres, each which was constantly in motion.¹² To these were attached one or more of the visible celestial bodies – that is, the stars, planets, sun and moon. Made of what Aristotle called the unchanging and eternal 'quintessence', each of these spheres, and the celestial bodies which they contained, was hierarchically organized according to their degree of rarefaction.¹³ Thus, as John Sacrobosco affirms in his *De sphaera*, the moon was situated within the lowest celestial sphere – that is, the sphere immediately adjacent to the earth – while the fixed stars, as the most rarefied celestial bodies, were attached to the outermost sphere.¹⁴ Possessed of perfect actuality and motion, it was this outermost sphere – on account of its proximity to God – which provided the motor which kept the lower spheres in motion and thus governed the behaviour of the planets within them. It is for this reason that St. Bonaventure of Bagnoregio, echoing Aristotle and the Islamicate scholar Averroes, tells us that the motion of the planets, and their respective spheres, was to be understood according to the manner in which a key in a lock operates: as the key – in this case the outermost celestial sphere – turns, so it causes all the lower spheres, and their respective planets, to move and obey its direction.¹⁵

As already indicated, demarking the boundary between the celestial and the terrestrial realms, it is the interface between the underside of the convex surface of the lunar sphere and the upper reaches of the terrestrial air which constitutes the space within which a comet is generated. According to Aristotle and his medieval interpreters, immediately beneath the concave surface of the lunar sphere are to be found several spheres of highly rarefied versions of the lower earthly elements – the most important of these, for our purposes at least, being that of fire.¹⁶ Caused by the friction of the lunar sphere's quintessence rubbing against the body of air beneath it, the fire in this space is of a diaphanous nature – hence it does not prohibit our ability to see the higher celestial bodies, as would be the case were it the same as the coloured fire found here on earth.¹⁷ As mentioned above, for Grosseteste and Albert – like Aristotle – it is when combustible vapours from the lower atmosphere ascend, in enough quantity, up through the air and enter into the sphere of fire that the heat of the latter causes them to ignite and produce a comet on the underside of the celestial vault. It is the same process, so the medievals note, which give rise to other, more short lived, luminescent phenomena in the night sky, including shooting stars and what Aristotle calls 'torches' and 'goats'.¹⁸ It is this location of comets within the boundary between the lowest celestial sphere and the terrestrial realm which explains why for the medievals they are to be classified as meteorological, as opposed to celestial, phenomena.

Before proceeding to explore Albert's and Grosseteste's thought on the role which the celestial bodies play in a comet's production it is worth noting what Aristotle himself says on the subject. For the Stagirite, it is the motion of the celestial bodies – as opposed to any attractive or quasi-magnetic agency – which is the force responsible for stirring up

the vapours from which comets and the like are birthed: 'so whenever the circular motion stirs this stuff up in any way, it catches fire at the point at which it is most inflammable'.¹⁹ In turn, he adds: 'we may say then, that a comet is formed when the upper motion introduces into a gathering of this kind a fiery principle'.²⁰ At this level, Aristotle's thought, as we will come to see, has more in common with Albert's position than it does with Grosseteste's – something which is hardly surprising given that Albert's account of comets is to be found in his commentary on the Stagirite's *Meteroa*. This, in turn, is coupled with the fact that it is not overly clear, in the opinion of some at least, that Grosseteste had any direct knowledge of the *Meterora* at the time he composed the *De cometis*.²¹ Importantly, as John North has noted, the notion that the stars and planets stir up the vapours by means of attraction, as opposed to doing so simply by through their motion, is something which Grosseteste shares with the Islamicate tradition, in particular Albumasar's *Introductorium in astronomiam*.²² Interestingly, however, Grosseteste – unlike Albert – does not reference Albumasar in his discussion of comets.²³ Furthermore, as North points out, Albumasar's account of how the celestial bodies govern the meteorological events, echoes the ideas found in early Indian astronomy in that it accords a much greater causal agency to the stars and planets in governing terrestrial and meteorological changes than Aristotle himself permitted.²⁴

Albert's critique of the 'modern doctors'

Albert begins his discussion by outlining the erroneous opinions which Aristotle himself successfully refuted – namely, the argument that comets arise from a conjunction of two or more planets or the blurring of a planet's light through a distortion of the air.²⁵ These authors, so he tells us, erred through weak reasoning and ignorance concerning the nature of vision and how light interacts with the transparent atmosphere.²⁶ Similarly, Albert rejects the views advanced by later thinkers, such as the Roman philosopher Seneca and the Eastern Orthodox theologian John Damascene.²⁷ For the latter, comets are not meteorological events, but rather genuine new occurrences within the celestial spheres themselves. While these thinkers were unknown to Aristotle, Albert insists that their arguments are nonetheless proved wrong by his logic. This is so because, as the Stagirite's *De caelo* clearly shows, nothing new is ever generated within the celestial region itself. The unchanging and sempiternal nature of the heavenly quintessence prohibits any change within it.²⁸ Comets, however, so Albert observes, are clearly sporadic phenomena. Not only is their appearance unpredictable, but so also is their movement within the night sky. Moreover, they themselves are subject to change and decay. The result, so Albert asserts, is that they cannot be part of the celestial realm but must instead be a purely sub-lunar reality. Particularly interesting, however, is the fact that Albert tells us that aside from these mistaken ancient authors there are also 'certain learned modern doctors' (*Quidam modernum doctorum*) who, due to their erroneous reasoning and inadequate observations, offer up what Albert regards as false opinions concerning comets.²⁹ Who exactly these 'modern doctors' are, however, is hard to discern.³⁰

Rejecting the scholarly consensus that comets arise from inflamed earthly vapours, these 'moderns' argue that a comet is in fact an 'impression' (*impressio*) of one or more of the five planets caused at the boundary separating the sphere of fire from that of air.³¹

The planets, so their thesis maintains, illumine certain ‘lines’ (*lineae*) of air and fire in the upper atmosphere, and, through doing so, give the illusion of a tail being attached to one or more of the celestial bodies.³² So as to support this highly novel position, Albert notes how adherents of this theory highlight what they see as several weaknesses in the Aristotelian theory of comets. They argue, for example, that if comets arise from a collection of ignited vapours condensing beneath the heavenly vault, then surely the same process of ascending condensation and ignition should be seen within the celestial spheres themselves.³³ After all, the principle of universal concordance dictates that what occurs in the earthly realm should also occur, or at least be mirrored within, its celestial counterpart. Yet clearly this is not the case. Furthermore, these ‘modern doctors’ argue that the theory that comets arise from ignited terrestrial vapours fails to convince on account of the weak and highly transient nature of these vapours themselves. Either they would be immediately consumed by the sphere of fire on account of its great heat, thereby preventing the accumulation of sufficient fuel to generate a comet; or they would be confined to the lower regions of the atmosphere which are ‘cold and depressed (*deprimitur*) down to earth’, thus meaning they would never be ignited and rendered luminous.³⁴

Albert’s refutation of the ‘modern doctors’

For Albert, the arguments put forward by the ‘modern doctors’ are entirely unacceptable. While firmly rejecting the theory that comets arise from illuminated lines of air and fire at the celestial barrier – a position which he rejects as both nonsensical and contrary to reason – Albert takes particular exception to their claim that comets arise solely as a result of the direct causality of the planets and stars. The principal difficulty which he sees with this claim is that it does not fit the evidence. If the celestial bodies are the primary forces responsible for the generation of comets, that is to say the illumination of the lines of fire and air, then why are comets not always visible in the night-sky? After all, the planets and stars are permanent fixtures within the celestial realm, and yet comets appear only rarely.³⁵ Moreover, how can these ‘modern doctors’ account for the wide diversity of places in which comets appear? If comets are caused by the planets, then surely comets ‘should never be seen outside the path (*extra viam*) of the planets’.³⁶ This, however, is manifestly not the case. Comets often appear far outside the zodiac, even coming as close as the horizon of the North Pole itself. Indeed, Albert himself remarks that he himself had once witnessed a comet of this sort: ‘I with many others in Saxony in the year 1240 from the Incarnation of the Lord saw a comet close (*iuxta*) to the North Pole’.³⁷ In short, for Albert the principal error of the ‘modern doctors’ is that they attribute too close a causal link between the celestial bodies and the generation of comets. Moreover, by doing so, they fail to appreciate that there are other causes involved in a comet’s creation.

