

Galileo and the Stain of Time

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Non è istoria / di ch'abbia autor fin qui fatto memoria

(It is not a story / which any historian has so far related).

--Ariosto, *Orlando Furioso*, XXVI.38.

The study of the relationship between science and temporality in the early modern period has been dominated by a single set of questions designed to explain the rise of factory time in the industrial revolution. The rise of clockwork over other modes of timekeeping, the replacement of religious with civic time, the spread of ideas and practices of precision and the imagining and imposing of absolute time together form an impressive narrative accounting, in part, for one version of modernity.¹ Recently, the teleology of this narrative has been questioned, and more attention has been given to the practices and beliefs of time-keeping, the tools of chronology, and wider questions concerning temporality, historiography and philosophy.² Almost all historical studies of temporal order, though, examine only their actors' notions of the past and the present;³ the history of the future remains relatively unexplored.⁴

Despite deep scholarship on certain aspects of early modern futurology, most obviously astrology and prophecy, we still lack an overview or vocabulary with which to write the history of the past's future.⁵ The dispute over the medieval origin of modern industrial time has left a legacy of competing socio-temporal groups, classically, a religious time run by monks and centered on monasteries, versus a more mobile mercantile time run by proto-capitalists. This schema seems over-rigid: there are clearly many other groups with clear notions of, and partial control over, portions of time, ranging from military and state bureaucracies, to diplomatic corps, postal organisations, religious groups, confraternities, families, as well as farmers, witches, local priests and lawyers. There are also identities and epistemologies whose notions of the future have scarcely been imagined. Thanks to recent studies on sixteenth-century Italian culture we

¹ See, in addition to the loci classici of Marx, Weber and Elias: Mumford (1934); Le Goff (1980); Cipolla (1977); Dohrn-van Rossum (1996); Wilcox (1987); North (2005).

² See especially, following questions raised first by Momigliano, the characteristically far-reaching studies of Grafton (1983); Rosenberg and Grafton (2010). For a trenchant analysis of philosophies of time, see Pomian (1984) reprinted from a series of articles originally published in the *Enciclopedia Einaudi* (1977-1982).

³ See, for example, Fortini Brown (1996) and Quinones (1972).

⁴ One recent and promising exception is Brady and Butterworth, *The Uses of the Future in Early Modern Europe* (2010), with a scintillating introduction by Peter Burke and an excellent treatment of English natural philosophical attitudes to the future by Rob Iliffe (2010). A full discussion of natural philosophers' conceptions of their own discipline's future, building on the classic studies of Zilsel (1945) and Rossi (1976), has still not been attempted.

⁵ See, for example Garin (1983); Grafton (1999); Niccoli (1990); Curry (1989); Dooley (2002); Leathers Kuntz (1999); Rowland (2004).

now know that apparently contradictory or opposed temporal orders could easily coexist with single social groups or even individuals.⁶ The clock does not kill other technologies for reckoning time, or modes of conceiving it.

Galileo might seem an obvious choice to add to the master narrative of the tyranny of precision time: his early education was governed by monastic time, but his final years included negotiations over the solution to the longitude problem and the development of a precise pendulum clock. His work on motion redefined the way time was fundamentally conceived within the physical sciences. Time ceased to possess an objective existence and began to inhere within materials as one of their properties, alongside dimension and weight.⁷ His work on pendulums is a necessary chapter in the story of the theory and practice of precision chronometers.⁸ This story might fruitfully be recontextualised within an account of his astrological activities, his longstanding interest in the problem of longitude determination, or even his attempts to control time, especially in securing primacy in priority disputes, by using resources as diverse as postal systems, anagrams, and manufactured testimonials (Biagioli 2006, 21-76). We might reconstruct his interaction with various pre-established temporal orders, such as local publishing industries, and their relation to the annual cycles of the major European book fairs, or the weekly schedule of Inquisition meetings, or the Paduan academic or Venetian civic calendar of rituals.⁹ We might also analyse his interventions in the measuring of time, from the pulse and chant to the pendulum, alongside planets and satellites, and chart how the very objects that were used to measure time became themselves time's object of study.

Alternatively, we might look at ways in which the instrument that became known as the telescope, or 'distant-seer' was originally presented, from its very inception and initial theoretical application as a military instrument that distorted not only space, but time. Galileo's claims for its virtues in official documentation to the Venetian Senate made this highly explicit:

un nuovo artificio di un occhiale cavato dalle più recondite speculazioni di prospettiva, il quale conduce gl'oggetti visibili così vicini all'occhio, et così grandi et distinti gli rappresenta, che quello che è distante, v. g., nove miglia, ci apparisce come se fusse lontano un miglio solo: cosa che per ogni negozio et impresa marittima o terrestre può esser di giovamento inestimabile; potendosi in mare in assai maggior lontananza del consueto scoprire legni et vele dell' inimico, sì che per due hore et più di tempo possiamo prima scoprir lui che egli scuopra noi, et distinguendo il numero

⁶ See, for example, on fortune-telling: Ruggiero (1993); on economic cycles: Sardella (1943). For important rediscovered documentation describing Guicciardini's astrological interest, see Castagnola (1990).

⁷ See Redondi (2007). On precision in Galileo, see Wootton (2010a), following Koyré (1953). On the centrality of time, rather than velocity or distance, to Galilean physics, see Wootton (2010b, 57ff) and Heilbron (2010, 138ff).

⁸ See, most importantly, Favaro (1891); Proverbio (1984); Bedini (1991).

⁹ Despite its unproven claims of Venetian exceptionalism, there are many suggestive ideas in Tenenti, (1973). The classic study of Venetian ritual, which has defined the field for comparative studies, is Muir (1986).

et la qualità de i vasselli, giudicare le sue forze, per allestirsi alla caccia, al combattimento o alla fuga. (Favaro 1890-1909, 10, 250-1)¹⁰

(a new artifice of a eyeglass drawn from the most recondite speculations of perspective, which draws visible objects so close to the eye, and represents them as so large and distinct, that something distant, for example, nine miles, appears to us as if it were only one mile distant: a thing that for every maritime or land-based business and undertaking might be of of inestimable advantage; being able at sea at much greater distance than usual to discover the boats and sails of the enemy, so that for two hours and more of time we are able to discover him before he discovers us, and distinguishing the number and quality of vessels, judge his forces, to ready ourselves to pursue, fight or flee.) (Translation mine)

“Two hours and more of time” is what the telescope produces, and what its owner sells, within an economy that calculated value based on ideas of time. This economy is founded on the idea of the event, albeit an event whose meaning is generated within a system of mid- and long-term trends. It is based in two places, the Ducal Palace, for the military event, and the Rialto market, for mercantile events. The event is here to be understood not merely as historical, but as actively constitutive of the present and future. Its material bases are global information networks (diplomatic, mercantile, missionary, postal etc.) that offer a regularity and rhythm to news systems.

