The Nova Stella and its Observers

P. Ruiz–Lapuente *,**

1. Introduction

In 1572, physicists were still living with the concepts of mechanics inherited from Aristotle and with the classification of the elements from the Greek philosopher. The growing criticism towards the Aristotelian views on the natural world could not turn very productive, because the necessary elements of calculus and the empirical tools to move into a better frame were still lacking. However, in astronomy, observers had witnessed by that time the comet of 1556 and they would witness a new one in 1577. Moreover, since 1543 when De Revolutionibus Orbium Caelestium by Copernicus came to light, the apparent motion of the planets had a radically different explanation from the orthodox geocentrism. The new heliocentric view slowly won supporters among astronomers. The explanations concerning the planetary motions would depart from the “common sense” intuitions that had placed the earth sitting still at the center of the planetary system.

Thus the “nova stella” in 1572 happened in the middle of the geocentric–versus–heliocentric debate. The other “nova”, the one that would be observed in 1604 by Kepler, came just shortly after the posthumous publication of Tycho Brahe’s Astronomiae Instauratae Progymnasmata which contains most of the debates in relation to the appearance of the “new star”.

The machinery moving the planetary spheres, i.e. the intricate system of solid spheres rotating by the motion imparted to them as the wheels in a clock, was not directly affected by the new heliocentric proposal. There, it was also needed to have a way to transmit movement. Most astronomers that accepted the heliocentric system stayed with the idea of solid spheres transmitting the movement, until the comets originating beyond the lunar realm and crossing therefore those “spheres” made their solidity impossible.

* Department of Astronomy, University of Barcelona, Martí i Franquès 1, E–08028 Barcelona, Spain. E–mail: pilar@am.ub.es

**Max–Planck–Institut für Astrophysik, Karl–Schwarzschild–Strasse 1, D–85740 Garching, Federal Republic of Germany. E–mail: pilar@MPA–Garching.MPG.DE
What was then the scientific relevance of the event of 1572 and that of 1604? A first implication was to start to look at the stars as material bodies, at least some kind of stars. More generally, it gave rise to a qualitative jump in the way to attempt the unification between microcosmos and macrocosmos. That can not be said to be the obvious conclusion derived by most of the astronomers who observed and wrote about SN 1572, but by a few of them and by those of later generations. Most XVI century astronomers were embedded in the Middle Ages notions of “sympathies” between the celestial and the earthly realm. Amongst those who wrote about SN 1572 some were practitioners of natural magic, as John Dee, actively involved in alchemy, and sharing the study of talismans and transmutation of metals with that of mathematics and books of hermetic and cabalist character. The connection between microcosmos and macrocosmos was nearly that of the Middle Ages at the time of the advent of SN1572. The heliocentrist astronomers who observed well in detail the nova stella, Digges and Maestlin, read the relation of the planets and their motions in terms of harmonies, both following the Neoplatonic views which inspired Copernicus. Sympathies and harmonies were central concepts in the study of the cosmos for the astronomers acquainted with the Corpus hermeticum and the Neoplatonic writings. Along those lines, the importance of geometrical beauty in the heavens is found in many XVI century astronomers.

Staying far apart from the Neoplatonic influence, Tycho Brahe would also keep the domain of the heavens away from that of the earth. Natural tendencies of the stars and of the bodies in earth would be different in both realms for him, suscribing here to Aristotle’s differentiation of movements. Tycho Brahe preserved as well the notion of quintessence from the Greek philosopher, the perfect immutable substance which permeates the heavens making them of different nature than the earth.

Therefore, either sympathies, harmonies or natural tendencies made the basis of the relation between the earth and planets and stars. The “nova stella” gave the chance to rethink the difference between our realm and the one of the stars. Some of the observers, as Jerónimo Muñoz, were radical in the conclusions and looked for a non–hierarchical view of the cosmos, basically made of matter stirring from the initial Chaos, and advanced mechanicist explanations. He wrote against the existence of quintessence as the perfect solid that made the sphere of the fixed stars.