Albert’s theory of comets

What then does Albert say that comets are? A comet, so he tells us, is a ‘sort of flame’ (*flamma quaedam*) arising from ‘enkindled fumes’ (*fummus ascensus*).³⁸ It is generated

from 'coarse terrestrial vapour (*vapor terrestris grossus*), whose parts lie very close together'.³⁹ These ascend through the atmosphere until they reach the 'concave surface of the sphere of fire' whereupon they are 'diffused and inflamed' (*diffusus et inflammatus*).⁴⁰ Albert explains that the reason why the ascending vapour must be of a coarse nature is due to the fact that if it were of a subtle, wisp-like quality then 'it would quickly evaporate (*cito evaporatur*)', thereby meaning that a comet would not persist but would burn up quickly, which, as experience reveals, is clearly not the rule of nature. Comets, after all, often last for days, even months.⁴¹ Here we thus see Albert offering a very succinct solution to the principal objection of the 'modern doctors' against the vapour theory of cometary generation. In turn, Albert notes that the reason why the 'parts' of this vapour are said to lie close together and are 'well-mixed' (*bene comixtus*) is because if the consistency of the vapour were of an irregular nature then it would be insufficient to generate a uniformly inflamed body.⁴² In Albert's opinion it is thus the coarseness and the viscosity of the ascending vapour which serves to guarantee both a comet's longevity and the regularity of its luminosity.

This coarse vapour, Albert argues, arises from 'ignited terrestrial parts' which are found within rain-producing vapours in the atmosphere.⁴³ Some of these fall with the rain itself but then re-ascend through a process of evaporation. Eventually these ignited parts, both those that remained in the sky and those that re-ascend to it, ascend above the cold air from which they are birthed into the higher, warmer parts of the atmosphere.⁴⁴ Here they gradually multiply and begin to converge, eventually forming a coherent mass, albeit one that is not entirely uniform or spherical. The reason for the irregular shape of this vaporous mass, so Albert tells us, is that as it comes into contact with the convex surface of the sphere of fire and is inflamed, parts of it are diffused and begin to streak across the sky.⁴⁵ However, the middle part of the ascending vapour cloud remains dense. This is because it is continuously supplied by the reservoir of ignited vapours existing below it in the lower atmosphere.⁴⁶ This condensed middle, Albert reasons, forms the body of the comet for it burns the brightest. By contrast, the vapours which are diffused from the vaporous body form a flame-like white cloud, and it is this which gives the comet its tail: '*et haec vocatur coma*'.⁴⁷ Albert claims that a comet will persist in the sky as long as the supply of vapours from the lower atmosphere beneath it lasts. Once these vapours begin to exhaust, the comet begins to fade as the intensity of its ignition starts to weaken.⁴⁸

Albert postulates that the diversity of colour, shape and brightness found within comets is derived from the quality and coarseness of the vapours which produce them. Following Algazel, he argues that there are three different types of inflamed vapours. First, there are those vapours whose rarity is such that they are enflamed entirely and burn brightly as pure flame. Second, there are those vapours whose coarseness is denser and is of a black appearance. This type of vapour functions like coal so that when it is enflamed through contact with the sphere of fire it gives the comet a glowing red colour.⁴⁹ Finally, there are those vapours whose coarseness is so great that when enflamed they produce comets which are 'black and extinct' (*niger et extinctus*).⁵⁰ Albert notes, however, that there are two further types of comet. The reason for this is that between these three different degrees of condensed vapour there are two intermediary states; namely, a mean between the first and the second, and one between the second and the

third.⁵¹ Thus, on this fivefold spectrum, the coarser and more ‘sticky’ (*coherens*) the vapour, the darker and less luminous a comet will be.⁵² In turn, the more rarefied – and thus more combustible – the vapours, the brighter and more iridescent its colour will be.⁵³

As noted earlier, Albert does not deny that the stars and the planets have a causal role in the generation of comets. Rather, he merely maintains that for the most part this role is not that of immediate efficient cause. Instead, the stars and planets function more akin to what may be termed ‘dispositive’ causes.⁵⁴ It is beyond question, so Albert tells us, that the celestial bodies do indeed play an active role in shaping the pattern of terrestrial life. After all, he observes, Albuasar convincingly shows that some of the planets stir up ‘humid’ and ‘aqueous’ vapours which precipitate storms.⁵⁵ Conversely, others – in particular Mars – stir up dry and highly flammable vapours.⁵⁶ These cause certain ‘coruscations’ or ‘scintillations’ in the air.⁵⁷ The latter, however, are of a highly transitory nature, producing short-lived ‘running fires’ in the atmosphere.⁵⁸ In Albert’s thinking, therefore, it is clear that, through their stirring up of different kinds of vapours within the atmosphere, the stars and planets serve to provide the material resources needed for many of the different meteorological phenomena observed within the night sky, including comets. Crucially, however, in the case of the latter, it depends more often than not on the atmospheric conditions, and indeed the predominance of the required type of flammable vapours, as to whether these then ascend to the underside of the heavenly vault and proceed to be ignited. What exactly these conditions are, however, Albert does not spell out for us. What is clear nonetheless is that for Albert a comet’s generation may occur independently of any direct involvement by a celestial power.

As Aristotle teaches, however, there are certain occasions when comets do appear to arise under the immediate direction of one or more of the celestial bodies. This occurs, for example, when the planets move in an unusual way or when two or more of them are in conjunction. Here, so the Stagirite affirms, the celestial bodies do not simply stir up vapours in the atmosphere, but facilitate their ascension and ignition. In light of this Albert notes that there are a number of ‘commentatores’ – including Haly, Abraham and Bulgafarus – who, taking their lead from Pseudo Ptolemy’s *Centoquilium*, accept that comets are ‘the effects of stars upon vapours elevated and ignited’.⁵⁹ Similarly, Albert observes that Albuasar affirms that there are times when Mars does not just stir up the dry fumes needed to form a comet, but directly facilitates the latter’s ascension to the heavenly vault. This occurs primarily when Mars is in conjunction with Jupiter. What is interesting, however, is that despite conceding that occasionally the celestial bodies do facilitate the ascension and ignition of the fumes which they regularly stir up, it is not overly clear that Albert sees this causal agency as functioning at the level of attraction or direct efficient causality. Rather, he seems to view their causal agency at this level as functioning akin to a secondary effect of their motion and, in particular, the warming effect which their ‘rays’ (*radii*) of light have as they traverse across the atmosphere.⁶⁰ Thus, in the same way that a stick upon being moved through a pond will stir up particles of dirt hidden at the bottom and cause them to ascend to the surface, so the same appears to be the case with those vapours whose ascension to the heavenly vault is caused by the motion of the celestial bodies and their *radii*.

