Title

Witnessing Astronomy

Authors

Biagioli, Mario

Biagioli, MARIO

Publication Date

2023-12-14

Peer reviewed

The American Bourgeoisie: Distinction and Identity in the Nineteenth Century
Edited by Sven Beckert and Julia B. Rosenbaum

Benjamin Constant and the Birth of French Liberalism
By K. Steven Vincent

The Emergence of Russian Liberalism: Alexander Kunitsyn in Context, 1783–1840
By Julia Berest

The Gospel of Beauty in the Progressive Era: Reforming American Verse and Values
By Lisa Szefel

Knowledge Production, Pedagogy, and Institutions in Colonial India
Edited by Indra Sengupta and Daud Ali

Religious Transactions in Colonial South India: Language, Translation, and the Making of Protestant Identity
By Hephzibah Israel

Cultural History of the British Census: Envisioning the Multitude in the Nineteenth Century
By Kathrin Levitan

Character, Self, and Sociability in the Scottish Enlightenment
Edited by Thomas Ahnert and Susan Manning

The European Antarctic: Science and Strategy in Scandinavia and the British Empire
By Peder Roberts

Isaiah Berlin: The Journey of a Jewish Liberal
By Arie Dubnov

Origins of Modern Historiography in India: Antiquarianism and Philology, 1780–1880
By Rama Sundari Mantena

The French Enlightenment and Its Others: The Mandarin, the Savage, and the Invention of the Human Sciences
By David Allen Harvey

Nature Engaged: Science in Practice from the Renaissance to the Present
Edited by Mario Biagioli and Jessica Riskin

History and Psyche: Culture, Psychoanalysis, and the Past
Edited by Sally Alexander and Barbara Taylor

Nature Engaged

Science in Practice from the Renaissance to the Present

Edited by

Mario Biagioli and Jessica Riskin

palgrave
macmillan

5

Witnessing Astronomy: Kepler on the Uses and Misuses of Testimony

Mario Biagioli

The role of eyewitnessing in science and natural philosophy has been a prominent research question in science studies and history of science in the last two decades. Philosophy too has begun to study its epistemic dimensions.[1] Looking at modern scenarios, scholars have focused mainly on the increasingly extensive role of scientists and scientific evidence in legal proceedings. Historians of early modern science have instead focused primarily on the borrowings of legal witnessing practices and standards of evidence into natural philosophy—borrowings aimed at buttressing the new concepts of experience and experiment being developed by mathematicians and experimental philosophers.[2] In this essay, I analyze the peculiar role of eyewitnessing in Kepler's observational astronomy to revisit and substantially revise some of the received views of the relation between law and early modern science.

We already know that Boyle, Pascal, and Newton had distinctly different uses for witnesses and circumstantial evidence in experimental and observational reports.[3] But if we comb through the texts that Kepler produced in response to Galileo's discoveries of 1609–1610 and through the letters he exchanged with the Florentine astronomers, we find yet another original perspective on the role of witnessing in astronomy—one that is elaborated through some references to procedures and standards of evidence of Roman-canon and inquisitorial law.

Kepler's uses of witnessing

In his 1609 *Phaenomenon singulare*, Kepler described what he took to be the transit of Mercury across the solar disk. (This was a phenomenon he was soon to reinterpret as something quite different—a large sunspot). Kepler calculated

that Mercury would enter conjunction with the Sun on May 29, 1607 and planned to observe both before and after that date. At first the weather did not comply with Kepler's wishes but, on May 28 (as he was talking to an unidentified Jesuit about the expected transit), the cloud scattered and out came the sun. Kepler rushed to the attic of his home in Prague where cracks between the roof tiles could function as pinholes for solar observation. Once there, he projected the solar disk on a piece of paper and observed "a small spot the size of a small fly on the lower left side" of the solar disk.[4] After moving the piece of paper around and trying out different pinholes to test whether the spot might be produced by either the paper or spiderwebs dangling from the ceiling, Kepler became convinced that he was not dealing with an artifact.

He immediately started to line up eyewitnesses. The first was Martin Bachazek the—rector of the University of Prague and Kepler's landlord—who wrote on Kepler's own report: "I, M. Martin Bachazek, was present to this observation and vow that this is what happened."[5] Kepler then left the house, went by the court (where he instructed a valet to report the news to the emperor), dropped in on the Jesuit to inform him of the discovery, and finally landed in the shop of Joost Burgi—the court clockmaker. Burgi was not in, but the sun (and the spot) were not going to stay up forever. Having no time to waste, Kepler rounded up two of Burgi's assistants and servants, closed all the doors in the shop, and darkened all the windows, except for a pinhole aperture (about 1/10 of an inch) from which they were able to observe (at about 14 feet from the aperture) the same spot in the same location on the solar disk. Like Bachazek a few hours earlier, one of Burgi's assistant was asked to autograph Kepler's report, which he did (in German): "Heinrich Stolle, junior clockmaker-journeyman, my hand."[6]