In all the years following 1572, the practice of printing and translating books helped to spread the ideas of the various observers of the nova stella. And most of the views and records by astronomers and philosophers ended up in the volumes of Tycho Brahe’s Progymnasmata. Though Tycho Brahe was not keen in abandoning the idea of the solidity of the celestial spheres and the immutability in the sphere of the fixed stars, he took care of quoting the debates and most of the observational facts. Systematically noting the evolution
in brightness of the event, his account in the *Progymnasmata* gives us the place where the *nova stella* should be located within the class of stellar explosions to which it belongs\textsuperscript{6}.

2. The records in modern perspective

The observers of the *nova stella*, known nowadays as SN 1572 or Tycho Brahe’s supernova, contributed to the empirical knowledge of this event by measuring its position and recording the brightness until it faded.

The observers measured angular distances from the supernova to the stars in Cassiopeia by naked eye and with the help of threads, rulers or sextants. They were limited by the eye’s precision in measuring angular distances, which is about 1 arcmin, and by the inaccuracies of their methods. Brahe, Digges and Muñoz achieved the 1 arcmin precision of the eye in their measurements of the angular distance between the stars in Cassiopeia and the supernova. Tycho Brahe was here as well the most exhaustive of them, measuring angular distances to a larger number of stars. Muñoz got to the limiting accuracy of the eye when obtaining the distance between the nova and $\alpha$ Cas and $\beta$ Cas while doing an error of 10 arcmin in the distance between the new star and $\gamma$ Cas. The same is found in Digges and Brahe for some of their measurements. Hagecius, in contact with Muñoz, learnt from him how to correct his results. His original measurements were up to 20 arcmin off\textsuperscript{7}. Stephenson and Clark\textsuperscript{8} reconstructed the historical position of the *nova stella* from Tycho Brahe’s measurements giving a final standard deviation of 22 arcsec. They found in the writings by Tycho Brahe the likely reason of the uneven quality of his measurements, as he did not use always his half-sextant. Eliminating measurements that were severely off, and using Digges observations, the original position by Tycho Brahe, well north of the centroid of the remnant, comes into agreement with the positions of the rest of observers who are closer in declination to the centroid. Both Muñoz and Digges got the declination right while carrying a larger error in right ascension. Green has recently reexamined the positions given by those observers and for others whose work had not been examined so far\textsuperscript{9}. Differences in the historical position of the *nova* as large as the radius of the present remnant are found. Overall, the accuracies of the observers are very different, as some of them used very crude methods.

While the position of the supernova can not be retrieved at an accurate level from the measurements done in 1572, the records of the brightness have turned out to be very useful. Just a paragraph in the otherwise rather extended account in the *Progymnasmata* by Tycho Brahe helps us to build up the visual *light curve*, i.e. the evolution of luminosity with time for this event. Tycho Brahe did not quote the specific date of the observations but the month
or even and interval within two months. However, for most of what one can extract, such an interval is enough. He and the rest of astronomers compare the magnitude of the supernova to that of stars and planets. Muñoz provides the most constraining account on when the explosion took place as he first observed it on Nov 2 but saw nothing. He writes that he was certain that on November 2, 1572 the “comet” was not in the sky, as he was “teaching to know the stars to a numerous group of people that evening”. In Nov 11 it was already seen by some shepherds in Ontiniente (near Valencia), and the author of the “Book of the New Comet” seems to have worked several chapters by Jan 7 1573, as he writes: “when it began to be visible, it looked larger than Jupiter, and now, on January 7, 1573, it already looks smaller than Jupiter; this could have happened because it had risen higher than where it was when it first appeared”. This note is an upper limit to the rate at which the luminosity of the supernova declines. It is consistent with the account given by Tycho Brahe that on January it was a little fainter than Jupiter and brighter than the brightest stars of first magnitude. Tycho Brahe first noticed the supernova on Nov 11 and finished recording the brightness on March 1574. On Nov 11 and Nov 16 it was observed as well by Caspar Peucer and Johannes Prätorius, whose records help to draw the premaximum phase in the evolution in luminosity of the supernova. From the combined records one can reconstruct the light curve of this event and say where it stands within this class of explosions. From the color evolution one can also state that Tycho Brahe’s nova was in fact a normal thermonuclear supernova as those used today in cosmology as distance indicators. The observations by Brahe, Maestlin, Muñoz and Prätorius were the most useful to trace the evolution in brightness and color.

