

## A STRATEGY FOR MEDIEVAL SCIENCE\*

Science and the humanities share the same kit of working tools, called the world's literature. While the author of this article deals mainly with the scientific and mathematical literature, the reader probably gravitates towards some other branches, but such distinctions were hardly made in the Middle Ages. The American philosopher, Wallace Stevens, in his book *The Necessary Angel*<sup>1</sup> remarks that at the time of Aristotle, the Greek language had no word to signify literature. The reason is surely that literature had long since been too universal an element in Greece to require a name. We have no name for the smell of air. This all-pervading power of literature is apparent already two generations before Aristotle, when Socrates made his defence against leading the youth of Athens towards atheism. Plato's *Apology* tells us how Socrates taunted his accuser: "Have you such a low opinion of the judges, that you fancy them so illiterate as not to know these doctrines are found in the books of Anaxagoras which are full of them? And so, my word, the youth are said to be taught them by Socrates, when they can be bought in the book-market for one drachma at most..." (a coin today worth 1.4 pence!).

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Empedocles, Democritus, Anaxagoras, and others founded the natural philosophy, subsequently synthesised by the arch-atheist Epicurus into a materialist doctrine upon which the leaders of thought during the Renaissance rebuilt the foundations of the modern world.<sup>2</sup> To the extent that the Middle Ages were the Dark Ages, they did form a tunnel in which the works of Anaxagoras could *not* be bought for a drachma. Instead, the physical preservation of the fragmented manuscripts containing the words or opinions of Greek scholars became the primary problem. The diffusion, analysis and extension of Greek science by new theory and observations were under threat of savage censorship. It could not be left to chance how the philosopher-scientist should conduct himself in order not to jeopardise this paramount task. A body of maxims and rules of conduct evolved and were handed on which, if we learn to decipher them systematically, form still to-day a coherent if a steadily evolving and adapting Strategy of Science. Accordingly, rather than emphasising the continuity of the *content* of science-cum-philosophy (*sapientia* of the radical scholastics), a very preliminary sketch of the continuity in the (less familiar) *strategic framework* (*prudentia*) is here attempted. Even an outline may serve to suggest that, when we return to the content, a greater measure of agreement will be apparent in the medieval arena than is usually acknowledged.

I picture the Middle Ages like a passion-play written for an enormous cast, while there was a severe shortage of competent actors. As a result, most actors played many parts. Geoffrey Chaucer—to whom poetry at first did not come easy—in his second role wrote the *Astrolabe*, one of the first scientific works in the English language. Dante has been called the greatest lay philosopher of the Middle Ages<sup>3</sup> and taken seriously as a penologist,<sup>4</sup> political thinker,<sup>5</sup> architect (by Galileo!),<sup>6</sup> as a physicist,<sup>7</sup> and, with Leibniz, as “the Copernicus of linguistics”.<sup>8</sup> Today, Omar Khayyam’s binomial theorem for integral exponents is probably no longer featured on the humanist’s syllabus.

As a result of such versatility, any list of the great strategians of science would probably contain men conventionally regarded as orators, medics, politicians, saints, philosophers or poets. I propose to take almost all my examples from the following list:

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Cicero 106-43 BC  
Seneca 4 BC-AD 65  
Galen 130-200  
Hieronymus (St. Jerome) 340-420  
Aurelius Augustinus (St. Augustine) 354-430  
Boethius 480-522  
Avicenna 979-1037  
Ibn Hazm 994-1064  
Averroes 1126-1198  
Roger Bacon 1214-1292  
Thomas Aquinas (St. Thomas) 1225-1274  
Dante 1263-1321

This apparent jumble conceals a surprisingly uniform typology. These men were all among the very first rank in their respective generations of those who helped to preserve and develop Greek natural philosophy in the widest sense. Saint Jerome was called a populariser of Greek science by Louis Bréhier.<sup>9</sup> The poet and politician Boethius is acknowledged as responsible for preserving and explaining the Geometry of Euclid to around thirty generations in the West. Dante “immortalized the Ptolemaic system of astronomy in his verse, adding to its popularity in his own day, and making it known to thousands of readers since...”.<sup>10</sup> The continuity of scientific strategy from Epicurus to Leibniz can be illustrated through the works of these twelve masters. Each built—consciously—on his predecessors in this list, with Cicero (a cicerone indeed) at the head. *He* had argued, ostensibly against Epicurus, for the subtler approach, for holding back on anti-religious defiance (though even Epicurus calmly performed the rites expected of him). Augustine<sup>11</sup> at one end, and Dante<sup>12</sup> near the other end of the “tunnel,” describe movingly how they came to philosophy by reading Cicero (whom Dante was able to bracket with Boethius), and *characteristically* when both of them were in despair. Again the continuity is displayed when Benvenuto, the fourteenth-century commentator of Dante, cites Jerome’s words that Seneca would not have been if Cicero had not existed.<sup>13</sup> Thomas Aquinas starts his commentary<sup>14</sup> on Boethius with the proverb “if you wish to attain true liberty you must become the slave of philosophy,” masking its heterodoxy by attribution to Seneca.<sup>15</sup> Only those in a position to follow up this reference

might discover that Seneca himself attributes the proverb to the dangerous Epicurus...

The masters of strategy were, like Epicurus himself, active in the diffusion of knowledge by correspondence—often necessarily committed to secretive letters. They showed concern with language, serious ciphers and symbolism, with the training of disciples, oral tradition and travel. Characteristically, they were encyclopedists intent on summarising into compact formats *all* that was known lest *any* of it be lost. Significantly, the largest single domain was medical science. Cicero introduced into Latin, and therefore into modern Europe, such Greek words as physiology: Galen, the greatest medic of antiquity, crystallised the notion of the *pneuma* (the breath of life,—we call it oxygen); Augustine through his re-interpretation of Galen's *pneuma* became a forerunner of Descartes.<sup>16</sup> Averroes published his *Collected* of medical recipes, while on Avicenna's *Canon of Medicine*, a true encyclopedia, the medical teaching at all European universities was largely based in the first 500 years of these rapidly proliferating institutions. Dante was registered as a medical man (his 7th or 8th role), and though he did not practice, his description of the symptoms of consumption has been admired by a twentieth-century practitioner<sup>17</sup> as “truly masterly from the medical standpoint.”