The telescope not only transforms the event-temporality of a news system, it is produced by it: Paolo Sarpi’s letters announcing news of telescopes shift seamlessly into accounts of long-distance, time-sensitive military news, as though the epistolary system need no instrumental supplement (1931, 45).¹¹ Following Sarpi’s dismissal of the practical application of spyglasses in the military and mercantile markets towards which it was first thrust, the first telescopically produced book, Galileo’s *Sidereus Nuncius*, retained this awareness of the instrument’s participation in and disruption of a news economy.

A history of the future through Galileo’s practices and beliefs should also include an attempt to reintegrate his oscillating attitudes on astrology. At times skeptical, even satirical of prognostications and almanacs, he also drew up horoscopes not only for paying clients, but his friends, children, even himself. The nature of the relationship between the movements of celestial bodies and human destinies, and their realignment in the light of the new cosmologies, has been only lightly studied.¹²

All these would be interesting stories, and need to be written. But here, I should like instead to dwell on a single episode that seems to have escaped the notice of most Galileo scholars, but carries enormous implications for the study of the history of time. I shall argue that, in addition to the contributions to chronometry and physics listed above,

¹⁰ See also <http://www.lib.umich.edu/special-collections-library/galileo-manuscript>.

¹¹ On the peculiar history of Sarpi’s letter, see Biagioli (2010).

¹² Favaro (1881); Ernst (1984); Rutkin (2001; 2005); Dooley (2004); Rutkin (2005); Campion and Kollerstrom (2003); the final word on the subject should, but will not, be Bucciantini and Camerota (2005).

Galileo initiated an important transformation of the nature and dominion of time itself, by dismantling the central Aristotelian distinctions separating the immutable heavens from a mutable earth. I shall argue that Galileo's major contribution to the history of the future lay in his universalization of terrestrial temporality, based on mutability and unpredictability, to the superlunary universe. Before Galileo, the universe did not exist in time; after him, it did. He gave the universe a past and future.

Galileo's revolution of astronomical observation via the telescope has always been seen as part of a larger redefinition of space. Following Alexandre Koyré, we might assume that all that was at stake in the discoveries, or detections, announced in the *Sidereus Nuncius* were a series of boundary disputes, both physical and epistemological.¹³ The most important of these, in Koyré's narrative, was the partial removal, or at least blurring, of the outer confines of the universe. But more important, though harder to understand, was the removal of the internal division between the sub- and supra-lunary worlds. This was not merely a spatial divide, nor purely a physico-ontological one, but also a wall between two different, and mutually exclusive modes of temporality. For Aristotle, the circular motion of heavenly bodies necessarily entailed their non-mutability (*De Caelo*, I. 3). Time did not exist outside the universe, and it is unclear to what extent, or in what manner, it existed within the superlunary sphere (*ibid.* I.9).¹⁴ The particular nature of the terrestrial metaphysics in the Aristotelian schema was precisely that it existed within time: the central tenet of decline and corruption was a marker of non-permanence. Aquinas neatly mapped Aristotle's segregated universe onto Christian theology (Kuhn 1957, Ch. 4). While the supra-lunary world undoubtedly took place within some kind of time, too, given that motion was evident (indeed, providing humans with the fundamental data and instrument with which to conceive time), its condition was essentially atemporal, in that only movement, or change of place, was possible. Change of essence, or unpredictable alteration of form was considered impossible.

The revolutionary nature of Galileo's claim has been curiously obscured from most accounts of his telescopic observations and philosophical innovations. Eager to wrestle with what is perceived to be the central issue of spatially conceived system, in a central show-down between Ptolemaic geocentrism and Copernican heliocentrism, historians have generally missed the importance of the universalization of time and reontologizing of the universe.¹⁵ By concentrating only on planetary orbits, and weighing the evidence for various non-Ptolemaic solutions to problems such as the novae of 1572 and 1604, the phases of Venus and the triple comets of 1618, historians have already removed what was, for contemporaries, a major obstacle in unthinking Aristotle, the fundamental and essential difference between the sub- and super-lunary spheres, both in physics and matter theory.

The debate over sunspots, from 1611 to 1613 (with several codas) has generally been understood only as a hyphen between the spectacular pamphlet of the *Sidereus Nuncius* in 1610 and the 1616 condemnation of Copernicus. Only recently has the debate started

¹³ Koyré (1957). For an account of philosophies of time up to the end of the late medieval period, see Duhem (1954-1965), with relevant sections available in translation in Duhem (1985, 295-366).

¹⁴ For a full discussion of the internal contradictions of Aristotle's treatment of time, see Coope (2005).

¹⁵ For the history of the notion of the universe as a system, see Lerner (2005). Two interesting contributions to the study of the introduction of corruptibility into cosmology are Ricci (1998) and Bucciantini (1999).

to receive scholarly attention beyond the resolution of priority disputes.¹⁶ Most attention has been focused on the use of images in scientific disputation, with little attempt to unravel the tangle of philosophical and theological issues as understood by contemporaries.

Mario Biagioli has argued that the debate between Galileo and Scheiner may rest on a central opposition between Galileo's ontologization of change and Scheiner's ontologization of its impossibility (2006, 216-7). The campaign to discredit Aristotle's celestial boundary swiftly escalated to include the issue of biblical hermeneutics, drawing theologians into the debate. Galileo was constantly advised by his Lincean patrons to avoid such a premature confrontation; evidence still exists, though, that demonstrates just what was at risk, and to whom, by extending the category of *istoria* to the sun, and endowing the previously timeless superlunary cosmos with terrestrial temporality. The issue was not simply one of telescopic novelty: in a sense, the announcements of the *Sidereus Nuncius* were philosophically tame when compared to those of the 1613 *Istoria e dimostrazione intorno alle macchie solari e loro accidenti*. Contemporary readers viewed at least the first part of the *Sidereus* as a commentary on Plutarch's *De Facie Quae in Orbe Lunae Apparet*; for many the most pressing issue was the question of the habitability of the moon (Casini 1984, 57-62). While the telescopic discoveries of a mountainous moon, innumerable stars and four satellites of Jupiter certainly demanded a thorough reconsideration of contemporary cosmology, there was nothing in these observations to dismantle Aristotle and Aquinas' entire universe. Certainly the Jovian moons established an alternative non-terrestrial centre of orbit that sat awkwardly with Aristotle's geocentrism, but the orbits still seemed regular, circular and, given enough computational skill and time, entirely predictable. The imperfections of the moon posed greater problems, and various ingenious solutions were constructed to preserve its spherical perfection, but one might always argue that Aristotle's boundary extended precisely to the centre of the moon, and that its rugged face showed no signs of ongoing change, only inherent and partial imperfection. Sunspots, as postulated by Galileo over the course of his dispute with Scheiner, introduced a more damaging attack on celestial perfection: their mutability and inherent unpredictability was simply inexplicable within an Aristotelian framework. As Galileo had long known, and showed now in his oscillation between research on floating bodies and sunspots, the introduction of mutability to the superlunary world would also necessarily cause the collapse of Aristotle's superlunary physics. As he told Federico Cesi in a letter dated May 12, 1612,