If we consider the errors that we can safely assign to those determinations, no doubt that the light curve observations should be regarded as precise. They were at the frontier of what it was possible to do before the telescope came into use. The method used by those authors, specially by Tycho Brahe, of noting when it appeared and how it changed in brightness, is the same one used in our times. Even the observational limit that they reach of 0.2 mag is in accuracy at the limiting magnitudes for the eye.

3. The nova stella and the turn of the cosmos

Since the appearance of the latin translation of the Corpus hermeticum by Marsilio Ficino, in 1463, a growing interest in these texts as containing fundamental truths of the Christian religion spread through Europe. The ancient cult to the sun by the Egyptians, viewed through the Christian prism, had an influence in Copernicus and his heliocentric system. Astronomers of Neopythagorean and Christian hermetic views such as Maestlin were all reluctant to accept SN 1572 as a natural phenomenon. They considered it a star.
that appeared as a supernatural act. That was as well the position that Maestlin’s disciple, Kepler, had towards the nova of 1604. It was also the position of Tycho Brahe regarding SN1572.

In the most conservative realm, some observers considered that the star of 1572 had always been there but a change in the air or in the celestial aether allowed it to be seen. Of that opinion was Francisco Valles, who wrote a treatise criticised in Tycho Brahe’s Progymnasmata. Francisco Valles had acknowledged three ways to know the truth: experience, reason applied to the experience and authority of the ancient and scholars, the third of which being the less suitable. However, regarding the nova, he would not depart from tradition.

Tycho Brahe himself defended as well traditional views for many years and did not change his position, motivated by the astronomical events that happened in the decade 1570-1580, until much later on. For long he denied that comets or meteors could be among the planets and the fixed stars and believed in the solidity of the celestial spheres, as it has been documented in letters to Caspar Peucer and Rothmann. He and Caspar Peucer held correspondence on the solidity of the spheres still around 1588, well after SN 1572 and the comet of 1577. Only gradually he accepted that the solidity of the spheres did not fit the observations and moved to admit a liquid nature for those. In all this, he seems to have tried to look into the Scriptures as a guide to find the true cosmological picture. The physical way to move the heavens was lacking if the spheres were not solid and assembled as in clockwork. He finally conceded to move away from previous views:

Heaven is not made up of real, durable and impervious orbs to which the stars are affixed and travel, but it consists of a substance that is very clear, very thin and very fine. This makes the courses of the seven planets free so that they move without any slowing wherever their natural impetus and their knowledge carry them. This was not seen by the ancients or even the greater part of the moderns, nor even conceded because it was never doubted. For it is enough for the restoration of astronomy to admit it as settled and known.

Lacking other better explanation, when the clockwork shell machinery transmitting the movement disappeared, the planets somehow would be following a natural impetus or knowledge, according to Tycho Brahe.

On the Neoplatonist shores, the harmonies and beauty necessary to the motions in heavens were confronted with the choice of an acceptable level of departure from the aimed circular perfection. In the world of “sympathies” or “consonances” as ruling the planetary
motions, exceptions were sometimes judged to add to the beauty of the cosmos: John Dee would consider that planets move according to law of “consonance” or “sympathy”, though some “dissonance” or “antypathies” are seen in the retrograde movement of planets contributing to the ornament of the universe. The degree of tolerance to exception within the tradition of natural magic could be very large.

In general, the Neoplatonist authors preserved Aristotelian notions of movement. Digges in his *A perfit description of the Caellestial Orbes* combines them with Platonic influences.