In the book, Kepler uses the terms "spectator" and "testis" to identify both Bachazek and Stolle, perhaps to specify that they were testifying to something they had personally seen rather than to something they had just heard and deemed credible (as was the case with so-called hearsay witnesses—an older form of witnessing that was still accepted in the medieval period).[7] While Bachazek's socioacademic status contributed to the credibility of his testimony, Kepler's inclusion of Stolle, a workman, suggests that his search for witnesses was nearly class-blind. That practice fit well with Roman-canon law as practiced in the Hapsburg Empire and the German lands, which stated that "adequate witnesses are those who are without evil repute and who otherwise are unchallengeable for any legal ground."[8] Religious differences also did not seem to matter as Kepler (a Protestant) seemed quite eager to enlist the testimony of a Jesuit.[9]

The typographic features of Kepler's text and the positioning of Bachazek and Stolle's testimonials in it are also important. Kepler does not limit himself to include their names within his printed observational narrative to let the reader know that he has people who can back up his claims. Instead, he asks Bachazek and Stolle to autograph the reports he had just written up—reports he then prints verbatim in the *Phaenomenon singulare* in a distinct format. After bracketing each line of the reports with quotation marks to make

them stand out from the rest of his own text, Kepler adds their date (Monday May 28, 1607—the same day on which the observations were conducted), and then appends his witnesses signatures using different fonts (regular for Bachazek's signature and gothic for Stolle's), as if to reproduce as much as possible the "aura" of the original signatures on the handwritten document.[10]

In a legalistic fashion, Kepler then writes in the margin (next to the section signed by Stolle) that, while the printed text appears in Latin, the original was written in German (most likely because of Stolle's limited linguistic range) and then translated into Latin by Kepler himself. Interestingly, Bachazek's and Stolle's signatures include their professional titles—the first a master, the second a clockmaker-journeyman—and Stolle's signature is prefaced by Kepler's description of his identity: "The witness is the assistant of Joost Burgi, the maker of automata, who was a spectator."[11] Because Stolle's modest professional title would have had little to add to the credibility of his testimony, the information about the witnesses' position was probably included not for epistemic reasons but for legal identification.[12] Roman-canon law required that testimonies submitted by the plaintiff be "properly written up and transmitted to the judge, along with the witnesses names and *addresses*" for follow-ups.[13]

Although we can assume that Kepler would have taken Rudolph II over Burgi's assistant as a witness, the observation of the (alleged) transit of Mercury was not a staged experiment but a time-specific and not fully predictable event. Because of the narrow window of opportunity, Kepler seemed just happy to find someone—anyone—who could witness it. As a literary genre, Kepler's narrative is closer to a police report of a crime scene than to the description of an instrument-produced experiment performed at the Royal Society at a preadvertised time, in front of preselected witnesses.

Kepler's legalistic concerns reemerge at the end of his report. While stating that he sought Burgi's testimony (when he got back to the shop) as well as that of the Jesuit (earlier in the afternoon), he reported that the priest was unable to corroborate the discovery because of the constraints imposed by his prayer schedule and his lack of a suitable pinhole, while Burgi's observations were cut prematurely short by cloud cover.[14] Interestingly, Kepler bracketed Burgi and the Jesuit out of the observational report not by saying that they had tried and *failed to witness* the truth of Kepler's claims, but rather because that they had *failed to be witnesses*. Instead of saying that he had two negative testimonies and two positive ones, Kepler wrote that he had only two witnesses (Bachazek and Stolle) because the other two (Burgi and the Jesuit) just did not qualify as witnesses (though we know that they did try to observe).[15] That done, Kepler proudly pronounced: "The testimonials of our witnesses [Bachazek and Stolle] are unanimous." Perhaps Kepler's selective counting might reflect the fact that two fully positive eyewitness reports provided a *probatio plena*—Roman Law's standard of criminal proof.

Kepler's use of witnesses was further refined in the *Narratio*—a short book reporting the observations of the surface of the Moon and of the satellites of Jupiter with a telescope between August 30 and September 9, 1610.[16] References to legal practices are found throughout the book. Kepler opens

by acknowledging that some had criticized his *Dissertatio cum nuncio sidereo* (published earlier in May) for uncritically upholding the truth of the observations put forward in Galileo's *Sidereus nuncius* (published in March).[17] Unable to access a suitable telescope to replicate some of Galileo's discoveries, Kepler had indeed endorsed the *Nuncius* prior to being able to replicate its claims.[18] The *Narratio* was written to fill such a gap, providing the testimonials he did not include in the *Dissertatio*. Together with the letters exchanged in those months between Kepler and Galileo, these three books provide a wealth of information about the vastly divergent roles the two astronomers attributed to witnessing.