Robert Grosseteste: Comets as ‘sublimated fire’

While Robert Grosseteste’s theory of cometary generation may not fit the profile of the opinions of Albert’s ‘modern doctors’, what is clear, even from a cursory reading of the *De cometis*, is that the Bishop of Lincoln nonetheless shares their assumption that the celestial bodies are the direct causes of comets.⁶¹ Written early in his career, Grosseteste’s *De cometis* argues that comets arise from fire ‘sublimated’ (*sublimatus*) from the earthly realm by the agency of one or more of the planets and stars.⁶² A comet, so he tells us, is ‘nothing else than fire’ (*nihil aliud quam ignis*) generated from rarefied matter arising from below (i.e. the earth) which is then ‘assimilated to the celestial nature’ (*assimilatus nature celesti*) by means of the agency of one or more of the celestial bodies.⁶³ Grosseteste notes, however, that fire is of two sorts. First, there is that fire which is associated with the combustion of earthly matter; second, there is that hyper-rarefied fire which is found just below the lunar boundary.⁶⁴ Sense experience reveals, however, that earthly fire cannot be responsible for cometary generation. This is on account of the fact that it does not persist long enough in the air to form a stable body.⁶⁵ Conversely, the hyper-rarefied ignition found within the upper atmosphere does not descend from its proper place and has a purely diaphanous nature, hence it also cannot constitute the fire generating comets.⁶⁶

The result, so Grosseteste argues, is that the fire responsible for the generation of comets must be unique. It is a fire which arises from the ascension of earthly matter – by this Grosseteste means, like Albert, earthly ‘vapours’ – which, upon ascending to the heavenly vault, is enflamed and ‘assimilated’ (*assimilatus*) to the celestial nature’ itself.⁶⁷ This ‘assimilation’ to the celestial nature explains why, unlike ordinary material fire, the fire generated by the ascending vapours which gather beneath the celestial vault is capable of persisting in the air for a long-time. By being ‘separated from [its] earthly nature’ (*seperata a natura terrestri*) it comes to possess something of the stability and perfect motion of the celestial spheres themselves.⁶⁸ The cause of this assimilation, however, Grosseteste asserts, cannot arise from the earthly vapours themselves, but must instead possess a celestial origin. The reason for this is that only a celestial agent, being the superior and more potent nature, has the capacity to act upon, and thereby assimilate to itself, inferior earthly matter. Consideration reveals, however, that the only celestial forces capable of such agency are the planets and fixed stars.⁶⁹

What is notable, however, is that for Grosseteste – unlike Albert – this causal agency exercised by the celestial bodies in drawing up earthly matter occurs not simply at the level of motion, and the subsequent stirring up of vapours within the atmosphere, but also, and most properly, at the level of attraction. The sublimated matter from which comets are birthed, so Grosseteste tells us, ascends to the underside of the heavenly vault due to the fact that the stars and planets actively draw up this matter to themselves. Thus, in the same way that a magnet attracts iron filings to itself, so the celestial bodies draw up rarefied earthly matter.⁷⁰ For Grosseteste there is, therefore, very much a direct causal link between the stars and planets and a comet’s epiphany. It is thus the agency of the celestial bodies, and nothing else, which underpins each stage of a comet’s production. Not only are the latter responsible for producing the material conditions necessary for a comet’s generation, but they also actively facilitate the ascension and ignition of the

vapours from which a comet derives. Here we can thus detect a very sharp point of opposition to the line of reasoning which Albert was later to adopt in his *Meteora*.

According to Grosseteste, the attractive agency of the celestial bodies is confirmed by the fact that comets not only follow the rotation of the night sky, and thereby the orbit of the stars and the planets themselves, but the tail of the comet nearly always points towards one or more of the celestial bodies; and this, in turn, so Grosseteste notes, is often the body responsible for creating the comet.⁷¹ The fact that the fixed stars differ in nature and correspond in quality to at least one of the seven planets also explains why comets differ in appearance, duration and timing. Some of the planets and fixed stars, for example, assimilate only certain types of matter to themselves – for instance, dry and hot – while others, by contrast, assimilate matter that is of a different nature.⁷² The result of course, so Grosseteste tells us, is that different types of comet will signify a change in specific earthly realities. For example, if the comet arises from the agency of the sun, which on account of the perfection of its luminosity, attracts ‘well-complexioned’ (*complexionata*) matter, then there will result a ‘weakening’ in human, animal and vegetative life forms. This is so because as the comet is formed it will abstract matter from these beings and they thus will lose something of their vital being.⁷³ A similar corruption, Grosseteste argues, would arise if Mars were the planet responsible for the comet.⁷⁴

Conclusion

In light of all this, it is clear that there is an interesting dialogue to be had between the cometary theories of Albert the Great and Robert Grosseteste. While both affirm the traditional peripatetic claim that comets are meteorological, as opposed to celestial, phenomena, careful inspection reveals that the two bishops nonetheless diverge on the question of the causal agency which the celestial bodies play in a comet’s generation. Broadly speaking, these differences concern two key areas. On the one hand, Albert distances himself from Grosseteste’s insistence that the celestial bodies are always the direct causes of comets, arguing instead that more often than not their agency is restricted to merely creating the material conditions necessary for a comet’s generation – that is, the stirring up of combustible vapours. On the other hand, Albert asserts that when the planets and stars do act as the immediate efficient cause of a comet’s generation they do so not by means of attraction, as Grosseteste supposes; instead, their causal agency appears to be simply an extension of their pattern of motion or conjunction with one another.

By way of conclusion, it can be noted that one possible reason for these differences is that there may be something of a divergence between the way Albert and Grosseteste understand the nature of the celestial bodies themselves. Where Albert repeatedly, and indeed unhesitatingly, affirms the Aristotelian doctrine that the planets and stars are made of the same celestial quintessence as the ethereal spheres in which they are nested, and thus are materially identical with them, Grosseteste’s position, by contrast, is by no means as clear cut. Indeed, it is decidedly ambivalent. Not only does the English bishop confess himself unsure of Aristotle’s claim that the celestial bodies are made of the quintessence – he is particularly explicit on this front in his magisterial *Hexaemeron* – but in the influential little treatise entitled *De generatione stellarum*, the Grossetestian heritage of which it should be noted is a matter of much dispute,⁷⁵ it is claimed that the stars and

planets are in fact made up of the same four elements found here in the sub-lunar realm: earth, air, fire and water.⁷⁶

If such an elemental reading of the celestial bodies is indeed to be attributed to Grosseteste then this may, perhaps, offer some insight as to why, in contrast to his German counterpart, he views the planets and stars as attractive agents drawing up vapours to the celestial vault.⁷⁷ The reason for this is that in the *De generatione stellarum* the argument is advanced that it is only because of the elemental – as opposed to ethereal – nature of the celestial bodies that they are able to influence sub-lunar realities.⁷⁸ Indeed, it is this agreement in substance, so the *De generatione stellarum* implies, which explains why the celestial bodies are able to affect the earthly elements in such a potent way, one which would not be possible were they materially different from the earthly recipients of their agency. Admittedly this view is not advanced, as far as this author can see, in the *Hexaemeron*, the *De cometis* or indeed in any of Grosseteste's other undisputed works; and whether one accepts it as offering a possible avenue for explaining Grosseteste's departure from Albert's position on the causal role of the celestial bodies in the generation of comets depends, of course, on whether one is willing to attribute the *De generatione stellarum* to him or not.⁷⁹ Questions of authorship, however, are beyond the scope of this article. What is clear, however, is that during the early- to mid-13th century the study of comets burned brightest in the hands of these two great bishops and scientists.

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Notes

1. Albert the Great, *Enarrationes in evangeli matthaei*, cap.13.35 'Totus enim mundus theologia est homini, dum caeli enarrant gloriam Dei'. *Opera Omnia*, tom. XX, L. Borgnet (ed.) (Paris: 1893), p. 571. For an introduction to Albert's life and general thinking see R. Van Nieuwenhove's *An Introduction to Medieval Theology*, 2nd ed. (Cambridge: Cambridge University Press, 2022), pp. 247–63. A highly focused introduction to Albert's contribution to the various sciences is to be found in I.M. Resnick (ed.), *A Companion to Albert the Great: Theology, Philosophy, and the Science* (Leiden: Brill, 2013). Also important are the various essays found in J.A. Weisheipl (ed.), *Albertus Magnus and the Sciences: Commemorative Essays* (Toronto, ON: PIMS, 1980).