Adding to their common ground, Digges and Brahe kept the distinction between noble and less noble movement as a separation of the motions between the realm of the terrestrial and the heavens and refer to “natural tendency” for the motions. In Digges, the domain of movements is in accordance to the noble or less noble realm that characterized as well the composition of the bodies, that of the harmonious as in the heaven or the forced or unnatural in our earthly realm. He distinguishes two types of motions, straight or circular, and discusses whether a violent movement or a natural movement is found in the earth’s motion.

The distinction between the domain of the perfect and the domain of the corruption and the perpetuation of the system of four elements (air, earth, fire, water) as the basis of the material world is the referent into which astronomers would state their views. In Tycho Brahe, whether quintessence was a crystal or a metal had been addressed as well.

Though all the ancient cosmogonies had a sequence of arrangements of planets which was more or less fortunate, transforming such sequence into a system of solid shells fitting inside each other resulted in the enduring basis of celestial mechanics. The solidity in the spheres is no Aristotle’s invention since solid wheels whose circular openings would make the planets are proposed in Anaximander. Previously to Aristotle, Plato had revived the animistic view of the cosmos in his *Timaeus*, where the world is argued to be a sphere in analogy with the man, as it is the best shape to be given to it as a living organism that does not need arms nor legs. Aristotle continued with the animistic trend from Plato’s *Timaeus*. Though in Aristotle the system is more elaborated and the intelligences moving the cosmos are eternal: the Universe is without beginning.

“In this way that according to Aristotle, the heaven and its intelligences are so eternal as the first cause, and over them there is no more power than the first mover, being in the supreme region makes the turn of the heaven and makes the intelligences to move and with that movement to place to move the inferior orbs”, summarizes Muñoz in his “Book of the New Comet” where he points the need to abandon this idea. Along the chapters of the book, he follows very orderly the various aspects that this new event raised and derives far-reaching
consequences for cosmology. From the lack of parallax of this “comet” Muñoz deduced that it did not happen in the “air” as in the comet theory of Aristotle and that there could be mutability in the heavens and that those were not solid. The comet appeared in 1556 had probably helped to build his opinion on the continuity of the heavenly and earthly domains. In the account on the new comet he clearly acknowledges the possibility of combustion in the heavens and that they are made of the same elements as the sublunar world. A unified cosmos where physical changes occur, and where motion is transmitted through rotation from the initial Chaos as suggested by Anaxagoras:

Aristotle understood that the comets were done in the superior region of the air and not in the heavens, as Democritus and Anaxagoras (philosopher and great mathematician) want, whose opinions Aristotle as he was not an astronomer did not understand, neither has the base to understand the Caldean and Egyptian doctrines.

... I have many experiences that force me to be in regard to the comets and other opinions closer to Democritus and Anaxagoras (who was philosopher and great astrologer) than to Aristotle, who in his works does not show to know astrology, while admiring the curiosity and diligence of the astrologers, and Egyptian, Caldean and Babilonic priests.

Muñoz calls comet to the nova meaning a new kind of comet, in the region of the fixed stars, which shows no parallax and does not cross transversally the skies, though likely moves just approaching and receding along our line of sight. He thinks that comets are bodies similar to the planets, but not planets themselves, and that they are made near the poles because the heavens are denser there due to the constellations. One has to keep in mind that Jerónimo Muñoz noticed that the comet was aligned with the Milky Way, and thought that it likely arises from it. When it comes to say how do these bodies get their motion, he looks for light as causing the effect, i.e. the planets, with their rays gathered towards the otherwise cold regions of the constellations would lighten a part of those regions, and from their rays and the stars a comet, or fire is made that “gathers strengths and circular movements different from those of its parents, or makers, and sometimes similar to them”. For the same reason, the conjunction of planets would favor the production of comets.