The *Narratio* presents a series of observations that Kepler and his witnesses conducted following a specific protocol to avoid influencing each other's findings. Witnesses' reports are most credible when independent, that is, when most likely to be unbiased and untampered with. Conversely, witnesses who observed together and discussed what they were seeing might have influenced each other's reports. Attempts to avoid the spreading of biases (observational or otherwise) are mentioned throughout Kepler's book. Kepler wants to show that he and his fellow observers did not influence each other, but also that he and Galileo had not staged his publication by communicating and comparing observations with him beforehand:

> Prague is my witness that these observations have not been sent to Galileo. Actually it is for this reason that I have not written him recently despite the fact that I owe him a letter. And those to whom I have communicated these [observations] in generic terms have not been able to copy anything from my papers kept at my house. Similarly, [Galileo] has not been able to send me his observations because only a few days have passed. You can therefore rest assured that there has been no communication.[19]

When it comes to observing, Kepler reports the provenance, ownership, and optical limitations of the telescope he used; some of the challenges he encountered while observing; the slight modifications he introduced in the apparatus; and the names of his various co-observers and witnesses (Benjamin Ursinus, Thomas Seggett, Frans Tengnagel, and Tobias Schultetus). As in the previous *Phaenomenon singulare*, the *Narratio* does not relate the witnesses' credibility directly to their social status. That was not the result of an egalitarian impulse but of a kind of "actuarial calculus." Kepler does not treat trustworthiness as inherently connected to a positive cause (social status and values of honesty) but to a negative factor such as risk (how much a person would lose were she/he to speak falsely). More precisely, Kepler assesses such a potential loss over time rather than in relation to a witness' status at the moment in which a testimony may be judged to be false. Ursinus is the youngest and least prestigious person among the witnesses, but that does not mean that he has less to lose than a more senior scholar like Thomas Seggett, "an Englishman already well known for his books and correspondence with famous men, who therefore cares dearly about the reputation of his name."[20] According to Kepler, because Ursinus "is passionate about astronomy, loves

that discipline and has decided to practice it as a specialist, it would not even cross his mind to ruin, right at the beginning, the credibility necessary to a future astronomer with a false testimony."[21] He would lose not only the modest name he had in the present but also the much bigger name he might have developed in the future—the "integral" of his reputation over the length of his professional life.

Kepler then describes the bias-control protocol that was followed throughout the observations:

> Each of us had to draw, in silence, with chalk on the wall anything he had observed without making it visible to the others. After that, we would look together and simultaneously at each other's picture to check our agreement.[22]

Kepler then maps both the consensus and the disagreement on the various observations, often specifying which observations were produced after being "tipped off" by other team members. For instance, "at the fifth hour, I lost sight of the eastern satellite, which was nevertheless spotted by Sir Tengnagel, secret counselor of Archduke Leopold (who had been instructed). He did not, however, see the western one."[23] Later on, "Seggett saw all three of them, and drew them up in the same configuration [as Kepler's and Ursinus']. Sir Schultetus, Imperial tax collector for Silesia, saw (after been instructed) the most luminous among the western ones."[24]

Kepler's protocol resembles Roman-canon law practices. I say "resemble" because it is important to acknowledge the differences between the scenarios dealt with by natural philosophers making claims about new and hard-to-observe objects and criminal cases where judges did not have to establish the fact of a crime but rather of the author of that crime. Placing a person at the scene of a crime (in the past) is quite different from placing a satellite in orbit around Jupiter (now) or from confirming an experimental finding that (unlike a crime) may be replicated. Perhaps cases involving reproducible evidence (like, say, cases of forgeries, coin clipping, etc.) involved evidentiary challenges much closer to those faced by natural philosophers.

Contrary to common law countries like England where trials took place in an open court, trials in Roman-canon law countries were based on evidence produced by interrogating witnesses in private and then forwarding the transcripts to a closed court. This was not just to maintain the power of the judiciary but to prevent what early modern jurist saw as unlawful storytelling. Defendants were often not told what crime they were accused of prior to being interrogated so that they would not be able to prepare self-exculpating narratives. (The documents of Galileo's trial show that the inquisitors followed such practice).[25] Also, when more than one defendant was imprisoned awaiting trial,

> they should be kept apart from one another to the extent that the gaol cells are available, in order that they may not plot false testimony with one another or discuss how they can explain away their deed.[26]

Denying defendants information about the crime was also seen as a way to prevent them from confessing things they had not done (or, in Kepler's case, to report things they had not observed). Jurists thought that, were defendants to know the circumstances of the crime, they might cobble them up into a confession just to get themselves out of the hands of the torturers (or, in George Bush's parlance, "professionals").[27] While the Royal Society's practice of collective witnessing has been shown to fit well the common law model of open trials in front of a jury, Kepler's *Narratio* seems informed by Roman law scenarios: the observers "interrogate themselves" privately and independently, and then show their independently obtained written evidence to the reader-judge (or to themselves as a collective judging body).