2. See E. Grant, *Planets, Stars, and Orbs: The Medieval Cosmos, 1200-1687* (Cambridge: Cambridge University Press, 1994), pp. 294–6. For a broader discussion of Albert's interest in cosmology and the heavenly bodies see the various discussions of his ideas in P. Duhem, *Medieval Cosmology: Theories of Infinity, Place, Time, Void, and the Plurality of Worlds*, trans. R. Ariew (Chicago, IL and London: Chicago University Press, 1985). A particularly helpful recent study concerning the medieval understanding of the nature of the stars, planets and the celestial spheres, and in particular how medieval thinking on these related to, was influenced by, and sometimes challenged, accepted theological wisdom and church teaching, is M. Sorokina's *Les spheres, les astres et les theologiens: l'influence celeste entre science et foi dans les commentaires des sentences (V. 1220-V. 1340) Studia Sententiarum 5* (Turnhout: Brepols, 2021). For a recent study which pays particular attention to medieval astrology and its close relationship to medieval astronomy, and how, in turn, astronomy and astrology were understood in the early modern period, see H.D. Ruskin's *Sapientia Astrologica: Astrology, Magic and Natural Knowledge, ca. 1250-1800, 1. Medieval Structures (1250-1500): Conceptual, Institutional, Socio-Political, Theologico-Religious and Cultural* (New York, NY: Springer, 2019).
3. See Albert the Great, *Meteora, Opera Omnia* VI.I, P. Hossfeld (ed.) (Münster: Monasterii Westfalorum in Aedibus Aschendorff, 2003). Albert's treatise on comets is to be found in lib. I, tract. 3, pp. 25–33. All translations from Albert's *Meteora* are taken from the translation of the latter found in L. Thorndike's *Latin Treatises on Comets, 1238-1368* (Chicago, IL: University of Chicago Press, 1950), pp. 62–76. For the dating of the *Meteora* and its relationship to Albert's earlier Aristotelian commentaries, see *Meteora*, pp. v–vi.
4. The literature on Grosseteste's life and works is profuse. For a general overview of Grosseteste's thinking, theological, scientific, and philosophical see J. McEvoy, *Robert Grosseteste* (Oxford: Oxford University Press, 2000). Recent studies and editions of Grosseteste's scientific works have arisen from the Ordered Universe Project based at Durham University's Department of History. Texts produced by the project include: G.E.M. Gasper, *et al.* (ed.), *Knowing and Speaking: Robert Grosseteste's De Artibus Liberalibus (On the Liberal Arts) and De Generatione Sonorum (On the Generation of Sounds): The Scientific Works of Robert Grosseteste, vol. 1* (Oxford: Oxford University Press, 2019); G. Dinkova-Bruun, *et al.* (ed.), *The Dimensions of Colour: Robert Grosseteste's De Colore* (Toronto, ON: PIMS, 2013).
5. This article uses the critical edition of Grosseteste's *De cometis* found in C. Panti's *Moti, virtù et motori celesti nella cosmologia di Roberto Grossetesta. Studio ed edizione dei trattati «De sphaera», «De cometis», «De motu supercelestium»* (Firenze: Sismel-Edizioni Del Galluzzo, 2001), pp. 321–8. The edition presented in L. Baur's *Die Philosophischen Werke Des Robert Grosseteste, Bischofs von Lincoln* (Munster: Aschendorff, 1912) is neither critical nor accurate; see Baur, *op. cit.*, pp. 36–41. For an overview of the manuscript tradition behind the *De cometis*, and a helpful breakdown of the limitations of Baur's edition, see C. Panti's "Robert Grosseteste's Early Cosmology," in E. Mackie and J. Goering (eds), *Editing Robert Grosseteste: Papers Given at the Thirty-Sixth Annual Conference on Editorial Problems*, University of Toronto, 3–4 November 2000 (Toronto, ON: PIMS, 2003), pp. 135–66, at pp. 144–9. Most scholars concur that the *De cometis* dates from the 1220s, with A.C. Crombie dating it to 1228, or shortly thereafter, as this is the year when Halley's comet would have been visible in the night sky. See A.C. Crombie, *Robert Grosseteste and the Origins of Experimental Science 1100-1700* (Oxford: Clarendon, 1958), pp. 48–9. J. McEvoy likewise concurs with this dating and notes that the presence of alchemical and Islamic influences within the *De cometis* suggests that the work is indeed an early one of Grosseteste: 'When Grosseteste enlarges upon the process of the generation of comets, bits and pieces of astrology and alchemy appear, notions that are of Arabic derivation but of course quite foreign to pure

- Aristotelianism. The presence of these ideas suggests that this treatise should be located early in his development, for they do not recur in his mature work'. J. McEvoy, *Robert Grosseteste* (Oxford: Oxford University Press, 2000), p. 79.
6. Editions of these texts are to be found in Thorndike, *op. cit.* (Note 3), pp. 87–184 and pp. 9–61, respectively.
 7. See Bonaventure, 2 *Sent.*, dist. 14, pars. 2, art. 2, q. 2, ad. 4 (Firenze: Quaracchi, 1938), pp. 371–2.
 8. J. Peckham discusses the nature of comets in his *Quaestiones de stellis*. These, so it seems, were disputed by Peckham during his time as *lector* at the papal curia. See Peckham *Quaestiones Disputatae*, G.J. Etzkorn, et al. (ed.) *Bibliotheca Franciscana Scholastica* vol. 28 (Grottaferrata: Quaracchi, 2002), pp. 195–224. The material focusing on comets in *quaestio* 2 is to be found on pp. 200–2; pp. 211–3. Peckham states his motivation for discussing comets was occasioned by the feast of the Epiphany, marking the advent of the magi to see the Christ child: '*Occasione solemnitate Ephiphanae incumbentis, quaesitum est utrum stella, quae duxit magos ad Christum, fuit vera stella*'. He asks in question two: '*An fuerit saltem cometa*'. Quotes on pp. 195 and 200, respectively. Peckham judges that the wandering luminary which led the magi to Bethlehem was neither a comet nor a real star, but rather a unique event within the night sky: '*Ad secundam quaestionem: sicut haec stella non erat vera stella sed conveniens cum ipsa, ita nec erat vera stella cometa, quamvis haberet aliquam convenientiam cum cometis. Tunc quia non legitur alicui stella fixae vel erraticae adhaesisse, sicut faciunt quaedam cometae, nec legitur crines habuisse vel comam, sed tantum in figurae stellae apparuisse*', p. 211. Likewise, Albert himself rejects the idea that the luminary in the night sky which the magi observed was a true star or a comet: '*Haec autem stella differebat in quinque a stellis aliis secundum omnes communiter, natura videlicet, situ, motu, claritate, et significatione. . . . Situs autem ejus fuit, quod non fuit in alio cum aliis stellis in firmament, sed in spacio hujus aeris vicina loco terrae tenebat. Non tamen erat cometes, qui in orbitibus et in mortibus regum apparere solet. . . .*' Albert the Great, *Enarrationes in evangeli matthaei*, cap. 2.2 (Note 1), pp. 64–5, at p. 65.
 9. See Aquinas, *Sententia super meterora*, Lect. 9–11. <<https://isidore.co/aquinas/Meteora.htm#1.11>>, accessed 5 March 2023. The commentary on the *Meterora* text attributed to Bacon is to be found in Rome, College of San Isidoro, Library, 1/10, ff. 112ra-134vb; 144ra-166vb. Originally this text was attributed to Bonaventure due to its having been listed amongst Bonaventure's works while the manuscript was housed at Assisi during the fourteenth-century. Inspection reveals, however, that the text is not concordant with Bonaventure's style and is, in the opinion of most, far more likely to be by Bacon. See B. Distelbrink, *Bonaventurae Scripta Authentica Dubia Vel Spuria Critice Recensita* (Rome: Instituto Storico Cappuccini, 1975). Adam of Buckfield's *glossa* on the *Meterora* survives in several manuscripts, including Munich, Bayerische Staatsbibliothek, Clm 14522 III, ff. 165va-190vb. For a detailed discussion of the debate concerning Bonaventure's literary corpus see P. Maranesi, "The *Opera Omnia* of St. Bonaventure: History and Present Situation," in J.M. Hammond, J.A.W. Hellmann and J.Goff (eds), *Companion to Bonaventure* (Leiden: Brill, 2014), p. 67. See also Maranesi's important study on Bonaventure's *Opera Omnia* "L'edizione critica bonaventuriana di Quaracchi," *Doctor Seraphicus*, 49 (2002), 13–67.
 10. Dante, *Quaestio de aqua et terra*, n. 21. Thus, Dante notes: '*manifestum est, quod virtus elevans est illis stellis quae sunt in regione coeli istis duobus circulis contenta, sive elevet per modum attractionis, ut magnes attrahit ferrum, sive per modum pulsionis, generando vapores pellentes, ut in particularibus montuositatibus*'. A bilingual edition of Dante's *Quaestio de aqua et terra* is to be found in A. Campbell White, *A Translation of the Quaestio de aqua et terra: With a Discussion of its Authenticity* (Boston: Ginn & Company, 1903), edition at pp. 1–59, quotation just given at pp. 46 and 48. Dante's authorship of this text has been