Moreover, reports on a variety of “comets” might have helped in making the supernova to be classified in such a way and not as a star. According to Muñoz, there were records of various types of comets and he devotes a chapter to their classification. The Comet of 1572 did not have parallax and was in the region of the fixed stars. But that would not be the first time that such kind was seen, as there are comets that show no parallax:
In no author I find Comet like that, who resembles more a star than a Comet. Ptolemy and Pliny mentioned some Comets that do not move and do not get apart from the stars from which they came out, but they do not describe their form. Lucanus says that before the civil war between Julius Caesar and Pompeius, *ignota obscurae viderunt sidera noctes*, that were Comets in the way of stars, not known to scholars: from that genre of Comets is without doubt ours.

Other than in the theory of comets, the attraction of this author to early Greek philosophers, and in particular to Anaxagoras, seems to be manifold. One aspect is the attraction to the “nous”, Mind that organizes the cosmos. Anaxagoras and his “νοûς” are at the start of rationalism, but it is also in the Genesis. Another link with the Presocratic philosopher is the rejection of the Aristotelian theory of the natural place of the elements in the cosmos while holding a view of matter made everywhere of the same elements. This view brings him close to the “seeds” of Anaxagoras or “atoms” of Democritus as the basis of the material world. The Aristotelian view of matter seems a step back if we consider the intuitions of a unifying principle under the diversity of the material world of some early Greek philosophers. Muñoz goes back to the philosopher Anaxagoras, who held the opinion that no thing is born or perishes, but composes itself and dissolves itself from the existent things. Birth would be composition and perishment dissolution. Parts of the script deal with the play of those mixtures of elementary components in the heavenly bodies and a chapter is entitled “Heavens and stars are not quintessence, but that they have a debt and relation with the elements”.

The origin of the cosmos from Chaos and the whirlpool model of transmission of movement is another connection that would place Muñoz in the line of thought of turbulence in the heavens and cosmic continuity, that one leading to Descartes’s planetary model. Rotation as inherited from the original Chaos, is noted by him to be proposed by Anaxagoras (and also found in Middle East cosmogonies). The motion, the rotation of the heavens, would have been there from the original moment of Chaos and since then it would have been preserved and passed on to the various bodies, i.e. rocks, in which the matter would be stirred. The Anaxagoras *nous*, the principle responsible for the material realm, governed the rotation at the beginning, starting on a small area to end up in a larger one and a still larger one in the future. The *nous* knows all the things mixed, separated and divided. The same rotation that was set on the things made them split. Within this view which is mechanicist after setting up the rotation, it is clear that there is no need for the existence of solid spheres passing movement. Moreover, for philosophers acquainted with the Middle East cosmogonies, Anaxagoras, rather than Aristotle, would be the philosopher that best explain the views transmitted in the Bible, Babilonic, and Middle East cultures to the ancient
Greeks. Along these lines, Jerónimo Muñoz has in mind a Universe opposite to the eternal cosmos of Aristotle, i.e. the cosmos as order coming from chaos as in the Scriptures\(^{23}\).

Thaddeaus Hagecius, who had contacted Muñoz on the subject of the nova, would refer largely to the Presocratics in his treatise published in 1574. This observer of SN 1572 had, however, interests in the other lines of thought of the time\(^{24}\). He widely discussed on the Cabala with John Dee and was in touch with Tycho Brahe.

The mechanistic picture of the “Book of the New Comet” was very different from the point of view of the Neopythagorean–Neoplatonic astronomers Digges, Mästlin and others (tradition culminated by Mästlin’s disciple Kepler). Their view, other than description in terms of purity of geometrical forms in the heavens, would not refer to transmission of impetus but, in the case where this is addressed, to a possible magnetic influence of the central body (the Sun) on the planets around. In Kepler, this idea is well developed up to the point that he considers the planets as possibly dragged by the magnetic force arising from the Sun.

Kepler would propose as a force to hold the planets\(^{25}\):

This force which takes hold of the planetary bodies and transports them is an incorporeal emanation from the force which is located in the sun.

... The force which extends out from the sun to the planets moves them in a circle around the immovable body of the sun.