Kepler and the lawyers

If the observational and witnessing protocols described in the *Narratio* were more sophisticated than those in the *Phaenomenon*, it was probably because of the pressure exerted on Kepler by Galileo's uncooperative behavior. On August 9, 1610, just three weeks before conducting the observations eventually published in the *Narratio*, Kepler wrote Galileo pressing him to send testimonials to Prague to help him to silence the remaining critics of the *Nuncius*. Kepler was concerned not only with Galileo's honor but with his own. Having enthusiastically endorsed the *Nuncius*' discoveries in his *Dissertatio*, he was then left to hang when Galileo refused to send him third-party testimonials or a telescope with which to produce his own:

> Although I continue to have no doubts, it nevertheless pains me to remain so long without testimonials by others to convince the remaining skeptics. I am asking you, Galileo, to produce other testimonials as soon as you can. From the letters you have sent to various people, I have learned that you do not lack witnesses. But I cannot cite anyone except you to defend the credibility of my letter [the *Dissertatio*]. The authority of the observation rests solely on you.[28]

In the absence of Galileo's collaboration, Kepler had already lined up all testimonials he could find (including ancient ones) for the irregularities of the lunar surface, and the many fixed stars in the Milky Way, but could find none for the satellites of Jupiter.[29] As he requests testimonials from Galileo, Kepler tries to explain to him why they are necessary to begin with by drawing a difference between philosophical and factual arguments. He tells Galileo that the debate over the discoveries reported in the *Nuncius* "is really not a philosophical problem but a juridical question of fact." The main question on the readers' minds is not whether Galileo is a good philosopher (that is, whether he has correctly identified the causes of the phenomena he presents) but simply whether he has "consciously lied to the world" by making false factual claims.[30]

Prefaced by a reaffirmation of Kepler's support of the *Nuncius*, these remarks do not necessarily convey distrust but rather a nonjudgmental description of

the predicament faced by anyone who happens to make statements about facts. Because of the nature of their discipline, early modern astronomers often relied heavily on the observations conducted by colleagues in other places and other times—more so than the practitioners of most other disciplines, including experimental philosophy. Still, Kepler is not lecturing Galileo about some delicate trust-based sociability of the astronomers' community and the need to sustain it through value-confirming behaviors such as the disclosure of the instrument's specification, observational practices, and testimonials. His letter does not intimate that Galileo's refusal to provide testimonials may threaten the stability of the astronomers' "form of life," but simply reminds him that, because of the empirical (rather than philosophical) nature of the claims he made in the *Nuncius*, his readers are expecting him to play by the rules of the legal (rather than philosophical) game.[31] Kepler seems to take for granted that Galileo has testimonials available and tells him that he ought to make them public.

Written a few weeks later, the *Narratio* suggests that Kepler had some dislike for the very rules of the game he is exhorting Galileo to follow—a dislike that resonates with some of the recent critiques of the feasibility of the jury system to judge complicated scientific matters. In the *Narratio* Kepler reports that some critics have dismissed his just-published *Dissertatio* as a rhetorical text: "According to them, [my arguments] are cheap and aimed at pleasing the masses, like those used in a tribunal to respond to questions about fact."[32] (The critics, most likely, were responding to seeing the book endorse Galileo's discoveries without replicating or providing testimonials about them).[33] That put Galileo and Kepler on the same boat. If some accused Galileo of lying about facts, others took Kepler to spread a cognate kind of lie—the kind lawyers tell in court when they cannot produce facts.

Kepler is no antiempiricist. He observes whenever he can, collects observations from wherever and whomever he can get them, and even writes a book—the *Ad Vitellionem paralipomena*—on optics and vision with the goal of improving the reliability of astronomical observations. His derisive association of rhetoric and judgments of fact, therefore, is not a critique of empiricism in general but rather a description of what *other people*—the common readers of Galileo's *Nuncius* and of Kepler's own *Dissertatio*—take to be the appropriate protocols to assess facts. Lacking a philosophical background, these people may assume that the discourse of lawyers and courts is the only way one can talk about empirical evidence.

What seems to bother Kepler is not the strictness or laxity of legal standards about fact but the way discussions about facts are framed in (and by) legal settings. Courts, it seems, are the place where facts are put forward, but they are also the place where their absence is routinely covered up by the lawyers' rhetorical arguments. Facts are indeed opposed to rhetoric, but this is an opposition that is *played out within the same legal discursive game*. Whereas rhetorical spins on evidence (or its absence) are corrupt, statements of fact are limited to effects—not causes. Both options are not terribly appealing to someone who, like Kepler, fashions himself as a philosopher (or as a theologian-turned-philosopher).

Shapin and Schaffer argue that Boyle drew from legal practices to build a methodology of experimental philosophy around the "matter of fact," but Kepler seems to see the law as part of the problem rather than of the solution. (His subsequent long and stressful engagement with the courts to defend his mother from accusations of witchcraft probably did little to make him appreciate the legal institutions' handling of testimony and empirical evidence).[34] Kepler's skepticism does not reflect a worry—shared by other seventeenth-century natural philosophers—that statements about nature have a tendency to turn litigious because of the dogmatism of the philosophical or theological frameworks in which they may be made to operate. Lawyers and courts can make facts litigious no matter what they might be about or what previous connotations they might carry. Kepler's solution is not to go for maximum facticity—matters of fact bleached of any interest or ideology—but rather to adopt a two-tier epistemology that, by separating factual statements from philosophical ones, accepts the sad fact of the lawyers' existence.