## THE FATES OF STRATEGISTS AND MANUSCRIPTS

Before I can adumbrate the strategy itself, some testimonials are in order concerning the kind of dangers it was designed to avoid. Cicero was twice exiled, finally murdered, and his head and feet nailed up in the Roman Forum. Seneca was exiled by Caligula and driven to suicide by Nero. Galen was forced suddenly to flee from Rome. Jerome (as Roger Bacon reminds us)<sup>18</sup> was persecuted as a heretic, Augustine could not prevent the martyring of his friend Marcellinus; Boethius, having coined the slogan *liberty of conscience* in prison,<sup>19</sup> was clubbed to death there; Avicenna exiled, Ibn Hazm and Averroes imprisoned and exiled from Cordoba. Roger Bacon spent his old age in a medieval prison in Paris under the rule of the saintly King Louis' son,

while the saint's brother was murdering St. Thomas Aquinas, as we read in Dante's *Comedy*,<sup>20</sup> which he wrote in exile, under sentence of death by burning, together with his sons, if he set foot again in Florence.

Passing to the fortunes of the written word, fire was also the preferred answer to unorthodox explanations of the universe, from before the time that Protagoras had his works burnt by the public herald in Athens, till well after Voltaire's were flung into the flames by the public executioner in Paris. Abelard<sup>21</sup> tells us that he regarded himself especially as the heir of Jerome, and relates what happened in Soissons, about 1120: "Then suddenly-called before the Council I went in, and, without any examination by questioning, they forced me with my own hand to throw my book into the fire, and so it was burnt." He is said to have turned to his treacherous pupil Gilbert, to quote him a line from Horace: "It matters to you, too, when your neighbour's house is burning." Gilbert understood at once, because both men, even at that tense moment, felt themselves standing on the mosaic pavement of antiquity, buried though it might appear under the dust of twelve centuries.

It was the same under Islam. The 11th-century poet-philosopher Ibn Hazm of Cordoba in many respects foreshadows Dante's case two centuries later. Gardía Gomez<sup>22</sup> has called Ibn Hazm a bitter intellectual *vagamundo* (a vagabond travelling the world). He too was a thunderer of progressive philosophy against sundry potentates. Ibn Hazm suffered imprisonment as well as exile, and his books were condemned to be burnt during his lifetime. He immortalised that event with a poem, containing the famous lines with an echo of Seneca<sup>23</sup>

"Aunque queméis el papel, no podréis quemar  
lo que encierra, porque lo llevo en mi pecho."<sup>22</sup>

Dante's *Commedia* was burnt—by a Cardinal—only after his death. It took 150 years of dialectical transvestism to make it safe and credibly orthodox; only then could Dante's own title "*The Comedy*" be expanded to "*The Divine Comedy*." In the 19th century, when Boethius was ready for canonisation, Dante's book on Monarchy could be deleted from the Index. How

seriously the Index was monitored, is seen in an edict signed by the Cardinal Bishop of Cremona<sup>24</sup> as late as 1639: “We command, under pain of excommunication, and other unspecified penalties... that no carrier, sailor, muleteer, or other, presume to carry books either into or out of any city... if he has not a catalogue of the books, signed by the Inquisitor.” Under threat of *excommunicatio*, *communicatio* was stifled!

Roger Bacon<sup>25</sup> tells us explicitly “If I had been able to communicate freely, I would have written a lot for my brother scholar, and others of my dearest friends (a most significant addition—see below). But when I despaired of communication, I abstained from writing.” In such circumstance, we must hesitate to interpret what remains of the course taken by natural philosophy in the Middle Ages as indicating the unfolding of the subject under its purely internal logical laws, or as being dictated by intellectual fashions, or least of all by rises and falls of Man’s capacity to reason. Instead, it represents what men dared or were able to write down, and leave behind, men who had an eye not only for the content of philosophy, but to saving that content from constraints or wholesale destruction.

## STRATEGY EXEMPLIFIED

As to the prudent strategies evolved to this end, I have space for only three salient features:

- 1) the doctrinal justification for preserving and teaching Greek natural philosophy.
- 2) The preoccupation with codes and language, particularly with Greek and the supremacy of the Greek language and culture.
- 3) The social or class-attitude to be adopted by the natural philosopher.

## DOCTRINAL JUSTIFICATION

On the justification of teaching otherwise forbidden knowledge, Augustine said much of what was needed. If you are to convert

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the heathen, you must be forearmed by knowing the objections that may be raised against scripture, and these could plausibly come from natural philosophy. If this much is granted: why wait?—you may *invent* scientific questions in case the answers chance to be needed. For instance, in his masterpiece, dedicated to the memory of the martyred Marcellinus, he ventures on this slippery slope when he leaves ambiguous the phrase: “*quae ab eorum parte contraria, me dirigente, videntur opposita*”<sup>26</sup> (objections which, *while myself in charge*, I imagine to be raised by those of the opposing party—[my emphasis]). Is he in charge of an actual controversy with a heathen, or of the invention of dangerous questions? The question at issue centres on Christ’s promise: not a hair on your head shall perish, and the heathen might ask you: “what about the hair and nails you have left at the barber’s?”... But for Augustine the most difficult problem,<sup>27</sup> treated in the last chapter of *The City of God*, concerned the resurrection of two bodies, one of which has, through enforced and unblameworthy cannibalism, become intimately mixed up with the other. The problem is an admirable vehicle for discussing the atomic structure of matter. Acknowledging his own debt to Cicero, and Cicero’s to the great philosophers (of Greece), Augustine drives this vehicle with gusto but with circumspection.

### CODES AND LANGUAGE—THE GLORY OF GREECE

Next, on language and symbolic codes, Jerome and Augustine are among the fore-runners of Dante, who was the master of all.

Among the letters of Augustine there is one, No. 118, in reply to his disciple Dioscorus,<sup>28</sup> who had naïvely written in for an exposition of some problems concerning the philosophical dialogues of Cicero. Augustine tells him (in a long reply) that such questions must no longer be put to him now that he is bishop; at most they are to be put as difficulties which have arisen directly, not relating them to Cicero. Moreover—a sign of bitter times—Augustine cannot lay his hands on manuscripts of Cicero’s works in Hippo to check the references. But he also counsels Dioscorus not to study Greek philosophers at second hand, in Latin expositions like that of Cicero, when he is able to

read them in Greek. Yet Augustine also implores Jerome to base his translation of the Bible into Latin, *not* on the original manuscripts in Hebrew, but on translations of the Hebrew *into* Greek *by* Greek scholars: “I would be extremely surprised” (he writes to Jerome)<sup>28</sup> “if anything is found in Hebrew sources which would have escaped so many most experienced interpreters of that language.”