... We may believe that in the sun there is no force attracting the planets, as in a magnet (for they would continue to approach the sun until they were completely joined to it), but only a directional force. Hence the sun has circular fibers which sweep around in the direction shown by the zodiac. Therefore the perpetual rotation of the sun is accompanied by the circular rotation of that moving force or outflow of the emanation from the sun’s magnetic fibers. This outflow is diffused throughout all the planetary distances, and its rotation occurs in the same period as the sun’s.

Along with Thomas Digges, Michael Maestlin was the other Copernican observer of the nova stella who significantly contributed with observations. His brightness and color estimates are useful accounts to retrieve the light curve of the supernova. Maestlin interests in the hermetic tradition and the Christian Cabala were as well as his Copernicanism an impacting influence on his disciple Kepler.
4. The *nova stella* and the Pythagorean views

Digges, in his treatise “A perfit description of the celestial orbes according to the most ancient doctrines of the pythagoreans” follows still the line of distinction between movements in the celestial spheres and those in the sublunar realm, and shows an aesthetic preference for the Copernican model. In fact, all what is contained in Digges’s treatise follows Copernicus’s *De Revolutionibus Orbium Caelestium*, as Thomas Digges’s intention was to improve the edition of the existing book by his father Leonard Digges appending what he considered the right cosmological model. Thomas Digges is convinced of Copernican heliocentrism.

His view on motions keeps Aristotelian concepts but outlines the geometrical relevance of the tendencies in the heavens.

Tight or straight motion only happen to those things that stray and wander, or by any means are thrown out of their natural place. But nothing can be more repugnant to the form and ordinance of the word, than that things naturally should be out of their natural place. This kind of motion therefore, that is by right line, is only accident to those things that are not in their right state or natural perfection, while parts are disjoined from the whole body, and convey to return to their unity therefore again.

Along these lines he defines gravity as a natural tendency of the bodies:

Gravity is not anything but the natural tendency given by the divine providence of the Creator to the parts, for which virtue they tend to unite with the bulk and to restaure in this way the unity or integrity under the spherical shape. It is very likely that this same property or affection is on the Moon and the other noble celestial bodies, in the way that they aim to gather their parts and preserve the spherical figure.

Thus Digges and many others would see in the spherical shape the natural one for the celestial bodies, so very much as in the Pythagorean tradition and that of the *Timaeus*.

Bodies tend to keep approaching following a sphere. Circular, spherical shape in the realm of the the noble bodies would prevail and there is an aesthetic preference for the sun at the centre of the solar system. As in Copernicus, Digges writes that Hermes Trismegistus called the sun the visible God and king of the planets.

Amongst the most appreciated contributions by Digges given in his treatise are the arguments on why the motion of the earth will not stir it apart: “But anyone who maintains the earth’s mobility may say that this motion is not violent, but natural.” He compares
it with sailing in a smooth sea: “A ship carried in a smooth sea does move so steadily that all things on the shores and the seas seem to the sailors to move while themselves remain at rest together with all things that are aboard with them. So, surely it may happen that the earth, its motion being natural and not forced, but most uniform and unperceivable, moves in such a way that to us, who are sailing therein, the whole world may seem to roll about”\textsuperscript{29}.

Digges uses arguments in favor of an infinite Universe, amongst them the suggestion that the heavens could be infinite because it makes no sense that \textit{nothing} will restrain the cosmos:

without the Heaven there is no body, no place, no emptiness; no, not any thing at all, whether heaven should or could farther extend. But this surely is very strange that nothing should have such efficient power to restrain something, the same having a very essence and being.\textsuperscript{30}

This argument is Copernican\textsuperscript{31}, as much as the views on gravity and the motion of the earth, but was stressed in Digges’s treatise including a diagramme of the cosmos where the sphere of the fixed stars extends to infinity.