If one's claims are primarily about observations (as in Galileo's *Nuncius* or Kepler's *Phaenomenon*) then one has to play by the lawyers' rules and provide testimonials. Although Kepler does not seem to enjoy having to write the *Narratio* to corroborate Galileo's discoveries, he feels compelled to do so to vindicate what he wrote in the *Dissertatio*. Philosophers may not need (or even like) testimonials, but they cannot forget that, infected by the "idols of the tribunal," the common readers do need them.

For instance, in the *Narratio* Kepler states that the "more secret" reasons for his trust in Galileo's observations predated his having "proof of the fact." Even in the absence of empirical corroboration, Kepler states that such reasons were strong enough to "completely satisfy my mind."[35] Having initially withheld those "more secret" reasons, he has decided to make them public now that he can provide empirical testimonials as well. We should not, however, take Kepler to behave like the textbook scientist who puts forward her/his claims only when she/he can empirically support them in front of colleagues.

The delayed publication of Kepler's "more secret" reasons does not result from the delayed availability of corroborative evidence but rather from the features of the audience he had to address in that specific book—an audience that was *not* primarily made up of colleagues. Kepler did not wish to address the "common readers" but was forced to do so because of Galileo's decision to pitch the *Nuncius* to them rather than to professional astronomers. Kepler's earlier decision not to take his reasons "in front of the judges" or to "the masses anxious with doubt" reflected a fear that, unable to understand his "more secret" reasons, they would have made fun of him.[36] Kepler seems less concerned with conveying knowledge to the masses than with avoiding being harassed by them.

This sounds like philosophical elitism of the Pythagorean type (a stance certainly not alien to Kepler), but it carries more mundane implications. Echoing the letter to Galileo from a few weeks earlier, Kepler is now suggesting that while philosophical readers would be able to understand Kepler's "secret reasons," common readers could be convinced (or perhaps just pacified) only by testimonials. Kepler does not provide testimonials to *prove* his "secret reasons" but rather to *shield* philosophical knowledge from the derision of the masses—to keep the readers happy and off the philosopher's back. In this sense testimonials function as the epistemological analog to what we now call "one-liners" or "sound bytes."

If the expectations of philosophically lowbrow readers may have been annoying to Kepler, they also came with some silver lining. The same legal conventions that make people expect testimonies from philosophers when they make statements of fact also places quite a low threshold on credibility: "Such is the way of the law: one is presumed sincere until the contrary is proven."[37] Although any additional circumstantial evidence (like, but not limited to, social status) may add to a claimant's credibility, the principle remains that in disputes over facts (as distinct from disputes over points of law) the burden is not on the claimants but on their critics.[38] This has tremendous consequences for discoverers as it means that, as Kepler often states, Galileo's opponents should not attack him and his claims without introducing empirical evidence to support their challenges. His claim that discoverers should be (legally) entitled to the benefit of the doubt is also traceable to lines such as "Why should not I believe in such a profound mathematician" or "Why should I deny my trust." More than rhetorical questions, such constructions indicate that Galileo ought to be granted credibility to begin with and that Kepler would have to find reasons for taking that credibility away from him.[39]

Kepler's application of the "innocent until proven guilty" legal standard to factual claims about nature may also explain his openness to using lower-class witnesses. High social status does help credibility, but that does not mean that claims put forward by a lower-class person are not credible. Technically, even a beggar's claims would have to be refuted to be dismissed—a position quite different from Boyle's who was eager to dismiss as untrustworthy testimony from laborers.[40] To Kepler it is all a matter of balance or, rather, of judgment. Everybody starts with some positive credibility that can be then increased or reduced by circumstantial evidence such as the character of the person, the risks that person would be taking by lying, the nature of the claim, the opposing or supporting testimonies, the modalities of observation, the way the claim is reported, and so on. Kepler does not treat testimonials as proofs, but only as evidence—entries in a long list of additions and subtractions through which credibility is assessed—a practice not unlike the evidentiary arithmetic of Roman-canon law.

Idols of the tribunal

I want to return to Kepler's complaint that the *Dissertatio*—a book that provided many arguments but little empirical evidence to support Galileo's claims—was criticized for putting forward arguments that were "cheap and aimed at pleasing the masses, like those used in a tribunal to respond to questions about fact."[41] Kepler's remark, it seems to me, is that his critics assumed that if a person supports somebody else's claims about facts without

introducing testimonies that person must be operating at the other end of legal discourse—that of rhetoric. Conditioned by the "idols of the tribunal," such readers are unable to see that if the *Dissertatio* endorsed Galileo's claims without replicating them, it is because Kepler was supporting those discoveries with arguments that were neither factual nor rhetorical. These were philosophical arguments about the causes of Galileo's phenomena rather than about the phenomena themselves.[42]