- disputed ever since its inclusion within his works during the sixteenth-century. However, E. Moore's defence of the text's link to Dante is now accepted by most Dante scholars as persuasive. See E. Moore, *Studies in Dante, Second Series* (Oxford, 1899), pp. 303–74.
11. Editions of Giles of Lessines' *De essentia, motu, et significatione cometarum* and the relevant section of Silteo's lengthy *Summa de astris* are to be found in Thorndike, *op. cit.* (Note 3), pp. 87–184 and pp. 185–195, respectfully. As even a cursory glance reveals, much of what Silteo writes on comets and their generation constitutes a close paraphrasing of Albert's key ideas in his *Meteorora*. See Thorndike, *op. cit.* (Note 3), esp. pp. 191–3. Pseudo-Scotus' *Quaestiones de Meteorologicae* are to be found in *Johannis Duns Scoti, Opera Omnia*, L. Vivés (ed.) (Paris: 1891), pp. 3–263, with the material devoted to comets found on pp. 83–96. Indeed, Pseudo-Scotus often speaks '*ad rationem Alberti*' and notes '*secundum Albertum super isto*', cf. p. 93.
 12. According to Grosseteste's *De sphaera*, the world stands at the centre of the universe and is surrounded by the celestial spheres to which are attached the five planets: '*Consimilis figure et situs corpus huius mundi est; unum quod quintum essentiam nominant philosophi, sive ethera sive corpus celi, et preter elementares proprietates circulariter mobile in quo 7 planete cum stellis fixis continentur*'. Text of Grosseteste's *De sphaera* is to be found in Panti, *op. cit.* (Note 5), pp. 298–319, quote at p. 290. Perhaps the most detailed and influential medieval discussion of the structure of the universe and the relationship between the celestial spheres and the earth's atmosphere is John of Sacrobosco's *De sphaera*. For an edition and translation of this text see L. Thorndike, *The Sphere of Sacrobosco and Its Commentators* (Chicago, IL: University of Chicago Press, 1949). Latin text at pp. 76–117. English translation at pp. 118–42.
 13. See Grosseteste, *De sphaera, op. cit.* (Note 5), p. 290. This notion that the superior celestial bodies, and the spheres to which they are affixed, consisted of a more rarefied element and found particular expression in Averroes' *De substantia orbis*. According to Averroes, the fixed stars consist of a perfectly rarefied version of the quintessence, while the moon consists of an imperfect and irregular condensed version of it. An edition of Michael Scot's translation of Averroes' *De substantia orbis* from the Arabic is to be found in A. Manuel *Comentario al "De substantia orbis" de Averroes: Aristotelismo y Averroismo, per Álvaro de Toledo* (Madrid, 1941). An English translation of Averroes' text is to be found in: A. Hyman trans. *Averroes' De Substantia Orbis: Critical Edition of the Hebrew Text With English Translation and Commentary* (Cambridge, MA and Jerusalem: The Medieval Academy of America, 1986).
 14. Sacrobosco, *De sphaera, op. cit.* (Note 12), p. 79. '*Circa elementarem quidem regionem ethera lucida, a variatione omni sua immutabili essentia immunis existens, motu continuo circulariter intercedit. Et hec a philosophis quinta essentia nuncupatur, cuius novem sunt spere, sicut in proximo pretactum est, scilicet lune, Mercurii, Veneris, solis, Martis, Iovis, Saturni, stellarum fixarum, et celi ultimum*'.
 15. Bonaventure, 2 *Sent.* dist. 14, pars. 2, art. 1, q. 2, resp., *op. cit.* (Note 7), p. 358. '*Positio vero naturalium est, sicut Aristotelis et Commentatoris, quod planetae non moventur nisi motu suorum orbium, sicut clavus fixus in rota movetur motu rotae. . .*'.
 16. Aristotle's description of the structure of the sublunary matter is found in *Meteorora*, 1.4, 341b. Text taken from W.D. Ross (ed.), *The Works of Aristotle*, vol. 3 (Oxford: Clarendon Press, 1931).
 17. Aristotle, *Meteorora, op. cit.* (Note 16), 1.4, 341b.
 18. Aristotle, *Meteorora, op. cit.* (Note 16), 1.4, 341b.
 19. Aristotle, *Meteorora, op. cit.* (Note 16), 1.4, 341b.
 20. Aristotle, *Meteorora, op. cit.* (Note 16), 1.7, 344a.