But Jerome did not heed Augustine’s advice. He found he could take greater liberties with the Hebrew, which finally rendered his Latin translation, the Vulgate, so explosive a book (cf. note 17) that it took a thousand years for the Church to accept and adopt it. He described in some detail how you *can* be flexible because of the fluidity<sup>29</sup> of the vowel structure in Hebrew (where vowels were omitted from the script). A typical example occurs in Jerome’s revision of Origen’s code-book for assigning a meaning to biblical proper names of Greek origin. The trick was that of finding a similar-sounding Hebrew word or phrase, carefully chosen for its meaning to flavour the biblical texts in which the proper names occurred. As elsewhere, Jerome improves on Origen in decoding the name “Acheia” used by St. Paul to designate the Roman province of Greece. Of course, the Greeks were called Achaeans by Homer, and when the Sirens flatter Ulysses, they address him as “the great glory of the Achaeans”. Origen had “translated” St. Paul’s Acheia in his code-book to mean “*their brotherhood*,” because the Hebrew word *achei* (אָחֵי) happens to mean “of the brothers, or countrymen.” Jerome modified an implied vowel, to read *achai* (אָחַי),

changing the possessive pronoun: of *my* brothers. In addition, he chose to treat the plural as a reinforced singular (the Hebrew plural of eminence). And so Achaia, Homer’s name for the country of the crafty Ulysses, comes to signify for Jerome:<sup>30</sup> *frater meus quispiam*, any one of my brothers. And he could well have used the flexibility of Hebrew to arrive at a very different solution, had he wanted. For instance, the standard English version of this game is found in the *Concordance of Cruden*,<sup>31</sup> which lists two less enthusiastic meanings for Achaia, the Greece of St. Paul. They are: *trouble*, and *grief* (I presume



from *achar*, (  $\text{אָכַר}$  ), which has those meanings). We should not smile at such conflicts of scholarship, apparently wasted on trivia over the course of millennia, since they allowed Jerome *safely* to signal his unqualified fraternity with Greece. A similar signal is rightly interpreted when Lagercrantz<sup>32</sup> recognises as Dante's own spiritual brother the powerful figure of Ulysses, portrayed aflame, in his *Inferno*, as the prototype of the scientific spirit; in the fourteenth century, Dante's *Inferno* was itself still recognised as a portrait of our own world, the Hell of the Living.<sup>33</sup>

### THE SOCIAL SITUATION OF SCIENTISTS

I turn to the third and last of my aspects of science strategy, the sociological, by citing three texts. First, from that "apex of the Arab Renaissance,"<sup>34</sup> Averroes, a summary text in his *Destruction of the Destruction*. (This is a witty title for the refutation of a book called the *Destruction of Philosophy* by the orthodox Ghazali). Taken from the paraphrasing French translation of Mehren,<sup>35</sup> which I supplement by the more literal English translation of van den Bergh,<sup>35</sup> this is what Averroes writes: "Philosophy speaks only to an élite, but since that élite cannot exist without the well-being of the class of the masses, it must adopt the role of a faithful and true guide. It must be on its guard against despising the degree of intelligence of the people, but always use the best way of explaining, in the conviction that the aim of instruction lies in truth as a whole, and not in the examination of specific problems, so that if the philosopher expresses a doubt concerning revealed truth, he deserves to be accused of being an unbeliever and risks punishment at the hands of the religious community in which he lives. Further, (and now I cite exactly from van den Bergh's orthodox English translation) he is under obligation to choose the best religion of his period, even when they are all equally true for him, and he must believe that the best will be abrogated by the introduction of a still better. Therefore the learned who were instructing the people in Alexandria became Mohammedans when Islam reached them, and the learned in the Roman Empire became Christians when the religion of Jesus was introduced there."

To-day the need for self-control as a means towards the scientist's self-preservation may seem less pressing. Yet, translated into modern terms, Averroes' recipe is still useful for scientists to follow vis-à-vis higher power, now more usually enshrined in givers of grants than in dispensers of religious salvation.

My second text is again from Roger Bacon, the Oxford physicist, in his encyclopedic *Opus Majus*:<sup>36</sup> "I have learnt more useful things and things valued beyond comparison from very plain people, unknown in learned circles, than from all the famous doctors who taught me."

My final quotation is from an early work of Aurelius Augustinus, *De ordine*<sup>37</sup> (*On order*), perhaps the first documented example ever of a woman participating in a philosophical discussion with men, namely his mother Monica. Augustine remarks: "The writings of the most learned men include philosophising cobblers and orators of even more lowly status, who nevertheless shone with so noble a light of gifts and ability, that they would not wish, even if they could, to exchange their true worth for any other kind of nobility. And (addressing his mother): "believe me, a generation of men will not fail to come, which will delight even more that *you* are here to philosophise with me, than if they found someone of rank and honours."

Even though we may believe that we are the very generation of men here envisaged by Augustine, in my experience most scientists to-day still agree with the views of Sir James Jeans who saw no continuity, only spasms, in medieval science and *no* role in it for the common man: "The story of such a spasmodic period of activity usually began with a stirring from the top, frequently by a highly placed personage, which failed to evoke any real interest in the masses of the population, few of whom had the education necessary for an interest in science."<sup>38</sup> If it were true that *interest* followed only on *education*, one might as well skip those dark pages crammed with superstition and go straight to the history of the Renaissance, whose sudden dawn, however inexplicable then, marks the beginning of what is worth attention. Why waste time, the reader may be asking (*me dirigente!*), on an era whose only known intellectuals wanted to debate such problems as how many angels can dance on the point of a needle? I must now accept that most difficult chal-

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lenge, with occasional help from the surviving heritage of the great philosophers (of Greece).

### THE DANCE OF THE ANGELS

On December 3rd, 1975, at the end of a correspondence in *The Times* on the dance of the angels on a needle-point, a mathematician, Professor Rosenbrock, argued with convincing illustrations that this kind of scholastic problem was related to modern set theory in mathematics, and that the real issues underlying the problems had only been settled by pure mathematicians rather recently.

This argument, that subjects of import to science were being debated by medieval theologians, can be greatly reinforced once we place it in the context of the general tactics and strategy of medieval science. Theology owned the communications networks which scientists had to capture. Accordingly, Roger Bacon, Dante, Siger of Brabant and William of Occam were Franciscans, before they fell foul of the Roman Church. But since we are discussing angels, we need to focus on Thomas Aquinas, a Dominican, who is called Dr. Angelicus—the angelic doctor. However, that name is only a belated result in the usual process whereby all but the most recalcitrant invaders were posthumously transmuted and finally absorbed into orthodoxy. With Thomas the time-table went like this: In 1276, two years after his death, some of his teachings were condemned by the Inquisitor Bishop Tempier together with those of the more revolutionary and heretical Siger. Forty years later, Dante pretends that Siger is established in heaven besides Thomas,<sup>39</sup> and another ten years later Thomas, if not Siger, could be safely canonised. It then took another 100 years before Saint Thomas obtained his famous nickname of Angelic Doctor. But since every respectable doctor did soon acquire such a code-name—Thomas's teacher Albert was Dr. *Universalis* and Roger Bacon was *mirabilis*—what *did* his contemporaries call Thomas Aquinas? Père Mandonnet<sup>40</sup> acknowledges that his first title was Dr. *Communis*—no less.