la quale novità dubito che voglia essere il funerale o più tosto l'estremo et ultimo giuditio della pseudofilosofia, essendosi già veduti segni nelle stelle, nella luna e nel sole; e sto aspettando di sentir scaturire gran cose dal Peripato per mantenimento della immutabilità de i cieli, la quale non so dove potrà essere salvata e celata, già che l'istesso sole ce l'addita con sensate manifestissime esperienze: onde io spero che le montuosità della luna sieno per convertirsi in uno scherzo et in un solletico, rispetto a i flagelli delle nugole, de i vapori e fumosità, che su la faccia stessa del sole

¹⁶ See, first, Galilei and Scheiner (2010); Shea (1970); Reeves (2005); Mayer (2011); Biagioli (2006).

si vanno producendo, movendo e dissolvendo continuamente. (Favaro 1890-1909, 11, 296, quoted in Bucciardini 1999, 412)

(this news might well be the funeral, or rather the Last Judgement of this pseudophilosophy, as signs have already been seen in the stars, the moon and the sun; and I'm waiting to hear the Peripatetics let off something big to keep the immutability of the heavens going. I don't know where this may be saved or hidden, as the sun itself has already shown us with extremely clear perceived experiences. For this reason I hope that the ruggedness of the moon might turn itself into a joke and a tickle, compared to the beatings of the clouds, vapours and smokiness that are produced on the very face of the sun, continually moving and dissolving.) (Translation mine)

The best effort to preserve the central distinctions of the Aristotelian cosmos attempted to use precisely Galileo's model of Jovian satellites to maintain the integrity of the solar body. Since his initial observations in January 1610, Galileo had worked diligently to produce ephemerides of the moons' periods, with an eye on the prize of using the system (especially when eclipses were incorporated) to solve the problem of longitude determination.¹⁷ Scheiner argued not only that Galileo had missed at least one Jovian satellite, but that the combination of complexity and regularity displayed by the satellites was central to understanding the superficially random (but actually deeply regular) manifestations of the 'maculae.' Scheiner's theory of innumerable stellar groupings, close to the surface of the sun, but by no means contingent to it, attempted to appropriate the most spectacular discovery of the *Sidereus Nuncius* to a universe where Aristotelian physics still worked. Galileo and his Medici patrons had invested heavily in the permanence and predictability of the satellites; Scheiner tried to extend the model to the sun.

Galileo's notion of time was, however, more flexible than that of his Jesuit opponent. While the Medici moons' monumentality remained intact, indeed, was further secured, by each successful ephemerides chart, the peculiar stains on the sun required an entirely different philosophical solution and an entirely different model of temporality. In his sunspot letters, Galileo adopted an epistemology and methodology strikingly at odds with the triumphal certainty of the *Sidereus Nuncius*. Whereas Scheiner sought to incorporate the maculae within the new tradition of a modified or tinkered cosmological system, Galileo repeatedly stressed the new phenomenon's essential unknowability. In the First Letter, for example, he responded to Scheiner's confident assertions on the nature of the phenomena with a marked skepticism:

io confesso a V. S. non aver sin ora tanto di risoluto appresso di me, ch'io m'assicuri di stabilire ed affermare conclusione alcuna come certa; essendo molto ben sicuro, la sustanza delle macchie poter essere mille

¹⁷ The best account of Galileo's use of the Jovian satellites is Andrewes (1996).

cose incognite ed inopinabili a noi, e gli accidenti che in esse scorgiamo, cioè la figura l'opacità ed il movimento, per esser comunissimi, o niuna o poca e molto general cognizione ci possono somministrare. (Favaro 1890-1909, 5, 105-6)

(I do not yet have enough confidence to dare to establish and affirm any conclusion as certain, for I am very sure that the substance of the spots could be a thousand things unknown and unimaginable to us, and that the accidents we observe in them – their shape, opacity, and motion, being very common, can provide us with either no knowledge at all, or little but of the most general sort.)¹⁸ (98)

He drew analogies to terrestrial clouds, but denied the analogy any explanatory strength regarding the actual composition of the spots (Favaro 1890-1909, 5, 108; Galileo and Scheiner 2010, 101).

The delimiting of the purview of knowledge actually produced more certainty than Scheiner's brash assumptions: by mathematising the phenomena, and treating only dimension and opacity, along with movement, Galileo's refusal to deal with the essence of the objects allowed him to make stronger claims about their behaviour. Even here, the very unpredictability does not lead to an epistemological chasm, but rather allows certain traits to emerge:

eccoci una vicissitudine di produzioni e disfacimenti che non finirà in tempi brevi, ma, durando in tutti i futuri secoli, darà tempo a gl'ingegni umani di osservare quanto lor piacerà, e di apprendere quelle dottrine che del sito loro gli possa rendere sicuri. (Favaro 1890-1909, 5, 140)

(We have a series of productions and disintegrations, one that will not draw to an end any time soon but, lasting through all the future ages, will give human minds as much time to observe as they desire, and to learn the doctrines that will render them certain of their own location.) (129)

The skepticism is at once an attack on Scheiner's overconfident hijacking of the Jovian model and an attempt to secure a new space of intellectual liberty where language does not overdetermine experience.

il dire, come egli mette nella prima ragione, non esser credibile che nel corpo solare siano macchie oscure, essendo egli lucidissimo, non conclude: perchè in tanto doviamo noi dargli titolo di purissimo e

¹⁸ All translations of the *Sunspot Letters* are from Galileo and Scheiner 2010.

lucidissimo, in quanto non sono in lui state vedute tenebre o impurità alcuna; ma quando ci si mostrasse in parte impuro e macchiato, perchè non doveremmo noi chiamarlo e macolato e non puro? I nomi e gli attributi si devono accomodare all'essenza delle cose, e non l'essenza a i nomi; perchè prima furon le cose, e poi i nomi. (Favaro 1890-1909, 5, 97)

(For it is not conclusive to say, as he [Scheiner] does in the first argument, that because the solar body is very bright it is not credible that there are dark spots on it, because so long as no cloud or impurity whatsoever has been seen on it we have to designate it as most pure and bright, but when it reveals itself to be impure and spotted, why shouldn't we call it both spotted and impure? Names and attributes must accommodate themselves to the essence of things, and not the essences to the names, because things come first and names afterwards.) (91)

This is not a mere Humpty-Dumpty game of power: at stake is the bigger issue of the knowledge of essences, which, Galileo argues, must also be universalized. Aristotle's distinction between sublunar essences and the unknowable quintessence is under attack here, and Galileo's response is to turn the usual distinction, between the knowable world and the unknowable heavens, on its head, by questioning the possibility of any knowledge of essences: "Il tentar l'essenza, l'ho per impresa non meno impossibile e per fatica non men vana nelle prossime sustanze elementari che nelle remotissime e celesti" (ibid., 5, 187 [254: I consider investigating the essence of the nearest elementary substance an undertaking no less impossible and a labor no less vain than that of the most remote and celestial ones]).