21. The suggestion that Grosseteste did not have first-hand knowledge of the *Meteorora* at the time he composed the *De cometis* is suggested by J.D. North in his “Celestial Influence – The Major Premise of Astrology,” in P. Zambelli (ed.), *Astrologi Hallucinati* (Berlin: DeGruyter, 1986), pp. 45–100, at p. 65.
22. For an overview of Albumasar’s life and works see J. Hackett, “Albumasar,” in J.E. Gracia and T.B. Noone (eds), *A Companion to Philosophy in the Middle Ages* (Oxford: Blackwell, 2002), pp. 102–3. The Latin text of Albumasar’s *Introductorium maius* is to be found in R. Lemay (ed.), *Introductorium maius* (Naples, 1995–1996), 9 vols. An English translation is to be found in K. Yamamoto and C. Burnett, *The Great Introduction to Astronomy by Abū maʿšar* (Leiden: Brill, 2019), 2 vols.
23. Cf. North, *op. cit.* (Note 21), pp. 62–9. As E.S. Laird has shown, however, the text known as the *Quaestio de fluxu et refluxu maris* attributed to Grosseteste shows a strong dependence on Albumasar’s *Introductorium maius*. See E.S. Laird, “Robert Grosseteste, Albumasar, and Medieval Tidal Theory,” *Isis*, 81 (1990), 684–94.
24. North, *op. cit.* (Note 21), pp. 52–4.
25. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 2-3 (Note 3), pp. 25–7. Albert is emphatic that while comets may look like stars they are not stars nor indeed any form of event within the celestial spheres themselves. Thus he writes in his commentary on the *De caelo*: ‘*Secundum veritatem autem dicuntur stellae quae similitudinem habent stellarum, sicut assub ascendens et cometes et ignis perpendicularis et huiusmodi; et illa dicuntur exacui propter multum calorem superioris aeris eius regio aestus vocatus, et est aer ignitus, qui est locus existens in circuitu talium stellarum, quae non in veritate sunt stellae, sed stellae dicuntur propter similitudinem, quam habent ad stellas*’. *De caelo*, tract. 2, cap. 2, *Opera Omnia*, tom. V. 1, P. Hossfeld (ed.) (Münster: Monasterii Westfalorum in Aedibus Aschendorff, 1971), p. 145.
26. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 1-3 (Note 3), pp. 25–7. According to Seneca comets are to be numbered ‘amongst the eternal works of nature’ (*inter aeterna opera naturae*) which, as true celestial bodies, actively traverse the different celestial spheres containing the planets and fixed stars through unique passageways: ‘*Nempe haec ipsa sidera quae sola moveri creditis alios et alios circulos habent; quare ergo non aliqua sint quae in proprium iter et ab istis remotum secesserint? Quid est quare in aliqua parte caeli pervium non sit?*’ Seneca, *Naturales Quaestiones*, lib. 7, trans. T.H. Corcoran (Cambridge, MA: Harvard University Press, 1972), pp. 272–3, 274, respectively.
27. Albert the Great, *Meteora*, lib. 1, tract. 3, caps. 4 and 6 (Note 3), pp. 27, 29–30, respectively.
28. For Albert’s affirmation of the Aristotelian doctrine of the quintessence, in particular its perfect immutability and circular motion see his *De caelo* commentary, esp. tract. 1, caps. 3-4 (Note 25), pp. 7–14.
29. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 27; Thorndike, *op. cit.* (Note 3), p. 65.
30. Despite much searching, I have been unable to identify concretely the positions which Albert attributes to the ‘modern doctors’ with any of his immediate contemporaries or predecessors. Having said this, in his edition of the *Meteorora*, Hossfeld alludes to Grosseteste as being one of the possible candidates for Albert’s ‘modern doctors’. As will become clear, however, Grosseteste’s understanding of how comets are generated differs from that which Albert attributes to the ‘modern doctors’, though it does share their underlying assumption that the stars and planets are always the direct causes of comets. For Hossfeld’s attribution see Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 27.
31. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 27. *Prima facie* what Albert means by ‘impression’ here is not overly clear. Albert explains that the ‘*impressio*’ which the ‘modern doctors’ speak of occurs not within the sphere of fire itself, nor in that of the air, but

rather in the meeting place where the two mingle: *'non in igne tantum nec in aere tantum, sed potius in termino coniunctionis ignis et aeris, ubi videlicet convexum aeris permiscetur cum concavo ignis'*. What these 'modern doctors' suggest is that the influence of the celestial bodies helps to illuminate further 'certain obscure lines' of air and fire at the meeting point between the two spheres thereby giving rise to the appearance of a comet: *'Ibi enim sunt quaedam lineae aeris obscuri, et quaedam lineae ignis, ut dicunt, luminosi, quibus in lumine addit illustrationem lumen descendens ab uno quinque planetarum, et ideo videtur sibi coma fieri ex lineis luminosis et obscuris sibi invicem permixtis'*.

32. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 27.
33. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 28. *'Tertia ratio est, quia si sit de vapore terrestri inflammato, videtur simile in illo contingere debere, quod contingit in assub, scilicet quod descendit statim vel ascendit. Et hoc non videmus, quia saepe diu circumvolvitur, ergo non est de vapore terrestri inflammato'*. One wonders whether Albert is guilty of oversimplifying the views of those whom he criticises here. After all, it is hard to understand the position which Albert is attributing to these 'modern doctors'. Given that both medieval and ancient cosmology insist that it is the celestial realm, which – on account of its superior nature – dictates the pattern of terrestrial behaviour and motion, it would be difficult to understand how these 'modern doctors' could suggest that occurrences in the lower terrestrial realm establish or dictate that similar phenomena should occur in the celestial spheres. However, it becomes less hard to understand this argument if the thinking of the 'modern doctors' is here understood in light of the medieval principle of cosmic concordance, and the distinctive theory of causality which underpins it – i.e., that lower creatures, while inferior and materially different, both in nature and properties, to the celestial ones, nonetheless resemble their patterns of motion and behaviour through their being actively influenced by them, and can as such communicate some information about their nature.
34. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 4 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 67. *'Quarta ratio est quia nullus vapor terrestris inflammatus, qui semel ascendit ad aestum vel descendit ad terram, secundario apparet oriri in aere, quia vel consumitur in aestu in quo vincit ignis, ut supra dictum est, vel gravatur frigore et deprimitur in terra, "cometes" autem apparet multotiens oriri in aere. Ergo non est ex vapor terrestri inflammato in aestu vel sub aestu'*.
35. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 29. *'Praeterea si interrogemus a Doctoribus nostris modernis, ex quo cometes est lumen extensum ab aliquo quinque planetarum ad terminum ignis et aeris, cum semper super huiusmodi terminum, ubi mixtus est aer cum igne, moveantur planetae, quare non semper apparent cometae?'*. Moreover, given that several planets could – and indeed do – arise over the same area of the spheres of air and fire at once, then surely several comets should be birthed at the same time, yet this hardly ever happens. *'Item, quare non apparent plures cometae simul, cum plures planetae super talem aeris et ignis commixtionem oriantur simul?'*, *Ibid.*
36. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 29; Thorndike, *op. cit.* (Note 3), p. 70.
37. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 29; Thorndike, *op. cit.* (Note 3), p. 70. *'Ego autem cum multis aliis anno ab incarnatione Domini, MCCXL in Saxonia vidi cometem quasi iuxta polum septemtrionalem. . .'*
38. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 29; Thorndike, *op. cit.* (Note 3), p. 69.
39. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 67. *'Dico ergo, quod cometes nihil aliud est quam vapor terrestris grossus, cuius partes sibi multum coniacent paulatim ascendens ab inferiori parte aestus ad superiorem partem eiusdem, ubi concavitatem ignis attingit, ibi diffusus et inflammatus'*.

40. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 67.
41. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 67. '*Et dico grossus, quia si esset subtilis, cito evaporaret et dissiparetur*'. It is interesting to compare Albert's thinking here with that of Aquinas: '*Et est simile sicut si aliquis in magnum cumulum palearum immiserit titionem, aut aliud quodcumque ignitum principium: non enim statim discurret, quasi exurens paleam, sed videtur ignitio diu in uno loco manere. Et ita, si quis recte consideret, videtur similitudinem quamdam habere discursus stellarum cadentium apparitioni cometae. Quia in stellis discurrentibus cito procedit ignitio in longitudinem, propter dispositionem scilicet hyeccaumatis ad hoc quod de facili aduratur: sed si ignitio maneret, et non pertransiret consumendo materiam, aut materia esset multum densa, ut non posset cito consumi, tunc, quasi subtracto medio discursu, remaneret solummodo stella manens, sicut est in principio discursus et in termino*'. Aquinas, *Sententia super meterora*, lect. 11 (Note 9).
42. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 67.
43. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*Dicitur paulatim assendere, quia sicut habuimus, in vaporibus pluvialibus immixtae sunt quaedam partes ignitae terrestres. . .*'.
44. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*[Q]uae cum pluvia non omnes descendunt. Et illae, quae descendunt, iterum humore pluviae solutae secundum plurimum reascendunt et ultra spatium medium frigidae regionis aeris evadunt propter suum acumen*'.
45. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*[E]t ibi stant et multiplicantur. Et ex illo multiplicato quasi ex quodam thesauro paulatim propter calorem regionis, quae dicitur aestus, ascendunt et quia multam habent constantiam in partibus primo calore, ignis diffunditur, et postea inflammatur*'.
46. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*[E]t sic in medio remanet semper spissus, ubi mutatur de thesauro suo, qui est sub eo, et ideo est ibi flamma alba valde et spissa*'.
47. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*Id autem, quod distat ab illo diffusum ad latera, tenue est et habet flammam tenuem ad modum nubis albae, et haec vocatur coma*'. It is interesting to note that where Albert prefers to use the term '*coma*' in his discussion of the question of comets and their tails, Grosseteste uses several terms interchangeably '*coma*', '*cauda*', and '*trica*'. See Grosseteste's *De cometis* (Note 5) throughout. Grosseteste's terminology is thus somewhat more nuanced than Albert's and one wonders if this could reflect his different way of understanding the role played by the stars and planets in facilitating the generation of comets.
48. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*Durat autem per totum tempus, quo sic ad ipsum evaporat suus thesaurus*'.
49. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28. '*Aliquando autem est grossa magis et tunc "ignitur sicut carbo" et ille videtur cometes rubeus*'.
50. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 28; Thorndike, *op. cit.* (Note 3), p. 68. '*Aliquando autem cum eo "ignis exstinguitur" propter nimiam materiae grossitiam, et remanet fumosum: et tunc apparet sicut carbo niger et extinctus: et ideo est, quod formina nigra in caelo videntur, quod a vulgo vocatur coeli perforatio*'.
51. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 10 (Note 3), p. 32. '*Differentiae autem vaporum sunt quod vapor omnis cometae, licet sit in genere grossus sibi cohaerens, tamen secundum exigentiam materiae potest esse grossus aut subtilis aut medius per aequidistantiam inter*