## THE MEANINGS OF ANGEL

Angel was simply a convenient code-word, at a time when codes were inevitable. Angel had two widespread code-meanings, not just one. Thomas himself writes in his *Summa Theologica* that in the allegorical sense the angels of peace are the Apostles *and other preachers* (my italics).<sup>41</sup> His writings often suggest that the ideal scientist-philosophers are the object of the code-word angel. E.g., in his *Summa Theologica* he states: The higher angel teaches the lower<sup>42</sup> “just as academics on earth (*sicut etiam apud nos doctores*) analyse in detail what they themselves understand in totality, making allowance for the capacity of others.” But scientists and philosophers are not the kind of individuals who—except very metaphorically—dance on the point of a needle. And indeed Thomas’s angels never do, and there is scant evidence in existence now of such needle-dancers ever having been debated in the Middle Ages. But that evidence does relate to the other major code-meaning of angel: namely *atom*.

I will analyse specific messages contained in the works of Aquinas to support the equation angel=atom. While it is idle to speculate on the hidden thoughts in Aquinas’s mind, it is legitimate to compare his texts on angels with those of physicists writing about atoms, and particularly to test my interpretation against the way Aquinas’s messages have been read by others. I will cite a few brief and fair summaries of lengthy and often complicated passages, specifically from the *Golden Table* of Aquinas’s works by Peter of Bergamo<sup>43</sup> (died 1482) and from the index of the 19th-century Leonine edition (sponsored by Pope Leo XIII), of the *Summa Theologica*.<sup>44</sup>

Epicurus described the properties of atoms in a famous text transmitted—eventually to Gassendi<sup>2</sup> and his followers—by Diogenes Laertius. Translations into Latin, originating in southern Italy in the 12th century, circulated from the Apennines to the Pennines. Aquinas must surely have known these when he wrote his *Summa* near his birthplace in southern Italy. He was born when Frederic II ruled the Holy Roman Empire from Sicily. That Epicureanism was rife is attested by the fact that Dante consigned to his Inferno over a thousand Epicureans<sup>45</sup> along with Frederic.

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In Epicurus's text, four properties are attributed, in one sentence,<sup>46</sup> to his atoms: indivisibility, immutability, impenetrability and incorruptibility. These four properties are assigned by Saint Aquinas to his angels within a space of 13 pages in his final *Summa*,<sup>47</sup> which covers over 4000 pages. To take the example of the interpenetrability of matter, an age-old problem in physics later to be highlighted by Joseph Priestley in the 18th century: Aquinas proves at length that two angels cannot be in the same place. Are we, then, to believe that Dr. Communis, whose skill in quoting Epicurus via Seneca was still admired nearly three centuries later, was seriously interested in the mutual interpenetrability of winged cherubs—except as a device for evading the Inquisition?

Again, from Thomas Aquinas's "Questions concerning Evil," Peter of Bergamo abstracted:<sup>48</sup> "The angel operates on a distant body through a medium, but not independently of a medium." If Peter was unaware that this question had been discussed concerning atoms ever since they had been invented, it is not credible that Thomas himself did not know. (Incidentally, the discussions continued,<sup>49</sup> even long after atoms had been *discovered*).<sup>50</sup>

### FORTUITOUS SIMILARITIES OR DELIBERATE CODE?

Is there more than coincidence in these examples? To make the case for a deliberate code more convincing requires supporting evidence which would ideally be of at least four kinds.

- i) One might expect explicit discussion of the use and the danger of codes in scientific and philosophical writing to have survived;
- ii) a specific code, angel for atom, should be shown to be serviceable for a sufficiently serious purpose;
- iii) a consistent pursuit and exploitation, in an historic setting, of tactics resembling the proposed coding would give further support; and, perhaps the most important of all:
- iv) evidence should be sought that the code was understood.

I address these four tasks in order, necessarily in the briefest outline.

i) In their preoccupation with codes the scholastics seemed to follow Jerome and indeed his brothers, the Greeks. But a code was not adopted as a mere game by serious scholars. Apart from the danger of inviting reprisals by too defiant a gesture, self-restraint was also recommended against fouling by ambiguity the hidden stream of philosophical exchange. The poet-scholar Gottfried von Strassburg warned in his *Tristan and Isolde* against what he called *bikkel worte*.<sup>51</sup> *Bikkel* means a die, and *bikkel*-words, aleatory or random words, were dicey. The context shows that he was thinking of unscholarly proliferation of metaphors. The network, once invaded, had to be kept pure. Dante wanted the new channel of *sommo volgare*, i.e. noble Italian, which he had helped to create, reserved<sup>52</sup> for authors gifted with caution and discretion (*cautionem atque discretionem*), and—quite apart from poetic genius (*ingenium*), a requirement which he clearly took for granted—with applied and speculative science (*arte scientiaque*).

ii) The purpose suggested for the code is not merely that it lends itself to euphemistic restatement of known positions, but that it allowed philosophers to broadcast their precise philosophical stands on a set of issues in natural philosophy. First, in the Leonine index we find: “Continuous motion of the angel is necessary through any medium, but it can be discontinuous in a vacuum (*sine medio*).”<sup>53</sup> Now every serious scholastic of the time knew that Aristotle in his *Physics* discussed the motion of bodies through different media, but that he was no atomist; and he denied the existence of a vacuum; otherwise bodies would, in his mistaken view, have to move with infinite velocity. If angel was read as atom, then Aquinas here extended Aristotelian physics towards that of Epicurus the atomist, who speculated that atoms moved through a vacuum, and did so with finite velocity. And on this point the indexer finds in St. Thomas’s *Summa* (quite correctly):<sup>53</sup> “the motion of the angels is not instantaneous but occurs in time.” The second example may, for future reference, be called Aquinas’s *exclusion principle*:

“Even if angels partook of matter, there could not be several angels of the same species.”<sup>54</sup>

*Designatio individui respectu speciei  
est per materiam determinatam dimensionibus*”

Here Thomas boldly sides with the physicist Anaxagoras, whose atheist doctrines were hung around the neck of poor Socrates. Anaxagoras wrote: "Every seed is different from every other;" and his invisible seeds were a solution intermediate between Epicurus and Aristotle, between the views of the atomists and those of their opponents, who held matter to be continuous and infinitely divisible. These questions, we shall now see, were far from peripheral.