What is presented as knowledge is merely slippage, deferral, mutability:

E se, domandando io qual sia la sustanza delle nugole, mi sarà detto che è un vapore umido, io di nuovo desidererò sapere che cosa sia il vapore; mi sarà per avventura insegnato, esser acqua, per virtù del caldo attenuata, ed in quello risoluta; ma io, egualmente dubbioso di ciò che sia l'acqua, ricercandolo, intenderò finalmente, esser quel corpo fluido che scorre per i fiumi e che noi continuamente maneggiamo e trattiamo: ma tal notizia dell'acqua è solamente più vicina e dependente da più sensi, ma non più intrinseca di quella che io avevo per avanti delle nugole. (Ibid.)

(If, upon inquiring into the substance of clouds, I am told that it is a moist vapor, I will then wish to know what vapor is. Perhaps I will be informed that it is water, attenuated by virtue of warmth and thus dissolved into vapor, but being equally uncertain of what water is, I will in asking about this finally hear that it is that fluid body flowing in rivers and that we constantly handle and use. But such information about water is merely

closer and dependent on more [of our] senses, but not more intrinsic than [the information] I had earlier about clouds.) (Ibid.)

Only properties are knowable during this life, not essences.

Galileo's skepticism regarding essences was, perhaps surprisingly, intimately linked, indeed fundamental, to his attempt to enact a future reform of philosophy:

la irrisoluzione resti scusata per la novità e difficoltà della materia, nella quale i vari pensieri e le diverse opinioni che per la fantasia sin ora mi son passate, or trovandovi assenso or repugnanza e contraddizione, m'hanno reso in guisa timido e perplesso, che non ardisco quasi d'aprir bocca per affermar cosa nessuna. Non per questo voglio disperarmi ed abbandonar l'impresa, anzi voglio sperar che queste novità mi abbino mirabilmente a servire per accordar qualche canna di questo grand'organo discordato della nostra filosofia; nel qual mi par vedere molti organisti affaticarsi in vano per ridurlo al perfetto temperamento, e questo perchè vanno lasciando e mantenendo discordate tre o quattro delle canne principali, alle quali è impossibile cosa che l'altre rispondino con perfetta armonia. (Ibid. 112-3)

(May my uncertainty be excused by the novelty and difficulty of the material, where the various ideas and different opinions that have passed through my imagination, sometimes finding assent and sometimes rejection and contradiction, have rendered me bashful and perplexed, for I hardly dare open my mouth to affirm anything. I do not want on this account to despair and to abandon the enterprise; on the contrary, I would hope that these novelties might serve me wonderfully to adjust a few pipes of this grand [but] discordant organ of our philosophy, which, in my view, many organists labor in vain to tune to perfection. And this is because they go about leaving and preserving three or four of the principal pipes out of tune, such that it is impossible for the others to respond in complete harmony.) (104)

The image here is not just a memory from a musical childhood, but a swiping reference to Aristotle's *Organon* and its necessary rebuilding on the basis of his own new instrument, the telescope, often pictured and even modeled as a trumpet, and described as a cannocchiale, or eye-tube, where the Italian term resonates with the organ tube (Reeves 2010).

Philosophical reform, the imaging of a future history of knowledge, is an enterprise rooted firmly in the past:

Ora, per raccòr qualche frutto dalle inopinate meraviglie che sino a questa nostra età sono state celate, sarà bene che per l'avvenire si torni a porgere orecchio a quei saggi filosofi che della celeste sustanza diversamente da Aristotele giudicarono, e da i quali Aristotele medesimo non si sarebbe allontanato se delle presenti sensate osservazioni avesse autà contezza: poi che egli non solo ammesse le manifeste esperienze tra i mezi potenti a concludere circa i problemi naturali, ma diede loro il primo luogo. Onde se egli argomentò l'immutabilità de' cieli dal non si esser veduta in loro ne' decorsi tempi alterazione alcuna, è ben credibile che quando 'l senso gli avesse mostrato ciò che a noi fa manifesto, avrebbe seguita la contraria opinione, alla quale con sì mirabili scoprimenti venghiamo chiamati noi. (Favaro 1890-1909, 5, 137-138)

(In order to reap some fruit from the unexpected wonders that have remained hidden until our age, it will be well that in the future we go back to lending an ear to those wise philosophers who judged differently from Aristotle about the celestial substance, and from whom even Aristotle would not have distance himself had he had knowledge of the present sensory observations, for he not only admitted manifest [sensory] experiences as one means of drawing conclusions about natural questions, but he even gave them pride of place. Hence, if he argued for the immutability of the heavens because in times past no alteration whatsoever had been seen in them, it is entirely credible that if vision had demonstrated to him the things that it makes manifest to us, he would have arrived at the opposite opinion, [the one] to which we are led by such wonderful discoveries.) (128)

In this, Galileo claims to out-Aristotle Aristotle:

Anzi dirò di più, ch'io stimo di contrariar molto meno alla dottrina d'aristotele col porre (stanti vere le presenti osservazioni) la materia celeste alterabile, che quelli che pur la volessero sostenere inalterabile; perchè son sicuro ch'egli non ebbe mai per tanto certa la conclusione dell'inalterabilità, come questa, che all'evidente esperienza si deva posporre ogni umano discorso. (Ibid. 5, 139)

(And I will further say that I think that I contradict Aristotle's doctrine much less – these observations being truthful ones – with the supposition of mutable celestial material, than do those who would prefer to treat it is inalterable, because I am sure that he was never as certain of the conclusion of inalterability as he was of the notion that all human discourse must defer to evident experience.) (128-9)