5. Geometry and the unified cosmos

Though acknowledging changes in the heavens, the picture of geometry ruling the cosmos prevailed among most astronomers of this generation that shared the Copernican influences and read the mind of God in geometry. Digges and other Neopythagoreans did not give up the spheres in view of the \textit{nova stella}. The perfection beyond the sphere of the Moon would still be the atmosphere where Kepler developed his studies. The geometrical approach would lead in Johannes Kepler to the description of the movements of the planets that inaugurated a new epoch in science. Isaac Newton, breathing similar philosophical influences, would much later bring the mathematical baggage for understanding Kepler’s laws and the motion of the bodies. With him gravity would move from the philosophical discourse into the discourse of science. But that would happen one century later.

The line of thought leading to the unified cosmos and the mechanicist transmission of impetus in it is already present in the debate around 1572, as has been shown here. It would gain a mathematical formulation in Descartes and his vortex cosmology in \textit{The World or Treatise of Light}. At the beginning of the XVII century atomism would be recovered. The corpuscular view of the cosmos common to earth and planets would be the basis of mechanics and of the discussion about gravity. That current of thought is also the seed of
Those steps occurred in the century following the “nova.” For what concerns the “nova” relevance, it certainly implied a gain of the importance of the empirical realm in relation to the philosophical discourse used for centuries in cosmology. The observers witnessed mutation in the heavens, and such mutability held a key to the relation between heavens and earth. It would take, however, five centuries more to start to know the closeness of the two realms.

The observations of the nova stella set up very high standards in the systematic way to proceed in astronomy. Tycho Brahe was precise and complete about the observations and his records would be discussed for the next five centuries.

6. Notes and references

1 Tycho Brahe, *Astronomiae Instauratae Progymnasmata* (Uraniborg, 1602), in Tycho Brahe Opera Omnia, 15 vols, ed. J.L.E. Dreyer (Amsterdam: Swets & Zeitlinger, 1972), vols II and III.

2 Kepler, who took care of publishing the work by Tycho Brahe, brought to light his “New Astronomy” in 1609, five years after seeing what he considered a sign. He completed his first law of planetary motion one year after his nova.

3 It is indeed diverse when and why the heliocentrist astronomers abandon the solidity of the orbits. Kepler first acknowledges that the celestial substance is tenous in his Optics written in 1604, well after the comets.

4 References to Hermes Trismegistus are common in the writings of the observers of SN 1572. All the observers mentioned here were acquainted with the *Corpus Hermeticum*. For an English translation, see *Hermetica: The Greek Corpus Hermeticum and the Latin Asclepius*, with Notes and Introduction by Brian P. Copenhaver (Cambridge: Cambridge University Press, 1995).

5 Jerónimo Muñoz *Libro del Nuevo Cometa* (Valencia: Pedro de Huete, 1573), re–ed. with introduction, appendices and Muñoz’s letters by V. Navarro–Brotons (Valencia: Hispaniae Scientia, 1981), hereafter cited as LNC.

6 See W. Baade, B Cassiopeiae as a Supernova of Type I, *Astrophysical Journal* **102** (1945), 309–317; P. Ruiz–Lapuente, Tycho Brahe’s Supernova: Light from Centuries Past, *Astrophysical Journal*, 612 (2004), 357–363. Walter Baade was the first to find that the nova was
in fact a supernova of Type I. That class of supernovae has been regrouped among supernovae of core-collapse (encompassing Type II and a part of the Type I class, i.e. Type Ib and Type Ic) and thermonuclear supernovae (Type Ia), those in which no collapsed object is formed but a white dwarf is explosively disrupted. It has been discussed for long whether SN 1572 was peculiar. Through the retrieval of the records and by measuring the extinction towards the supernova it can be seen that it was the most common type of event, such as those used for distance estimates to other galaxies. The rate of decline is found to correspond to a “stretch factor” $s = 0.9 \pm 0.05$.

7 This is seen in the letters by Muñoz. The correspondence between Hagecius and Muñoz is included in the letter of Muñoz to Reisacher. Muñoz to Reisacher LNC, 107.