The notions of Epicurean atomism, or Anaxagoras's earlier and less materialistic version, certainly were taken seriously, because atoms were to be the *units of material substance* and, among atheists, their motions were to explain all our experience of the universe. Substance itself was the most important concept in philosophy a millennium and a half before Aquinas, when Aristotle made it the first and most fundamental of his categories. Half a millennium after Aquinas, substance formed the key of Leibniz's philosophy, as we learn from his letters.

iii) Even Leibniz's texts, written around 1700, must be read with due allowance for strategic considerations; there were those who wanted to see him on the stake.<sup>55</sup> For his unit of substance he used the abstract and safe term "monad" (unit), made respectable already by the idealist Plato. Leibniz's monads, like Anaxagoras's seeds and Thomas's angels, were all different. They seemed to lack concreteness, since, unlike the atoms of Democritus, they lacked extension in space. Yet Leibniz's code is essentially revealed, when he writes in a letter that the monads are "the veritable atoms of nature, in a word the elements of things." This was not a chance remark. Grau<sup>56</sup> observed that Leibniz's "much noted tendency to make concessions in all directions mostly consists only in this, that he picks up traditional terms (here monad) and gives them a new sense."

The pressure on the scholastics to make concessions was much greater, but their dialectical skill was no less developed. A favoured trick to get a new truth accepted had long been to state a false but widely held proposition, and then gradually to change the meaning of the terms in it. An example from Averroes, (who added the refinement of attributing the re-definition of terms to his opponents), illustrates this trick for the case in question. He reports in his *Metaphysics*<sup>57</sup> that one "hears the

orthodox theologians of our time designate the atom as the individual substance.” If we return to Aquinas, the Leonine index will immediately send us to the *almost* parallel key passage which confirms the code once more:<sup>58</sup> “every angel taken in the generic sense (*in genere*) belongs to substance.”

They are not quite parallel, because individual and genus are of course different. When we have examined this difference in its strategic context, it will emerge that Thomas here followed the other great Arab, Avicenna, rather than Averroes, who had been able to refurbish Avicenna’s analysis in a bolder spirit.

Substance (*soliditas*) had been described as the *genus* composed of atomic particles (*particula*) forming its *species* already in *Asclepius*. This Latin version, attributed to the philosopher-poet Apuleius, of a Greek work masquerading as an inspiration by the Egyptian god Hermes Trismegistus, was widely diffused in the Middle Ages. If the code “angel=atom” was to be scientifically fruitful in discussing the physics of the material universe, an extension by way of analogy of this hermetic description was essential. Angel taken *in genere* could then be identified with substance, and substance in due course with matter in bulk. But this could hardly be done too openly at first. In fact it took two characteristic dialectical adjustments to establish a synonymy between angels and substances. Dante, in his *Paradise*,<sup>59</sup> was finally able to present angels directly as *sustanze* (substances). But this was only the third form, after the initial cautious form: Angel=(substance-separated-from-matter), and the second, a little more careless: Angel=(separated substance). Indeed Thomas Aquinas used already all three forms.

This gradual erosion of the idealistic and safe immateriality of substance had also been a stratagem already in antiquity. Aristotle, endeavouring to wrest philosophy from the grip of Platonic idealism, had dared in his *Physics* to write:<sup>60</sup> “matter is... in a certain sense, almost a substance.” Five hundred years later, Galen could go further. Expounding a dangerous topic in his book: “*On the semen*,” he maintains: “But it is of no concern for the present whether we call it matter or substance...”<sup>61</sup> The aged Leibniz’s belief “that every created substance is accompanied by matter”<sup>62</sup> in order that God’s opportunity for “exerting his goodness” should not be diminished,



still seems typical of the Ciceronian tradition of prudence. These examples must suffice to document the historical continuity underlying linguistic concealments in atomic physics.

iv) Towards the end of his life, Aquinas, too, had learnt to make concessions. When it came to the problem whether an angel had extension in space (see above *re* Leibniz's atoms), he avoided the issue: "a point is indivisible inasmuch as it occupies space, while the angel exists outside the realm of the measurable and of location in space."<sup>63</sup> In his very first book he had been bolder. Even though he tells us in its first sentence that its title was based on the work of (the infidel) Avicenna, the book is accepted as programmatic for Thomas's later thought.<sup>64</sup> In chapter 3, Thomas (following Avicenna) proclaimed what has been called the *principle of individuation*:

*"Designatio individui respectu speciei est per materiam determinatam dimensionibus"*

(the identification of the individual within its species is by its matter, determined through its extension in space).

No serious scholastic could doubt that the argument would be applied to the atoms of the material world. Though I have translated *individui* as the genitive of the Latin word *individuum*, in its medieval meaning of an individual, the scholastics knew full well that it was also the genitive of the word *individuus*. And they knew, too, that the original *individuus* was a technical term, introduced into scientific Latin by Cicero, as a translation of a Greek term: *in-dividuus*, that which cannot be divided, from Greek *a-tomos*, an atom. Besides, the angelic doctor used the dangerous word *atomus* itself rarely—it is not present at all in the classical Catholic indices (*Tabula Aurea* and *Leonine Index*) though it does occur 83 times in Aquinas's works according to Busa's computerised concordance,<sup>65</sup> against an estimate of ca. 15,000 entries under *angelus*. Thomas found an ingenious occasion to quote, and translate into Latin from Damascenus:<sup>66</sup> "*In atomo i.e. in individuo.*" Again the *individuum* and the atom (*individuus*) become grammatically indistinguishable by a skilful process of convergence. But the code angel=atom was still necessary: the risk that Dr. Communis would be as-

simulated as Dr. Angelicus could be taken; his survival as Dr. Individuus was unthinkable.

Angel and atom, too, became interchangeable in crucial propositions by a convergence which provides the best evidence that the code was understood. *The principle of individuation* in Thomas's first work was seen to apply to atoms, but angels were not mentioned; the *exclusion principle* in his last work applied to angels without mentioning atoms. These two principles gained importance, converged to juxtaposition when cited, and to symmetry in meaning. The papal inquisitor Tempier, two years after Thomas's death, prepared a list of 219 errors circulating in Paris. Thomas was not named, but a sprinkling of propositions identified with his teaching, chosen from his enormous output, were included in paraphrase. The two principles were there: God had been denied the power to make, without matter and within one species, more than one angel (error 81)<sup>67</sup> or more than one *individuum* (error 96). Tempier could not have failed to understand that angels and atoms had become interchangeable. After Tempier's death, Gaufridus joined the fight at the Sorbonne to annul the condemnation of Thomas's propositions. The two crucial principles together head his list of ten, extracted from Tempier's 219 errors. Gaufridus pleaded that through condemnation of these few arguable propositions,<sup>67</sup> the great Aquinas's "so solemn and so useful" doctrines as a whole might come to be neglected by students...