The future of the sciences, as Peter Dear and others have so forcefully shown, was often imagined through a humanist lens focused on Antiquity.¹⁹ The appeal to the past was a major resource for both natural philosophers while compiling their objective observations. Scheiner's citation of the line from Virgil's *Georgics* that "The Sun will also give signs: who would dare call the Sun false?" (I. 463-464) is meant as a prophecy fulfilled by his own letters rather than proof of classical sunspot observation (Favaro 1890-1909, 5, 32; Galileo and Scheiner 2010, 73).²⁰ It supports the claim, added to the last of his *Tres Epistolae*, that "In all sciences a great journey remains and what has already been discovered must be counted as the smallest part of what will be discovered." This is an epistemology of futurity based on humility, but one that needs to be sure of its foundations, even if they are to be found in poetry. Galileo, by contrast, compiled an historical account of observations that retrospectively must have been of sunspots. He inserted sunspots into history, including in his Second Letter one image of a naked eye observation, "similarly shown to many" from August 19-21, 1612 (ibid. 166).²¹ Non-telescopic observation data allowed him simultaneously to avoid charges that the telescope had manufactured the scientific object into being and call upon a much larger set of data and observers than he might otherwise have access to. There was a risk involved here, too, though, one of which Scheiner was aware: "Solar spots were never seen in ancient times" (ibid. 172). If pretelescopic observers could see the spots, why had the Ancients not? For Scheiner, the phenomenon was produced by modernity, but predicted in Antiquity; for Galileo, the telescope provided the corrective lens allowing one to rewrite the historical record of misunderstood past observation and bring the undisciplined archive into chronological meaningfulness. The Lincean 'Preface' inserted Galileo's observations within an heroic narrative of modern competition with Antiquity, in a standard trope whereby epistemological discovery went hand in hand with allegorized geographical discovery: traveling beyond the Pillars of Hercules, astronomy both literally and metaphorically went beyond classical limits (Favaro 1890-1909, 5, 80; Galileo and Scheiner 2010, 374).

For both natural philosophers, the construction of reliable observation networks was crucial, not only to secure the central problem of the objects' position relative to the sun by detecting potential parallax, but also to guarantee the credibility of telescopic solar observation. This was a new application of a new technology, and several rival observational techniques were deployed. Naked eye observation was the least used, but helped calibrate both instruments and observers. Usually some kind of filter was used, between the observer and the object such as an extra sheet of coloured glass or light cloud cover. The adaptation of the camera obscura into a sunspot observing device (both with, and without telescopes) was considered a major breakthrough. Generally the idea of,

¹⁹ A good introduction is Dear (2001). See also, among many, Rose (1975) and Grafton (1991).

²⁰ Reeves and Van Helden provide an excellent discussion of the meteorological uses of classical sunspot observation, which provides the original context of Virgil's verse. This semiotic field apparently survived even the realization that sunspots could hardly be described as terrestrially local phenomena. See Scheiner's remark in Galileo and Scheiner (2010, 229) and Baliani's comment that the sunspots must block the sun's rays, changing the weather (Favaro 1890-1909, 20-21; 44)

²¹ Galileo did not have a monopoly on naked-eye sunspot observation: both Thomas Harriot and Giovambattista Agucchi independently carried them out. See Herr (1978), and Bucciantini (1999, 440).

Benedetto Castelli, Galileo's pupil, has been celebrated as an advance in the progress of scientific observation towards an ideal of absolute objectivity. Certainly, it reduced the amount of human interpretation and manipulation in the making of the object, but we should be wary of applying anachronistic categories such as 'photography' to early modern projection (Gorman 2004b; Biagioli 2006, 135-217).

A contemporary category did exist for representational images made without human interference: icons, especially the so-called 'Veronica' icons of Christ's face, were thought to be acheiropoietic, that is, made without the human hand. Such images reproduced themselves across media, through mosaic, paint and even print, without apparent loss of aura. Occasionally, as Nagel and Wood have argued, they create a powerful 'anachronic' effect, disrupting common notions of authenticity and chronology, bearing traces of divine, non-human production even in, or perhaps especially in, their replication (2010).²² Dürer's depiction of the Veronica as print is especially suggestive in this context, as it shows the disembodied head on the *sudorium* as a drying print (Koerner 1993). The celebrated prints of Galileo's *Istoria*, carefully made to look self-produced, display a similar aura and authenticity. The sun, the sign of absolute time for early moderns, manifests itself in the Roman images, as archeiropoietic, self-evident, unique and yet always self-representative. Whereas all iconographic traditions, especially those coalescing around the Jesuit cult of light in this period, would encourage the viewer to expect the solar disk to be depicted precisely as an exercise in undifferentiated splendour, Galileo's images reveal a daily pulse of blotches. Each image is an icon, but an icon negating precisely the eternal or atemporal, and enacting instead a manifestation of immanence. The day of each observation is carefully recorded on the engraving as further testimony of authenticity, but, most important is the sequential effect produced by moving from page to page through the image narrative. Galileo, his patrons and printers, carefully manipulated the images so that they would 'read' correctly and so that the labour of observation would seem to be effaced. Biagioli, while referring to the images as a 'movie' also attempted to historicise their sequentiality by comparing them to the slightly later *De formatione ovi et pulli by Aquapendente* (1621) (2006, 138). A better contemporary vocabulary for depictions of temporal sequences in different frames is to be found in late medieval church interiors, whose supreme example, easily accessible to Galileo, is Giotto's Scrovegni chapel (where the sequential images are, admittedly, also arranged typologically), and in the similarly local genre of Venetian narrative cycles produced predominantly for the *scuole*.²³

That the illustrations enact mutability seems obvious. We are, perhaps, too eager, though, to accept the rhetoric and assumptions of early modern print standardization in image as well as print. It would be interesting to compare surviving copies of the engraved plates in order to chart the inevitable wear on the plates and similarly inevitable minor, but in this case crucial, blots and smears produced in the printing. The initial high print-run desired by Cesi, of three thousand copies, was soon cut in half; whether this was due to the high printing costs, negotiation of the printer or material considerations, is not known.²⁴ Sunspot observation networks laboured hard to produce a convention, or

²² See also Parshall (1994) for the important distinction between acheiropoietic and 'counterfeit' images, the tradition in which Galileo's sunspot images are usually positioned.

²³ The best work on these cycles is still Fortini Brown (1990).

²⁴ See Thomas F. Mayer's forthcoming census of the *Istoria* for a full discussion of its printing.

fiction, or simultaneity: parallax was eliminated precisely in the agreement between two observers' simultaneous and identical observations in different places, collated at a central site. In reality, the slow movement of the phenomenon allowed for a wide timeframe for 'simultaneous' observations; those of, say, Jovian satellite eclipses, by contrast, fixed the observer's position by relying on a more precise notion of time. Galileo stressed the swift skill required to produce reliable observations, even of these slow-moving objects, but his sense of urgency seems generated to reinforce the idea of mutability as much as guide technique. Observational simultaneity in the sunspot debate should be understood as the product of the *Istoria's* images, rather than the other way around.