grossum et subtilem, In quocumque autem est medium per aequidistantiam, in eodem est medium, quod est vincinius extremo’.

52. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 10 (Note 3), p. 32; Thorndike, *op. cit.* (Note 3), p. 74.
53. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 10 (Note 3), p. 32.
54. This is a term which Albert himself does not use. Nonetheless, it seems to fit with his thinking on the role of the celestial bodies in a comet’s generation. Significantly, Albert does refer to the celestial bodies as the ‘*causa efficiens*’ of the generation of vapours in the atmosphere, claiming that the heat radiated by the sun and the planets is the primary cause of the stirring up of earthly fumes and vapours. Thus when considering the nature of the running fires which sometimes arise within the atmosphere he writes: ‘*Dico ergo, sicut ante dictum est, quod quando sol inflammat terram per motum splendoris sui super eam, elevantur calidi vapores de terra, qui sunt quattuor specierum. Ascendit enim ex ea vapor calidus et siccus, quando non est in eo pars humiditatis vincens super ipsum, licet sit in ipso humiditas continuans et constare faciens vaporem, quia nihil terrenum continuatur sine humido, ut diximus in II De Generatione et Corruptione. Ascendit etiam vapor frigidus et siccus, qui etiam est terreae naturae. Et ascendit ex ea vapor calidus et humidus, in quo est humiditas aquea vincens. Et ascendit ex ea vapor frigidus et humidus, quando vincit in eo natura aquae omnio. Et isti vapores materia sunt omnium impressionum in alto generatorum. Et calor solis est causa efficiens*’. Albert the Great, *Meteora*, lib. 1, tract. 4, cap 1 (Note 3), p. 34. As with the generation of comets, however, Albert avoids attributing exclusive efficient causality to the celestial bodies in terms of the ascension, positioning, and ignition, of these running fires. A similar position is affirmed in Albert’s *De caelo*, lib. 2, tract. 3, chap. 2 (Note 25), p. 144. Here Albert notes that heat within the air and the stirring up of vapours is also caused by the friction caused by the revolving of the celestial spheres and the sub-lunar elemental atmospheric spheres.
55. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 11 (Note 3), p. 33; Thorndike, *op. cit.* (Note 3), p. 75.
56. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 11 (Note 3), p. 33. See also the comments found in lib. 1, tract. 4, cap. 9 (Note 3), p. 39: ‘*Significationes omnium istorum sunt secundum effectum Martis, et praecipue quando fiunt in anno, quando Mars et Iuppiter sunt coniuncti. Tunc enim in aere signant huiusmodi ignes tempestates et in hominibus iras et pestilentias ex aereo veneno, quia scintillationes huiusmodi saepius discurrentes per aerea, cum sit vapor frigidus et siccus combustus, corrumpunt aerum et faciunt venenosum, praecipue ad apostemata generanda et variolas et huiusmodi*’. Here we see a very clear example how for Albert the celestial bodies shape not only the sublunary atmosphere, but by doing so the very pattern of human and animal life as well.
57. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 11 (Note 3), p. 33; Thorndike, *op. cit.* (Note 3), p. 75. ‘*[E]t ideo sunt ab ipso sicut a movente primo, nisi forte aliquando, sint a coniunctione Iovis et Martis: quia ex illa conjunctione scintillationes coruscationes et ignes currentes per aerem commoventur*’.
58. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 11 (Note 3), p. 33. Albert’s reference to Haly here pertains to the commentary on Pseudo-Ptolomy’s *Centoquilium* by ‘Alī ibn Abī l-Rijāl al-Shaybani (الرجال أبي ابن علي الحسن أبو), known in Latin as Haly Abenragel (d. 1037). For that part of Haly’s thought which Albert appears to be referencing here see Pseudo-Ptolomy, *Centoquilium cum commentato Haly* (Venice, 1493), f. 107rb. The Abraham to whom Albert refers is the Catalanian Jewish astrologer Abraham bar Hiyya ha-Nasi (1070-1136/45). I have not been able to identify the specific aspect of Abraham’s thought on comets to which Albert refers. Abraham composed two main works on astrology: his *Surat ha-’Ares* (*The shape of the*