Ostensibly, Tempier had feared that the materialist principle of individuation entailed giving up the individuality of angels (who must on no account be contaminated by matter). In reality, he dreaded that their individuality would *not* be given up. But that, instead, the point-like immutable and incorruptible "angels," moving individually with finite velocity through various media without interpenetration, would re-enter the garden of the atomist Epicurus.

## SCIENTISTS, HISTORIANS, POETS

If modern practitioners of science have abandoned both interest and education in the historical roots of their subject, it is mostly

due to the prestige of their own achievements. One relevant achievement deserves exposition here, with minimal technical detail. In 1937, before the advent of the electron microscope allowed us actually to look at molecules, E.W. Mueller invented the field emission microscope. He sealed a fine tungsten wire into an evacuated bulb with a fluorescent screen, much like a small modern TV tube. By applying a large electric field gradient of about 500 million volts per centimetre, he was able to pull fast flying electrons out from the tip of the wire. They flew in straight lines to light up on the screen an enormously enlarged image of the very tip of the wire.

When a small amount of gas was admitted, a single layer of its atoms or molecules formed a very mobile covering on that tip of the tungsten wire. The rapid random motion hither and thither in this adsorbed layer became visible on the screen, and the film that Mueller took became a scientific landmark. For the first time in history the necessary tool had been found to make atoms and their motions visible. The reader will have grasped the moral of my tale: Mueller's atoms were dancing on the point of a needle.

Though this is true,<sup>68</sup> it is also in one sense a fairy-tale. Professional historians warn the meddling scientist against the fatal trap of anachronism, of projecting his modern knowledge into the innocent minds of medieval mystics, among whom Aquinas is often given a place of honour. For Aquinas the field emission microscope was a fairy-tale, and so be it.

My layman's model of medieval science strategy should be received with scepticism, because I admit, and lay claim, to having abstracted it, not so much from historians, but rather from those other inquirers into human motivation, the poets. To invoke Dante's texts to substantiate this claim will require at least an article of its own. Long after Dante, the poetic tradition continued to re-encode the language of medieval science, and to camouflage the self-fulfilling mechanism which lies behind prophetic fairy-tales. For an illustration, I return to my opening remarks about the philosopher Wallace Stevens. Strangely, even the twentieth century has been short of actors, and Stevens is, rightly, regarded as "a kind of poet prophet for his age."<sup>69</sup> He culled the title of his book of philosophical essays: *The Necessary*

*Angel*<sup>1</sup>, from the middle of one of his own earlier<sup>70</sup> poems in *The Auroras of Autumn*. It was a poetic phrase, an insight that seems to have haunted him—the clairvoyant reflection in a Venetian glass of what he must have read in St. Thomas:

*Motus angeli, non est propter indigentiam suam, sed nostram.*  
The motion of the angel is not because of *his* need, but of *ours*.<sup>71</sup>

A generation after Stevens, the tradition was rendered inaudible by Ginsberg's *Howl*. His poem,<sup>72</sup> whose title he lifted from Kerouac, tries to found absolute love on the absolute abandonment, paradoxically inspired by wrath, of self-restraint. Accordingly, *Howl* is widely regarded as the programmatic statement of the beat poets, and at the same time forms their ultimate *Summa scatologica*. In this poem, having with gay abandon enumerated the parts of the human body which are holy to him, Ginsberg goes on:

“Everything is holy! Everybody’s holy!

...

Everyday is in eternity, Everyman’s an Angel!”

If the Inquisitor is holy and if everyone is an angel, then Aquinas’s necessity of angels is finally flushed away by a poet’s false love. Ginsberg’s admirer, William Carlos Williams, erred when, in a flattering foreword,<sup>73</sup> he compared Ginsberg to Dante. Dante never howled. The punishment meted out to sinners in his Hell usually moves him to compassion, but not indiscriminately. When he finds himself in the company of the homosexuals, he pays a courteous tribute to his teacher Brunetto; but he does emphatically approve of the punishment of those, in Canto VIII, whom wrath had led to loss of control. Here he allows Virgil to kiss him, and address him with approval as “*alma sdegnosa*” (disdainful soul). It was Dante who gave us the modern meaning of the word culture.<sup>74</sup> In his disdainful and discriminating soul, he—like his brother Ulysses—knew<sup>75</sup> what we ought still to know: how to restrain ourselves lest a sub-culture should lead us astray, with the flattery of the siren’s song, as we navigate

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through that very realm—indivisibly yours and mine—for which the Greeks had no name: I mean the Realm of Literature.

Manfred Gordon  
(*University of Essex.*)

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### NOTES AND REFERENCES

<sup>1</sup> Wallace Stevens, *The Necessary Angel, Essays on Reality and the Imagination*, London, Faber and Faber, 1954, p. 43. (First Edn. 1942).

<sup>2</sup> Pierre Gassendi (1592-1655), brought the natural philosophy of Epicurus to the notice of the founders of modern *physics* and *chemistry*:

● The mathematician Sir Edmund Whittaker (*Space and Spirit*, London, Th. Nelson and Sons, 1946), himself a sincere “neo-Thomist,” wrote: “Gassendi... reverted to the teaching of the Greek atomists...” and: “The importance of Gassendi is due to the fact that his principles were adopted by Newton, and thus became fundamental in classical physics.” See also J.E. McGuire, *Arch. Hist. Exact Sci.* 3, 1966/7, p. 206-248.

● Robert Boyle (1627-1691), the “father of chemistry,” forcefully expressed his indebtedness to Gassendi’s summary review of the philosophy of Epicurus (see pp. XCVII-CCLXI of P. Gassendi, *Epcuri Philosophia*, Vol. III, Lyon, Barbier, 1649). Boyle acknowledges that this work, and Descartes’s *Principles of Philosophy*, might have enriched his own essays “with divers truths, which they now want, and have explicated divers things much better than I fear I have done.” (R. Boyle, *The Works*, Vol. I, London, 1772, p. 302).

<sup>3</sup> G. Carducci, *Prose*, Bologna, N. Zanichelli Editor, 1922, p. 1152.