Kepler's definition of philosophical claim includes the physical causes of natural phenomena but is broader (and less clear) than that.[43] What remains clear, however, is that Kepler attributes certain a priori features to philosophical arguments. Although they may be refuted by empirical evidence, those arguments do not develop from evidence in an inductive fashion. According to the *Dissertatio*, "it is truly not without reason that we much esteem those who [...] precede the senses with reason."[44] One does not need an hourglass to figure out that summer nights are shorter in England than in Rome because that can be easily derived from geographical and astronomical considerations without any further empirical input.[45] At a much higher level of complexity, a sophisticated astronomer can appreciate the truth of Copernican cosmology even in the absence of conclusive empirical corroborations (which, in fact, became available only much later). Another example is Kepler's own "discovery" of the relationship between planetary orbits and Platonic solids in the 1596 *Mysterium cosmographicum*. Empirical data about planetary orbits is of course crucial here, but what Kepler takes to be the explanation for their distribution stems from an a priori construct: the number and geometrical features of the Platonic solids.

This last example introduces a key feature that Kepler attributes to natural philosophical arguments—a feature that can be used to assess the credibility of factual reports even in the absence of direct or reported empirical evidence. By uncovering some of the causes of observed phenomena, philosophical arguments also point in the direction of yet undiscovered phenomena, relations, or even mechanical inventions. When discovery happens, it derives credibility from having been "predicted." What Kepler means by prediction is much broader than a law's ability to predict a certain event (such as shorter summer nights in England compared to Rome, or an apple departing from a tree branch with a certain acceleration). Philosophical arguments are generative of entire families of new arguments and discoveries. For instance, Kepler suggests that his discovery of the correlation between planetary orbits and Platonic solids is not altogether surprising because it is little more than a "confirmation" of Plato's and Proclus's original "prediction" about the role of the perfect solids in the structure of the cosmos. He goes so far as to suggest that Columbus's discovery of the new world is credible (and perhaps not deserving the extraordinary recognition it had received) because, in the end, his voyage corroborated philosophically reasonable speculations about the existence of other continents on earth dating back to Plato.[46] The same logic applies to Galileo's telescope. Kepler has not seen it but believes that it produces the observations described in the *Nuncius* because its optical principles were already laid out in Kepler's 1604 *Ad Vitellionem paralipomena*.

The telescope, Kepler suggests, is the "effect" of the "causes" discussed in his book—a book that can be now seen as having predicted that invention.[47]

Kepler's characterization of his critics' habitus suggests that they did not understand the epistemic status of philosophical arguments, that they do not need the support of testimonials to accept them, or that Kepler's saying that Galileo's claims were "most certain" was quite different from what *they* would take to be the endorsement of a statement of fact. Kepler found the philosophical arguments about the new discoveries so convincing to compel him to endorse Galileo, but "no one should think that, in my eagerness to endorse Galileo, I intend to take away from others the liberty to reject his claims."[48] Unable to tell the difference between a philosopher and a lawyer, Kepler's critics took him to act as Galileo's attorney, trying to force assent with lawyer-style rhetorical arguments packed with invocations of truth when, in fact, he was simply expressing his philosophical appreciation of the discoveries.[49]

Such misreadings, however, were facilitated by the specific contents and literary genre of the *Nuncius*. It is well known that Galileo's book became a cause celebre by blurring the disciplinary lines between mathematics and natural philosophy through the presentation of astronomical evidence with extraordinary implications for natural philosophy and cosmology. Furthermore, such claims were made with a new and poorly understood instrument —an issue that forced a redefinition of the very meaning of "eyewitnessing." Kepler, however, suggests that the *Nuncius* caused even bigger disruptions, such as the scrambling of distinctions between philosophical discourse and legal arguments about facts.

It would have never crossed the mind of the readers of *De revolutionibus* to ask Copernicus to prove his arguments according to the standards of the court of law. Readers of technical astronomical texts belonged to an elite operating according to its own rules of discourse and evidence—rules that, as shown by the outcome of Galileo's trial of 1632–1633, were difficult to translate into to those of the law. But common readers who would have never picked up a traditional astronomy text bought the *Nuncius* because, in addition to the extraordinary nature of its claims, it was presented as an astronomical news-sheet, with very few technical arguments.[50] Furthermore, the book made philosophical arguments almost without stating them, that is, by presenting stunning new facts while keeping discussions of their philosophical implications to a minimum. It did not only blur disciplinary boundaries between mathematics and philosophy but also mixed "high" and "low" audiences without actually warning the readers that what they had bought was a philosophical bombshell in sheep's clothing. That supported the "common" readers' tendency to see it as a book that was purely about facts—though one that failed to provide testimonials for those facts. (This was, I think, the meaning of Kepler's remark that, from the readers' point of view, the issue was "really not a philosophical problem but a juridical question of fact").[51] The (unacknowledged) scrambling of the boundaries between disciplinary genres and audiences complicated the *Nuncius*' reception as well as that of its defense—Kepler's *Dissertatio*.

Marking truth, marking lies

As he discusses the "secret reasons" for endorsing the *Nuncius*, Kepler makes an intriguing statement: he finds Galileo sincere because his book contains things "that are both credible and incredible."[52] Claims that are too good to be true are likely to be untrue; which means that, to (appear to) be true, a claim needs to simultaneously confirm and subvert the reader's expectations.