8 F. R. Stephenson & D. H. Clark The Location of the Supernova of AD 1572, Q.J.R.A.S.,18, (1977), 340–350. The positions are given in the equinox of 1950. They would correspond to an uncorrected position in right ascension and declination in the equinox of 2000.0 of RA=00$^h$ 24$^m$ 48$^s$ and Dec=64$^0$ 08′ 49″ (J2000.0) and a reconstructed position of RA=00$^h$ 25$^m$ 20$^s$ and Dec=64$^0$ 07′ 55″ (J2000.0).

9 D. W. E. Green, Astrometry of the 1572 supernova (B Cassiopeiae), Astron. Nachr. 325, 9 (2004), 1–13. The astrometry of SN1572 from most observers of SN 1572 can be found here.

10 See Muñoz, LNC, 7.

11 In Ruiz–Lapuente, 2004, 360-361 a reconstruction of the supernova visual light curve and color light curves is found. It is derived where SN1572 stands amongst Type Ia supernovae in intrinsic luminosity and rate of decline. It is also compared to other Type Ia supernovae of the last decade.

12 In today’s astronomy, using CCD detectors one quotes typical accuracies of 0.01 mag in these supernovae when they happen in other galaxies.

13 Thomas S. Kuhn, The Copernican Revolution, (Cambridge: Harvard University Press, 1957), 130–131.

14 M. A. Granada discusses the interpretation of the stella nova as a supernatural phenomenon in El Umbral de la Modernidad, (Barcelona: Herder, 2000), 397–403.

15 Tycho Brahe Opera Omnia, III, 87–92.

16 See Brahe to Peucer, undated letter of 1590, Tycho Brahe Opera Omnia, VII, 231, Brahe to Peucer, 21 February 1589; VI, 177; Howell, K. J. 1998, The Role of Biblical Interpretation in the Cosmology of Tycho Brahe, Stud. Hist. Phil. Sci., 29, 4, 515–537; Granada, M. A.
2004, Astronomy and Cosmology in Kassel: the Contributions of Christoph Rothmann and his relationship to Tycho Brahe and Jean Pena, in *Science in Contact at the Beginning of the Scientific Revolution*, (Prague: Jitka Zamrzlová, 2004), 236–249.

17 John Dee 1567, *Propaedeumata Aphoristica* in *John Dee on Astronomy, Propaedeumata Aphoristica*, edited and translated with notes by Wayne Shumaker, (Berkeley: University of California Press, 1978).

18 *A Perfit Description of the Celestiall Orbs according to the most auncient doctrine of the Pythagoreans*, Thomas Digges (1576), Folio 46 in the volume including Leornard Digges treatise *A Prognostication Everlastingge, Corrected and Augmented by Thomas Digges* (London: Thomas Marthe, 1576), re–edited in *The English Experience*, (Amsterdam: W. J. Johnson, Inc., 1975), vol. 727, hereafter PDCO.

19–21 Muñoz, LNC, citations from p. 2, 26, 15 respectively.

22 Walter Burkert in “From Homer to the Magii” points out a parallellism between the cosmological picture in Anaxagoras and the Genesis, *Da Omero ai Magi* (Venezia: Marsilio Editori, 1999).

23 Muñoz, LNC, 25.

24 The works written by Hagecius are analysed in Granada, 434–438.

25 Johannes Kepler *Dissertatio cum nuncio sidereo. Conversation with Galileo’s Siderial Messenger* translated with an introduction and notes by Edward Rosen in *Kepler’s Conversation with Galileo’s Siderial Messenger* (New York: Johnson Reprint Corp. 1965), 42 and note therein.

26–30 Digges, PDCO, citations in p. 12, 13, 9, 11, 10 respectively from the reproduced manuscript. The quotations from Digges’s English manuscript are here rephrased for the sake of text uniformity.

31 Digges’s citations 26–30 are similar to excerpts from N. Copernicus’s chapters VIII and IX of Book I *De Revolutionibus Orbium Caelestium*, translated with an introduction and notes by A.M. Duncan in *On the Revolution of the Heavenly Spheres* (ed. David & Charles, 1976).

32 For Descartes influence in Newton and the path towards the laws of motion, see Kuhn, 1957, 258–259.