<sup>4</sup> C. de Antonellis, *De’ principi di diritto penale che si contengono nella Divina Commedia*, Città di Castello, S. Lapi, 1894.

<sup>5</sup> V. Botta, in Appendix 2 to F. Ueberweg’s *History of Philosophy*, London, Hodder & Stoughton, Vol. 2, 1874, writes: “But as a promoter of freedom in philosophy as well as in political science, Dante (1265-1321) stands preeminent in the history of his country.” (Cf. ref. 74 below).

<sup>6</sup> G. Galilei (*Le Opere*, Florence, G. Barbèra, 1899) calls Dante an *architect of sublimest judgment* in the opening paragraph of his first lecture on Dante’s *Inferno*.

<sup>7</sup> C.O.F. Mossotti (in a letter dated 9-7-1874) published in *Coll. di Opuscoli Danteschi*, Città di Castello, Ed. Passerini, S. Lapi, Vol. 6.10.

<sup>8</sup> F. D’Ovidio, *Atti Reale Acad. de scienze mor. e polit.*, 26, 275 (1892).

<sup>9</sup> Louis Bréhier, *L’Eglise et l’Orient au Moyen Age*, Libr. Paris, V. Lecoffre, 1921, p. 11.

<sup>10</sup> M.A. Orr, *Dante and the Early Astronomers*, London and Edinburgh, Gall and Inglis, 1913, p. 5.

<sup>11</sup> Aurelius Augustinus, *Confessions*, Book VIII, Chapter VII.

<sup>12</sup> Dante Alighieri, *Convivio*, Book II, Chapter XII.

<sup>13</sup> Benevenutus de Rambaldis de Imola, *Commentum super Dantis Alligherij*

*Comoediam* (written about 1376), Vol. 1., G. Barbèra, Florence, 1887, 178, (Comment on *Inf.* III, 141).

<sup>14</sup> See also Boethius, *De Consolatione Philosophiae et de disciplina scholarium*, ca. 1514 (British Library Cat. 1502/129) where the anonymous commentator begins by re-calling Aquinas's opening.

<sup>15</sup> Seneca, Letter VIII to Lucilius.

<sup>16</sup> G. Verbeke, *L'évolution de la Doctrine du Pneuma. Du Stoïcisme à St. Augustin*, Paris, Desclée de Brouwer, 1945.

<sup>17</sup> A. del Gaudio, *Archeion* (Rome), 6, 121-138, 1925.

<sup>18</sup> R. Bacon, *Opus Majus* (1267-8). Part I, Chapter IX: "The Blessed Jerome... was called a corrupter of Scripture and a forger, and a sower of heresies. and in his own day was overwhelmed and unable to publish his works..." (translated from the Latin by R.B. Burke).

<sup>19</sup> Boethius, *De Consolatione Philosophiae* (ca. 524), I.IV, 28: "Hence my grievous and irreconcilable disagreements with corrupt men, and—what freedom of conscience holds as its own—namely, in the interest of justice, always to spurn the hatred of the powerful."

<sup>20</sup> Dante Alighieri, *Purg.* XX, 69, cf. D. Clemente, *Napoli e San Tommaso*, Naples, Accattoncelli, 1873, p. 32: "all the biographers of the Saint (sc. Thomas), and the writers of that time, agree..." that Charles of Anjou poisoned him or had him poisoned. But this accusation could now only be tested, if at all, by reference to primary sources.

<sup>21</sup> See Abelard's *Historia Calamitatum* in J.T. Muckle, *Medieval Studies*, Vol. XII, 1950, pp. 195, 210.

<sup>22</sup> Abu Mohammed Ali ibn Ahmad ibn Hazm, *El collar de la paloma*, Spanish by Garcia Gomez, Madrid, Soc. de Estudios y Publicaciones, 1952; "Though you burn the paper, you cannot burn what it contains, because I carry it in my heart."

<sup>23</sup> Seneca, Epistle 88: "Safer is memory, which has no external substrate."

<sup>24</sup> Philip a Limborch, *The History of the Inquisition*, (transl. by Samuel Chandler), London, J. Gray, 1731, Vol. II, p. 113.

<sup>25</sup> Quoted by E. Massa, *Ruggero Bacone*, Rome, Edizioni di Storia e Letteratura, 1955, p. 12.

<sup>26</sup> A. Augustinus, *The City of God*, Book 22, Ch. XIII.

<sup>27</sup> *Ibid.* Ch. XX.

<sup>28</sup> Migne, *Patrolog. Lat.* 33, col. 431; 111.

<sup>29</sup> Migne, *Patrolog. Lat.* 23, col. 773, where Jerome writes e.g. "But as we do not have such a diversity of vowels (sc. as in Hebrew), we are content with a simple choice."

<sup>30</sup> *Ibid.* col. 1211.

<sup>31</sup> A. Cruden, *Complete Concordance to the Old and New Testament*, London, William Tegg, 1863.

<sup>32</sup> Olaf Lagercrantz, *Von der Hölle zum Paradies* (transl. from the Swedish by G. Jänicke). Insel-Verlag, 1964, p. 79.

<sup>33</sup> See Benvenuto da Imola in ref. 13 Vol. 1, *Inf.* X, p. 346: "*infernum viventium*," and pp. 37/8: "*lo'nferno... idest mundum*" (the Inferno... i.e. the World).

<sup>34</sup> H. Ley: *Geschichte der Aufklärung und des Atheismus*, Berlin, Deutscher Vlg. der Wiss., Vol. II/1, 1970, p. 209.

<sup>35</sup> A.F. Mehren, *Etudes sur la Philosophie d'Averroës*, Louvain, 1888; Averroës's *Tabafut al-Tabafut*, transl. S. van den Bergh, Oxford University Press, 1954, Vol. 1, p. 360.

<sup>36</sup> R. Bacon, *Opus Majus*, translated by R.B. Burke, Part 1, Ch. X. This passage should be compared with the text to note (25).

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<sup>37</sup> Cf. A. Dyroff, *Aurelius Augustinus*, Eds. M. Grabmann and J. Mousbach, Festschrift d. Görresgesellschaft, Köln, 1930, p. 15 ss.

<sup>38</sup> Sir James Jeans, *The Growth of Physical Science*, Cambridge University Press, 1950, p. 111. This passage should be contrasted with that cited under ref. 36 above from Roger Bacon, whose vision Jeans described (*ibid.* p. 124) as having “ever been restricted by theological blinkers.”

<sup>39</sup> In *Par.* X, 137-9, Thomas introduces to Dante “the eternal light of Siger who reduced enviable truths to syllogisms.” Dante was in his teens when Siger was murdered by a cleric.