In the *Narratio* (but also in the earlier "Defence of Tycho") Kepler remarks that liars need to have excellent memory.[53] Memory is a crucial skill for those who make things up, as they need to ensure that each step of their story is construed to fit the previous one. Liars also have a tendency to find an answer to any question that may be posed to them. By contrast, it is a sign of sincerity to say "I do not know," as well as to report phenomena that are difficult to explain: "Why, I ask, would one willfully complicated matters by inventing such things one would the despair to explain?"[54] Galileo, Kepler argues, reported the surprising variation of the brightness of Jupiter's satellites while failing to properly explain it. It is precisely the fact that Galileo is struggling to explain what he has reported (and that Kepler himself could not do better) that convinces Kepler that this is a real phenomenon. It is real because it is difficult, but not as difficult as to be incredible.[55]

Similarly, Galileo's claim that the satellites' periods around Jupiter are remarkably fast (especially compared to Jupiter's 12-year period) is a surprising statement that has the ring of truth—even more so after reading of Galileo's skepticism about being able to determine their exact periods. Had he been a liar, Galileo could have instead "organized those apparitions imagining them on the basis of precise orbits and periods, as if drawing them from an ephemerides."[56] And if he really wanted to make up new planets, Kepler continues, why not make their number infinitely large and place them around an infinite number of fixed stars so as

> to corroborate Cardinal Cusanus, Bruno, and others, and to say things made credible by their authority? And if he did not like the fixed Stars, why should have he invented them around Jupiter while neglecting Saturn, Mars, and Venus? Why would have he imagined four rather than only one (as only the Moon goes around the Earth) or six (as there are six planets around the Sun?)[57]

To be credible, new claims need to defy the most mechanical of expectations, that is, they need to be a bit incredible. But all this is lost on those whose thinking is conditioned by the "idols of the tribunal." With a mix of perplexity and sarcasm, Kepler reports that some people took the many questions he asks around Galileo's claims—questions introduced to argue that Galileo's claims are true because he could have made different ones more easily—to be a sign of skepticism rather than appreciation. By mistaking questions *around* those claims to be *about* those claims, the critics seemed to conclude that Kepler was treating Galileo as a hostile witness.[58]

Kepler's notion of the "mark of truth" applies to arguments that humans develop about nature but hinges, I believe, on ontological rather than epistemological considerations. Deriving from God's infinite power, the workings of nature always exceed our knowledge and expectations. Philosophical narratives that acknowledge gaps in the philosopher's understanding of nature confirm such ontology and derive a ring of truth from it. Unable to fully comprehend nature, the philosopher can only display the gaps and deferrals she/he incurs with while inexorably failing to keep up with it. While nature shows itself to be natural by displaying its *infinite* creations, the philosopher shows her/himself to be truthful by displaying her/his *finite* ability to grasp such infinite complexity and variety. One kind of mark produces the other as its complement.

Admitting to gaps in one's argument, then, is not so much a sign of personal sincerity—the demonstration of socially sanctioned marks of modesty—as a trace of the ontological gap between what nature does and what humans can understand about it. Unlike good philosophers who know and make visible their limitations, liars invent seamless narratives. But even when most intricate and skillful, the liars' fabrications display the smoothness of artifacts—a smoothness that gives them away as mere simulacra of knowledge or creativity.[59] Gaps or statements like "I do not know" in philosophical arguments are the equivalent to the accidental chisel scratch or brush stroke that sets apart a handmade artwork from machine-made identical multiples. Exceptions that confirm the rule, they are signs of authenticity because they mark excess or unnecessary difference (as opposed to the fake smoothness of the liar that signals only her/his lack of real knowledge or creativity).

This may explain why Kepler is not embarrassed to present partially diverging observational reports in the *Narratio*. Such practice, I argue, is quite different from apparently similar admissions of error found in other texts by Kepler or experimental philosophers. For instance, Kepler's chronicling, in his 1609 *Astronomia nova*,[60] of his many missteps on the way to determining the elliptical shape of Mars's orbit, or the reports of failed experiments found in Boyle's *New Experiments* were meant to demonstrate one's sincerity: "I am admitting to you that I expected X, but got Y instead."[61] Because Y is openly presented as a wrong result, such a tactics might help you win the sincerity contest, but not the one about truth. Such reporting of struggles and false starts needs, in fact, to be followed by the delivery of what is deemed to be the right result. The *Narratio*, instead, puts seemingly analogous discrepancies to a completely different use. We have seen that in that book Kepler describes how different people were often unable to observe the same satellites of Jupiter at the same times. Still, he presents such observations as testimonials to the truth of Galileo's claims. That's no slip of the pen. Right at the beginning of the book (well before he describes the observations), Kepler states that

> if, dear reader, you notice some discrepancy or if, as I believe, you will realize that sometimes I have seen fewer satellites than Galileo, *this should not produce any confusion concerning the fact itself.* These, in fact, are my first experiment with such observations; the sky has been often cloudy; the

> presence of the Moon has bothered us; the instrument was not very good nor very easy to use; the telescope mount was fixed; it was very hard to find Jupiter[62]

Giving information about the limits of one's instrument has been discussed as a tactic used by experimenters to avoid "giving the lie" to other practitioners whose results did not match their own.[63] But here Kepler uses the very same kind of evidence to say that, despite the discrepancies caused by constraints in the apparatus and in the conditions of observation, the observation stands corroborated. He invokes observational contingencies not to maintain polite intercourse in the face of disagreements about facts but rather to say that such differences do not amount to actual disagreements.