- Earth) S. Munster, (ed.) (Basilica, 1546); and his *Heshbon Mahlakhot ha- Kokhavin* (*Computations of the Motion of the Stars*). A Spanish edition of the latter work was produced by José M. Millás Vallicrosa, *La obra Sefer Hesbon mahleket ha-kokabim de Abraham bar Hiyya ha-Bargeloni*, (Barcelona: Instituto Arias Montano, 1959). For an overview of Abraham's work on Astronomy see S. Sela, "Abraham Bar Hiyya's Astrological Work and Thought," *Jewish Studies Quarterly*, 13 (2006), 128–58. Most likely, Albert's reference relates to the *Surat ha-'Ares* which studies the creation of the earth and celestial bodies, and pre-dates the *Heshbon Mahlakhot ha- Kokhavin*.
59. Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 5 (Note 3), p. 29. '[Q]uod secundae sunt effectus stellarum in vapore ignito et elevato'.
60. Thus, Albert speaks of the motion of the planets and stars, and in particular the motion of their *radii* through the atmosphere as serving to stir up vapours within the atmosphere: '*quia illa commovet vaporem*'. He writes: '*Attende ergo ad his similia, quia sicut dicit Albumasar in septimo tractatu de coniunctionibus planetarum, adventus ignium et assub et cometae non sumuntur ab aliquo planeta nisi a Marte, praecipue quando fuerunt radii eius in signis terreis vel aereis, luna non impediende: quia illa commovet vaporem aqueum humidum, qui impedire posset huiusmodi ignes*'. See Albert the Great, *Meteora*, lib. 1, tract. 3, cap. 11 (Note 3), p. 33; Thorndike, *op. cit.* (Note 3), p. 75. It is interesting to note this belief that it is through their movement, as opposed to any attractive or quasi-magnetic agency, which serves to stir up flammable vapours within the atmosphere from which comets can then be birthed is likewise affirmed by Aquinas: '*Deinde cum dicit: quando autem sub astrorum aliquo etc., assignat alium modum apparitionis cometae. Et dicit quod quando sub aliqua stellarum errantium vel non errantium, exhalatio adunatur per motum illius stellae, tunc aliqua stellarum dictarum fit cometa: non quod stella quae apparet sit aliquod igneum in aere, sicut in superiori modo dictum est, sed est verax stella, errans vel non errans; non tamen coma eius fit in loco caelesti ubi sunt astra, sed est sub caelo in aere*'. Aquinas, *Sententia super meteorora*, lib. 1, lect. 11, comm. (Note 9).
61. Like Albert, Grosseteste maintains that the celestial bodies directly impact the sublunary atmosphere. Thus, in his *De impressionibus elementorum*, he states that even the ancient philosophers grasped the fact that the celestial bodies directly effect change in the earthly elements: '*Quare philosophi, etsi perfecte res non intelligentes, cum naturas rerum non ignorare debent, radios corporum supercaelestium descendentes super res corporales mutationis earum maximam causam praebere non ignorantes dicunt, quod radii reflexi et condensati causa sunt caloris generati apud nos*'. Baur, *op. cit.* (Note 5), p. 87. Particularly interesting to note is Grosseteste's assertion in the latter work that the heat within the sublunary atmosphere is not a product of any celestial heat – Grosseteste denies that the sun itself is hot; rather, the heat in the lower regions of the atmosphere is caused by the reflection and condensation of the rays of light emitted by the sun. Thus, he writes: '*et haec omnia eiusdem signa sunt, scilicet quod calor non provenit ex corpore solari, sed ex reflexione et condensatione radiorum*'. Ibid.
62. Robert Grosseteste, *De cometis* (Note 5), p. 325.
63. Robert Grosseteste, *De cometis* (Note 5), p. 325. '*Palam est igitur quod coma est ignis sublimatus seperatus a natura terrestri et assimilatus nature celesti*'.
64. Robert Grosseteste, *De cometis* (Note 5), p. 324. '*Ignis autem duplex est, quia aut est manens non simul cum generatur desinens, qualis est ignis elementum in sua sphaera, aut est ebullitio fumi accensi simul cum generatione sua desinens, qualis est flamma apud nos generata*'.
65. Robert Grosseteste, *De cometis* (Note 5), p. 324. '*Non est autem possibile ut trica sit ignis simul cum generatione sua transiens, quia non haberet materiam continue foventem eam in diuturnitate permanentie suae, nec sequeretur materia illa motum celi diurnum necessario, cum esset materia terrestris non completa sublimata*'.

66. Robert Grosseteste, *De cometis* (Note 5), p. 325. ‘*Hunc autem ignem descendere in regionem aeris a sphaera ignis elementi non est possibile, quia non descendit ignis elementum cum corpulentia sua a sphaera sua, sed virtus eius tantum descendit cum radiis stellarum in sphaera eius ignitis, nec attingit ad sphaeram eius ignitis motus turbulentus aut violentia*’.
67. Robert Grosseteste, *De cometis* (Note 5), p. 325. ‘*assimilatus nature celesti*’.
68. Robert Grosseteste, *De cometis* (Note 5), p. 325.
69. Robert Grosseteste, *De cometis* (Note 5), p. 325. ‘*Cum autem agens et patiens, completis actione et passione, assimilentur, cum prius fuerint dissimilia, causa generans tricas necessario erit virtus celestis, scilicet virtus stelle fixe vel erratice*’.
70. Robert Grosseteste, *De cometis* (Note 5), p. 325. ‘*[T]rahitur a stella illa sicut ferrum ab adamante*’.
71. Robert Grosseteste, *De cometis* (Note 5), pp. 325–6. ‘*Locatio autem come e directio unius stelle plusquam e directo alterius, non erit, nisi propter maiorem assimilationem illi stelle e directo, loquatur, qui propter similitudinem, quam habet cum stella, cuius virtus eam sublimavit; trahitur a stella illa sicut ferrum ab adamante*’.
72. Robert Grosseteste, *De cometis* (Note 5), p. 326. ‘*Ex hiis ergo manifestum est quod trica, quae est ignis sublimatus a partibus mundi sensibilis, signum est praecedens sublimationis et separationis nature spiritualis incorporate rebus complexionatis et assimilate trice in natura spiritali*’.
73. Robert Grosseteste, *De cometis* (Note 5), pp. 326–7. ‘*[Q]uapropter signum est infirmationis aut corruptionis rerum complexionatarum, quibus dominator planeta, cuius nature assimilatur trica visa. Utpote si fuerit trica de natura solis, virtus stelle, que tricam sublimavit et seperavit eam a natura terrestri, separabit spiritus, qui sunt in corporibus complexionatis assimilati nature solis. Et erit infirmatio aut corruptio in hominibus et animalibus et sementi, quibus sol principatur vel principaliter dominatur*’.
74. Robert Grosseteste, *De cometis* (Note 5), p. 326.
75. As even a cursory glance reveals, the text differs notably in terms of style and format in comparison to many of Grosseteste’s other works. Nonetheless, scholars such as E. Grant and A. C. Crombie are willing to attribute the text to Grosseteste. See A.C. Crombie, *op. cit.* (Note 5), p. 48; E. Grant, *op. cit.* (Note 2), p. 94, n. 15. By contrast, the current editors of Grosseteste’s scientific works are minded to claim that the text is not in fact by Grosseteste, but rather by one of his Franciscan associates. I am grateful to G.E.M. Gasper for his conversations with me about the authenticity of the text. In his *Hexaameron*, he openly states that he cannot tell if the philosophers were right in positing the existence of such a rarefied element: ‘*Sed nescio an aliqui veritatem invenerunt; aut si forte invenerunt, nescio an eorum aliqui se invenisse veritatem veraci et certa ratione deprehenderint*’. R.C. Dales and S. Gieben (eds), *Hexaameron* (Oxford: Oxford University Press, 1982), pars. 3, cap. 6, n. 1, p. 106.
76. The claim that the celestial bodies must be of an elemental, as opposed to ethereal, nature so as to explain their causal agency upon the earthly elements is the central claim of thesis of the *De generatione stellarum*: ‘*Res eiusdem naturae eiusdem operationis secundum naturam suam effectivae sunt. Ergo si secundum naturam suam non sunt eiusdem operationis effectivae, non sunt eiusdem naturae. Sed sphaerae et stellae non sunt eiusdem operationis secundum naturam suam effectivae. Ergo sphaerae et suae stellae non sunt eiusdem naturae*’. For an edition of the *De generatione stellarum* see Baur, *op. cit.* (Note 5), pp. 32–6, at p. 32. With regards to Grosseteste’s ambivalence regarding the material identity and the doctrine of the quintessence in his undisputed works see his *Hexaameron*, pars. 3, cap. 6, n. 1. ‘*Sed nescio an aliqui veritatem invenerunt; aut si forte invenerunt, nescio an eorum aliqui se invenisse veritatem veraci et certa ratione deprehenderint*’. *Hexaameron* (Note 75), p. 106. It is interesting to note, however, that Grosseteste explicitly accepts the existence of the quintessence in his *De sphaera* (Note 5), p. 230.

77. Robert Grosseteste (?), *De generatione stellarum* (Note 5), p. 32.
78. Robert Grosseteste (?), *De generatione stellarum* (Note 5), p. 32.
79. One possible further reason why Grosseteste feels the need to attribute such a strong causal relationship between the celestial bodies and the generation of comets via the ignition of ascending vapours is perhaps his conviction that all material reality, both animate and inanimate, shares the same metaphysical basis, namely the 'first corporeal form' – i.e., light (*lux*). This primordial light is that which not only forms the ontological basis of all creation, but through doing so serves as the binding principle which unites all creatures at the level of their created being. See Grosseteste's *De luce*. For a critical edition of the *De luce* see Panti's edition in J. Flood, J.R. Ginther and J. Goering (eds), *Robert Grosseteste and His Intellectual Milieu: Editions and Studies* (Toronto, ON: PIMS, 2013), pp. 93–238, edition at pp. 226–38.