The illustrations in the printed book served as a testimonial and record of a unique but arbitrary set of observations: whereas the *Sidereus Nuncius's* observations of the movements, and ultimately, periodicity of what turned out, during the narrative, to be four satellites orbiting Jupiter, was established in a peculiar dialogue of text and image, the sunspot images were meant to speak for themselves. Their message, however, was radically different to that of the Jovian moons: the engraved tables of the "Moediceorum planetarum" placed at the end of Galileo's Third Letter, for the "future months of March, April [and part of May] 1613" for Florence reveal the certainty of scientific prediction, a model of the future that not only predicts with unsurpassed precision the complex movements of distant bodies, but also allows its user, in theory, to know his position anywhere on the planet at a given time.²⁵ The sunspot images were a historic record, never to be repeated, of no predictive use other than in a general sense that one might well expect more of the same. Scheiner's satellites, with their necessary periodicities and therefore mathematical stability, fail to emerge from the sequence and therefore become impossible. Scheiner almost admits as much at the end of the *Accuratio Disquisitio*, saying, "We are still at a loss about one thing alone: whether these bodies are generated and perish or whether they are eternal" (Favaro 1890-1909, 5, 70; Galileo and Scheiner, 2010, 230). Galileo annotated his copy with the comment: "He has said a thousand times that they are stars, but now he is uncertain whether in fact they are generated and perish or not" (Favaro 1890-1909, 5, 70, n.9; Galileo and Scheiner, 2010, 230 n.138).

It was not just Scheiner or the Jesuits who had problems with the issue of the mutability of the heavens: the Dominican chosen censors also intervened and changed Galileo's text on this issue.²⁶ Drafts of various versions of the Letters still exist, as well as a dense epistolary exchange among the Linceans that display the interconnection of ideas in the censors' minds. Galileo's early eagerness to display the compatibility of celestial mutability with Scripture, which received some degree of encouragement from Carlo Cardinal Conti,²⁷ was jettisoned on the advice of the Lincei. Redondi has suggested that the argument would have stirred up a hornets' nest of scriptural exegesis and led swiftly to a direct confrontation with the Jesuits; in the Copernican Letters of 1613 to 1616,

²⁵ The Latin plates were printed so as to be available as a separate, too.

²⁶ See, for an introduction, Rossi (1978, 54-71); Stabile (1994, 37-64); Redondi (2004). Redondi claims that the dating of the imprimatur shows that only the first of Galileo's three letters was officially approved and that the *Istoria* was not only Galileo's first direct contact with the Roman censorship system, but also that of his patrons, the Lincei (122). This is implicitly corrected in Brevaglieri (2009). The fullest and most suggestive treatment of this issue is Mayer (2011).

²⁷ For Conti's letters to Galileo, see Galileo and Scheiner (2010, 349-352). On Conti's relationship with Galileo, see Poppi (1996-1997).

which were a direct result of these negotiations, the first, if not the second, of these conditions was fulfilled. When the censors came to some strongly worded passages at the end of the Second Letter, they demanded a rewrite. Several versions, with some corrections, of the pre-censored version exist, and they reveal the high stakes Galileo wished to play, and the censor's rejection of them. Originally, it seems, the Second Letter meant to argue:

Or chi sarà che vedute, osservate e considerate queste cose, voglia più persistere in opinione non solamente falsa, ma erronea e repugnante alle indubitabili verità delle Sacre Lettere? Le quali ci dicono, I cieli e tutto'l mondo non pure esser generabili e corruttibili, ma generati e dissolubili e transitorii. Ecco la Bontà divina, per trarci di sì gran fallacia, inspira ad alcuno metodi necessarii. (Favaro 1890-1909, 5, 138, note to line 24)

(Who is it that, after having seen, observed and considered these matters, would want to persist in a belief that is not only false, but erroneous and repugnant to the indubitable truth of Sacred Scripture as well? For Scripture tells us that the heavens and entire world are not only generable and corruptible, but also generated, dissoluble and transitory [corrected to 'transitory and to be destroyed' in one manuscript]. Notice how Divine Goodness, in order to retrieve us from such an immense error, inspires some people with the necessary approaches.) (240)

Another version reads:

Or chi sarà che, vedute, osservate e considerate queste cose, non sia per abbracciar (deposta ogni pertubazione che alcune apparenti fisiche ragioni potessero arrecargli) l'opinione tanto conforme all'indubitabili verità delle Sacre Lettere, le quali in tanti luoghi molto aperti e manifesti ci additano l'instabile e caduca natura della celeste materia? Non defraudando però intanto delle meritate lodi quei sublimi ingegni che con sottili specolazioni seppero a i sacri dogmi temperar l'apparenti discordi de i fisici discorsi. Li quali ora è ben ragion che cedino, rimossa anco la suprema autorità teologica, alle ragioni naturali d'altri autori gravissimi e più alle sensate esperienze, alle quali io non dubiterei che Aristotele stesso avrebbe concesso.... Ecco la Bontà divina, per rimuoverci dalla mente ogni ambiguità, inspira ad alcuno etc. (Favaro 1890-1909, 5, 138, note to line 24)

(Who is it that, after having seen, observed and considered these matters, would not be willing (once every doubt occasioned by apparent physical

reasons has been dismissed) to embrace a belief that so conforms to the indubitable truths of the Sacred Scripture? For Scripture in so many passages quite openly and clearly shows us the unstable and fallen nature of the celestial material, without depriving of their deserved praise, however, those sublime intellects who with subtle speculations managed to harmonize sacred dogma with the apparent discordances of the physical discourses. This supreme theological authority having been removed, there is now good reason for [those minds] to yield to the natural [i.e. Scientific] reasons of other grave authors, and even more to sensory experience, to which I don't doubt Aristotle himself would have given way.... Notice how Divine Goodness, in order to remove all doubts from our minds, inspires some people with the necessary approaches.) (240-1)

The censors, according to Cesi, found this passage, with its blatant attack on Aquinas's Christianised Aristotle, "repugnante alle Sacre Lettere" (ibid., 11, 428; repugnant to Holy Scripture). Galileo's toned down version was better received. Cesi also supplied ten passages from the Scriptures and as many from Patristic authors that seemed to him to supply evidence for Galileo's anti-Peripatetic universe. But the weight of Thomist commentary was too great to allow for the kind of revisionist reading described in the Letter to the Grand Duchess Christina. Any use of Biblical commentary was decreed off-limits in the discussion of sunspots; Galileo was to speak only 'as a philosopher' (ibid. 11, 439, 447, 453).²⁸