<sup>40</sup> P. Mandonnet, O.P., *Siger de Brabant et l'Averroïsme latin au XIIIe siècle*, Librairie de l'Université, 1899, p. 253.

<sup>41</sup> Thomas Aquinas, *Summa Theologica*, Rome, Forzanas et S., 1894, I, Qu. CXIII, 7 (cf. Revelation, 2, 1, 8, 12).

<sup>42</sup> *Ibid.* Qu. CVI, 1.

<sup>43</sup> See *Opera Omnia* Divi Thomas Aquinatis, Paris, L. Vivès, 1880, Vol. 33 & 34.

<sup>44</sup> Vol. VI of ref. 41 above.

<sup>45</sup> *Inf.* X, 118-119. Dante's best friend was the leader of the Epicurean sect in Florence, Guido Cavalcanti. See also note 33, and text to which it refers.

<sup>46</sup> In the letter to Herodotus in Diogenes Laertius's *Life of Epicurus*, having explained that compounds are composed of atoms, Epicurus continues: “The latter are indivisible and immutable, or else everything would disappear into non-existence; besides, during the dissolution of compounds the atoms resist by being impenetrable by their nature, and as such afford no possibility of destruction.”

<sup>47</sup> i) I. Qu. L., Art. V: “...I answer by saying that necessarily angels are incorruptible by their nature.”

ii) Qu. LII. Art. III: “I answer by saying that two angels cannot simultaneously be in the same place.”

iii) Qu. LIII, Art. I. (Ad primum): “but the angel is indivisible.”

iv) Immutability of the angel is involved in the subtle discussion of motion in question LIII, Art. II, III. In Qu. IX Art. II, Thomas circumvents Augustine's embarrassing claim that only God is immutable thus: “Good angels... have immutability of choice, through divine power, yet there remains in them mutability of location.” (Epicurus's atoms are mobile!).

<sup>48</sup> Reference 43, Entry *Angelus*, number 86.

<sup>49</sup> Newton rejects, in the fourth sentence of his *Principia*, the assumption of a “medium which pervades the interstices of the parts of bodies” (cf. ref. 2).

<sup>50</sup> The avoidance of a medium, notwithstanding the abhorrence of “action at a distance,” underlies the application of the tensor calculus to physics by Einstein and by Weyl, and the modern compromise notion of a “field” of force.

<sup>51</sup> Gottfried von Strassburg, *Werke*, Vol. 1, Tristan and Isolde, ed. F.H. von der Hagen, Breslau, J. Max and Co., 1823 line 4693. (Cf. *The Tristan and Isolde of Gottfried von Strassburg*, transl. E.H. Zeydel, Princeton, Univ. Press, 1948). This contribution to the evolving legend, written about 1210, is still far from its swan song at Bayreuth: Gottfried's Tristan plays chess and teaches Isolde Latin...

<sup>52</sup> Dante Alighieri, *De Vulg. El.* II I and II, IV.

<sup>53</sup> Ref. 44, p. 79.

<sup>54</sup> *Ibid.* Vol. 1, Qu. L., IV.

<sup>55</sup> G.W. Leibniz, letter to John Bernoulli, 12-8-1702, in *Leibnizens mathematische Schriften*, Ed. C.I. Gerhardt, Halle, E.W. Schmidt, 1855 Vol. 3.

<sup>56</sup> K.J. Grau, *Abb. zur Philos. und ihrer Geschichte*, 39, Ed. B. Erdmann,

Halle, M. Niemeyer, 1916. Grau lists earlier writers who had noticed this trick in Leibniz.

<sup>57</sup> *Die Metaphysik des Averroes*, transl. from Arabic and explained by Max Horten, *Abb. zur Philos. und ihrer Gesch.*, Ed. B. Erdmann, Halle, M. Niemeyer, 1912, p. 14.

<sup>58</sup> Ref. 44, p. 77.

<sup>59</sup> Par. III, 29; VI, 5; XXIX, 76.

<sup>60</sup> Aristotle, *Phys.* I (A) 192a.

<sup>61</sup> Galen, *Peri Spermatos*, Book II, Ch. 2; in *Medicorum Graecorum Opera*, ed. D.C. Kühn, Leipzig, C. Knobloch, Vol. 4, 1822, p. 611.

<sup>62</sup> G.W. Leibniz, third letter to Clarke, 1715.

<sup>63</sup> Ref. 41, I, Qu. LVIII, Art. 1.

<sup>64</sup> R. Allers in *Tb. Aquinas, De ente et essentia*, (1252 or 3), in German-Latin edition, ed. R. Allers, Thomas-Verlag, Vienna, J. Hegner, 1936, p. 10.

<sup>65</sup> *Index Thomisticus*, R. Busa, S.I., (ed.), Milan, Cartiere Binda, 1971, Vol. I.

<sup>66</sup> Ref. 41, III, Qu. 2, Art. 5.

<sup>67</sup> C. du Plessis d'Argentré, *Collectio Judiciorum etc.*, Paris, A. Cailleau, 1728, Vol. I, (pp. 180-1). For *angelus*, Tempier skilfully substituted *intelligentia*, and skilfully defined "intelligences" as "separated substances," but his readers knew (as we can ascertain from modern Dante dictionaries) that both of these terms meant angels *Idib.* p. 215: Gaufridus.

<sup>68</sup> See R. Gomer, *Field Emission and Field Ionization*, Oxford University Press, 1961, p. 32: why sharp needle-point necessary; p. 112: the motions of atoms on the needle-point filmed.

<sup>69</sup> J.N. Riddel, *The Clairvoyant Eye*, The Poetry and Poetics of Wallace Stevens, Baton Rouge, Louisiana State University Press, 1965, p. 4.

<sup>70</sup> W. Stevens, *Collected Poems*, London, Faber and Faber, 1955, p. 192.

<sup>71</sup> Ref. 43, Entry *Angelus*, number 119.

<sup>72</sup> A. Ginsberg, *Howl* and other poems, San Francisco, City Light Books, 1956.

<sup>73</sup> See A. Ginsberg, *Empty Mirrors*, New York, Totem Press and Corinth Books, 1961.

<sup>74</sup> *Convivio*, IV., Ch. 7: "How great is my undertaking in this song, to try and weed at last a field so overgrown with clover, as that of public opinion, after its long neglect by our culture." It subsequently took 200 years for Italian writers to accept the meaning of *cultura* in Dante's metaphor.

<sup>75</sup> Dante Alighieri, *Purg.* XIX, 19-35.