The constant revisions of the passage concerning the compatibility of universal mutability with the Bible were themselves referred to as 'mutations.' This is more than a good joke: rewriting the text is an enactment of the philosophy of the universe. Galileo's use of the commonplace of the Book of Nature, deployed most famously in *Il Saggiatore*, is usually assumed to refer to a beautifully printed but unique volume of idealized mathematical abstraction.²⁹ Here we see the universe as a work in progress, with cancellations, revisions, insertions, rejected drafts, clean copies and marked-up proofs. Galileo turned down suggestions for idealized literary titles for his book, such as *Scoprimenti* or *Contemplazioni solari*, referring to them always as his *Lettere solari*, relying on the same ambiguity of oscillation between concrete medium and abstract message that powered the conceit *Sidereus Nuncius*.³⁰ Nor is it an accident that Galileo insisted on using a vocabulary of blotting, spotting or smudging, an inky epistemology, when depicting the sunspots: the Crusca's 1612 *Vocabolario* defines *macchia* as a "segno, che lasciano i liquori, e le sporcizie nella superficie di quelle cose, ch' elle toccano, o sopra le quali caggiono" (the mark left by liquids, and the mess on the surfaces that they touch, or which they cause). Philip Sohm has shown how the term *macchia* could refer both to artificial and natural marks and would become intensely problematic in seventeenth-century art theory (1999, esp. 116-124). The congruence of phenomenon

²⁸ For an introduction to the vexed question of Galileian biblical hermeneutics, see, amongst a vast and still polemical literature, Carroll (2001), as well as Galilei (2009); McMullin (1998); Fantoli (2003); Camerota (2004); Pagano (2009, xvii-xlvi).

²⁹ For Galileo's transformations of the trope of the universe as a book, see Biagioli (2006, 219-260).

³⁰ For the contemporary range of meanings of the Plinian term 'istoria,' see Pomata and Siraisi (2005).

and philosophy is not casual, but becomes explicit in Galileo's correspondence. His self-fulfilling prophecy of a paradigm-shift is also a self-consuming artifact. Here is how he describes and enacts the situation to Maffeo Cardinal Barberini:

Se occorrerà a V. S. Ill.ma trattare di questa mis risoluzione con i litterati di cotesta città, haverò per grazia il sentire alcuna cosa de i loro pareri, et i particolare de i filosofi Peripatetici, poi che questa novità pare il giudizio finale della loro filosofia, poi che iam fuerunt signa in luna, stellis et sole; onde, insieme con la mutabilità, corruzione e generazione anco della più eccellente sustanza del cielo, tal dottrina accenna corruzione e mutazione, ma non senza speranza di rigenerarsi in melius. (Favaro 1890-1909, 5, 311)

(If Your Most Illustrious Lordship happens to discuss this solution of mine with the learned men of your city [Rome], I would be grateful to hear something of their opinion, and in particular that of the Peripatetic philosophers, because this new development appears to be the Last Judgement of their philosophy, "for there have already been signs in the Moon, the stars, and the Sun" [adapting Luke 21: 25]. For this reason, this [Peripatetic] doctrine itself, along with the mutability, corruption, and generation of even the most excellent substance of the heavens, shows signs of deterioration and change, but not without the hope of regenerating into something better.) (339)

In a neat feint he renders the phenomena observed analogous to the model of knowledge observing them: Aristotelian philosophy itself is described as undergoing corruption; this key term is then redefined as neutrally amoral mutation, to save the episteme from itself, then transformed into its opposite, generation; once the term has been redefined, the original system's objection no longer holds, and therefore the philosophy has already been mutated, like the sunspot, into something new, that is, the observational methodology that correctly views the object as non-corruption. Galilean science is generated from, and replaces, Aristotelian science, in the very act of rethinking corruption as generation. In a riskier move, Galileo invokes his telescopic observations as the fulfillment of Jesus' reported prophecy of the end of time, but turns this into a joke about the Final Judgment of Peripatetic philosophy. Galileo's tone here suggests that he regards the application of astronomical observation to biblical commentary as entirely vain, though it is important to remember that it was the debate over sunspots, rather than the discoveries of the Sidereus, which prompted him first to engage seriously with the issue of the correct relationship between natural philosophy and theology.

Mutability was the motivation as well as the message of the sunspot letters in another way, too: a constant theme in the exchange between Mark Welser and Galileo is their mutual illness. For Welser, this is presented primarily as an impediment to correspondence, but for Galileo, it becomes another resource in his argument. Welser

regarded death as the sole state in which absolute and certain knowledge may be attained, contrasting the view from heaven to that of “questa valle di miseria” (Favaro 1890-1909, 5, 184; this vale of misery [252]). Galileo responds with a different distinction, between “vero Sole puro ed immacolato” (5, 187 [254: the true, pure and immaculate Sun]) of Divine Knowledge and that “altro Sole materiale e non puro” (ibid. [other material and impure Sun]) which has left us “abbagliati e quasi alla cieca” (ibid. [dazzled almost to the point of blindness]). Illness was more than a nuisance, it was a constant memento mori, a goad to activity for those who wished “lasciar qualche vestigio di esser passato per questo mondo” (5, 191 [258: to leave behind some trace of his passage through this world]). Even a miserable life, argued Galileo, in a passage excised by the censors, was a gift from God, who might have chosen “il farci un vil verme ed anco il non ci far nulla” (5, 191 note to line 25 [to make us a vile worm or nothing; translation mine]).³¹ Galileo complained that he had heard such sentiments expressed frequently from pulpits, and couldn’t see why he should cut them from his letter to Welser, but we must wonder whether the censors detected another whiff of his ontology of change here. If terms like ‘corruption’ were revealed to be anthropocentric tricks with little relationship to reality, even illness might be regarded as a purely natural, rather than spiritual state. Galileo is quite explicit in his condemnation of the universalization of the human condition: “Io dubito che ‘l voler noi misurar il tutto con la scarsa misura nostra, ci faccia incorrere in strane fantasie, e che l’odio nostro patricolare contro alla morte ci rende odiosa la fragilità” (5, 235 [294: I suspect that our desire to evaluate everything according to our own meagre measure makes us fall into strange fantasies, and that our particular hatred of death makes us detest frailty]).

But this logic of fear is literally paralyzing, its ideals turning us into stone, petrifying us and negating the movement of life:

tuttavia non so dall'altra banda quanto, per divenir manco mutabili, ci fosse caro l'incontro d'una testa di Medusa, che ci convertisse in un marmo o in un diamante, spogliandoci de' sensi e di altri moti, li quali senza le corporali alterazioni in noi sussister non potrebbero. (5, 235)

(I don't know if, in the pursuit of immutability, we would prize an encounter with the Medusa's head, so that she would turn us into marble or diamond, stripping us of our sense and other movements that could not exist without bodily alterations.) (294)

This is a remarkable transformation, to turn Aristotelianism into the Gorgon's gaze.³² The response to Galileo's rhetorical question had, of course, already been supplied by Benvenuto Cellini in Florence's Piazza della Signoria with his Perseus, competitively

³¹ Censorship is discussed in Favaro (1890-1909, 11, 465).

³² Galileo was obviously fond of this image, and recycled it in the *Dialogo*. See Galilei (1998, i, 64 and ii, 256). The relationship between the petrification of the spectator here and the famous removal of sense organs in *Il saggiaiore* remains unexplored.

petrifying Michelangelo's David: a philosophy of fluidity would always trump fixity (Shearman 1992; Cole 1999).

The central site of Florentine political power was not alluded to casually.³³ Galileo was fully aware that his letters to Welser were part of a larger political and cultural campaign to wrestle control over epistemological matters from the perceived monopoly of the Jesuits (Redondi 1987). This was conceived of in geographical and military terms: Galileo claimed to Welser that his Florentine and Roman communities of readers read Welser's Italian

con molto maggior diletto e meraviglia che se fossero scritte del più purgato stile latino; e parci, nel leggere lettere di locuzione tanto propria, che Firenze estenda i suoi confini, anzi il recinto delle sue mura, sino in Augusta. (Favaro 1890-1909, 5, 190)

(with much greater delight and wonder than if they had been written in the purest Latin. And when reading letters of such elegant locution, it seems to me that Florence extends its borders, or rather its ramparts, all the way to Augsburg.) (256)

The effort to extend terrestrial temporality across the universe was therefore analogous to, and enacted by, a forceful spread of vernacular and anti-traditionalist philosophy across the Alps. The Alps are seen as a powerful yet arbitrary divide in the world of knowledge, much like the sub- super-lunary division. In the Third Letter, Galileo refers to conservative philosophers "di qua dall'Alpi...a i quali non grava il filosofare per desiderio del vero e delle sue cause" (Favaro, 1890-1909, 5, 231 [291: on this side of the Alps...men for whom philosophizing does not bear the burden of a desire for truth and for its causes]).

He offers a transalpine alliance to Welser, "è ormai tempo che ci burliamo di loro e che essi restino invisibili ed inaudibili insieme" (ibid. [now is the moment for us to jest about these men, and for them to keep both quiet and out of sight]). Welser, described by a correspondent of Galileo in 1610 as "tutto spagnuolo et poco amico de' Venetiani"³⁴ (ibid. 10, 418; [completely pro-Spanish and no friend to the Venetians; translation mine]) was gradually converted to Galileian science by the sunspot debate. He recognized the gravity of Galileo's argument, starting his first (pre-conversion) letter to Galileo with the line "The Kingdom of Heaven suffereth violence, and the violent take it by force" (Galileo and Scheiner 2010, 239).³⁵ When it came to printing the *Istoria*, this was too extreme for the censors, who had the line changed to Horace's "Virtue, opening heaven to those who do not deserve to die, makes her course by paths untried" (*Odes* III, ii, 21)

³³ On the development of this space, and relationship between the gaze and politics, see especially Trachtenberg (1997). On the special relationship between the Medusa and the Medici, who owned the Tazza Farnese and had recently been given Caravaggio's convex circular canvas, see Conticelli (2008).

³⁴ On Welser see Gabrielli (1937).

³⁵ "Regnum caelorum vim patitur, et violenti rapiunt illud" (Matthew 11:12).

followed by the non-Biblical “Già gli umani intelletti da dovero fanno forza al cielo, e i più gagliardi se ’l vanno acquistando” (ibid. 5, 93 [87: Human reason is already launching a serious assault on heaven, and the most vigorous are going to conquer it]).

Universal temporality was site specific: Galileo had to extend Florence’s ramparts over the Alps to establish a territory from which the cosmos might be colonized by time. Paradoxically, at precisely this time, the papacy, especially through the global Inquisition and the missionary activities of the Society of Jesus, began to realize something approaching a global temporal order.³⁶ Jesuit publications celebrated the worldwide coverage of their missionary network; anti-Jesuits such as Sagredo and Pascal satirised these claims. Sagredo actually wrote to Scheiner to explain how the very claim of geographical universality contradicted Catholicism by forcing the invention of a date-line, which would create the absurd situation of two priests in contiguous zones simultaneously practicing different days’ rites. Nevertheless, the sun-dial, in whose construction and erection Jesuits excelled, became itself a symbol of Catholic orthodoxy: one Spanish (non-Jesuit) preacher, Fra Diego Murillo, described the Pope as the sun-dial (*relox de sol*) by which all human clocks are set and which “cannot err, because it governs the movement of the heavens, with the assistance of the Divine Spirit” (quoted in Smith 1978, 152). The Inquisitors were, in turn, good time-keepers, who set all the clocks of Christendom to Roman time and corrected them when they deviated.

The subsequent future of the sunspot debate reveals further historical ironies: in 1621 Scheiner’s satellite theory, by this point clearly failed, was revived by Jean Tarde, who dedicated the non-existent solar moons to the French royal family (1621; see Baumgartner 1987). The act was repeated, to a different patron, in 1633 by Charles Malapert (Malapertius 1633). Scheiner went on to produce the exhaustive study of sunspots, correcting the inexactitudes of Galileo’s observations in his *Rosa Ursina* (1626-1630), which Galileo in turn probably plagiarized for his *Dialogo* (1632). Scheiner’s response, the *Prodromus pro sole mobili et terra stabili*, was written before Galileo’s trial in 1633, but only published posthumously in 1651.³⁷ Other observers, such as Gassendi and Peiresc, continued to make their own observations over these decades. A full account of sunspot observation and theory in this period remains to be written. The most dramatic twist in this open-ended debate is by the sun itself, which, from the mid-1640s until at least the turn of the century, produced very few sunspots. The periodicity of this decreased solar activity is still not fully understood: Galileo may well have extended terrestrial temporality to the universe; no one could make it predictable.

This account of universalizing temporality in turn needs to be reintegrated within the histories of other futures sketched out in the introduction. Early modern time was not merely a political and economic tool used to govern labour relations; it also changed the nature of the cosmos. The sunspot debate allows us to rethink the many potential histories of the future.

³⁶ For an excellent comparative analysis of the Inquisition, see Bethencourt (2009); for references to the Society of Jesus as a global sundial, see Gorman (2004a, esp. 248-250).

³⁷ The most accessible study of Scheiner’s work is Daxecker (2004).

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