Kepler's radically different stance in the *Astronomia nova* and the *Narratio* may have to do with the specific differences between the problems discussed in the two books. The error-packed struggle chronicled in the *Astronomia* was a mathematical one. Kepler was trying to detect the orbit of Mars based on a specific set of Tycho's observations—a process he described as having clearly binary outcomes: match or no match. He describes the many mismatches until he reports what he takes to be the one that fits. The corroboration of the satellites of Jupiter is a different problem altogether. As he told Galileo a few weeks earlier, it was not a philosophical but a juridical matter. It did not concern the determination of the true orbit of the satellites but the corroboration of their *existence;* that required producing observations (rather than finding the one geometrical figure that made sense of them). Not only do these two different puzzles require different approaches to their solution, but they also fall into what Kepler takes to be two different epistemic registers. The orbit of Mars is more of a philosophical problem (and he cites no witnesses in support of his discovery), while the existence of the satellites of Jupiter is a straightforward empirical or, as he says, a juridical issue (and he cites three witnesses besides himself). This, however, does not quite answer why Kepler thought that observational discrepancies could add (rather than subtract) from the strength of the collective testimony. To get there, we may have to go back to his remarks about liars.

Liars make up improbably seamless stories. Along those lines, Kepler seems to treat full consensus in observations conducted by different people as suspicious rather than reassuring—as if total consensus about a matter of fact is just too improbable to be true.[64] It could suggest that, Mafia-style, someone got to the witnesses. It could also suggest that Kepler and Galileo had checked their observations (or even coordinated their cooking) before Kepler's publication to make sure that they matched. (That's a possibility that Kepler dismisses by citing that "everybody in Prague" knew that there had been no communication between the two).[65] In sum, Kepler behaves as if differences in the observational log do not imply that the phenomenon is unstable or artifactual but that *other differences are at play*—some of them in nature (changing lighting conditions due to the Moon's position), some in the witnesses' perceptual abilities, and some in the apparatus. Those differences tell the reader that the witnesses have not been tampered with.

Kepler's endorsement of the "innocent till proven guilty" rule is also key here. According to that legal stance, the divergent observations of Seggett, Ursinus, and Schultetus do not refute each other. If Seggett reports one specific satellite but Schultetus does not, that does not mean that Seggett's observation is wrong. It simply means that Seggett's report is credible but not confirmed by other testimonials. When multiple observations of the same object confirm each other, the claim's credibility is reinforced. But when they don't, the claim's epistemic status remains positive, though lower than that of a claim that has been corroborated. In sum, Kepler would have been in trouble if all of the four observers had come up with either completely nonoverlapping drawings or with completely overlapping drawings. The first scenario might have indicated failure, whereas the latter would have looked too good to be true. But as Kepler put it, claims need to be both credible and incredible to be true. Some overlap and some nonoverlap provided just the right mix—a proper "reality effect."

Between prediction and prophecy

There is, I believe, a connection between Kepler's notion of the "mark of truth" and his attribution of additional credibility to claims that were somewhat predicted by philosophical arguments. The emphasis here is on *somewhat*. Kepler does not attach credibility to just all factual claims predicted by philosophical arguments but only to those that have been *predicted imperfectly*. Similarly, he attributes truth to philosophical arguments that have been generative enough to produce *imperfect* predictions. God, I think, is just around the corner in Kepler's argument. Imperfection goes with generativity, but not with the infinite power and generativity of God. If humans were God, they could come up with perfect predictions because they could create what they were predicting. However, not being God, they can only produce partial predictions based on some good hunch about physical causes. A too accurate prediction (by a human) would either predict nothing new or predict too much to be true. A perfect prediction is as mechanical as a copy—like a die striking yet another identical coin—or as dubious as something that has been made up to fit.

Kepler argues, for instance, that his discovery of the relationship between planetary orbits and the Platonic solids in the *Mysterium cosmographicum* has simultaneously confirmed and refuted the ancients' claims about "how the five [Platonic] solids were expressed in the cosmos." Kepler credits the Platonists for attributing a key role to the perfect solids in the structure of the cosmos but disproves the specific role they attributed to them. Galileo's discoveries do the same with regard to claims about the fixed stars having their own satellites—claims that Kepler traces back to Edmund Bruce and Giordano Bruno. Bruno and Bruce, Kepler tells us, were right in arguing that there were more satellites in the world, but Galileo has shown that such additional satellites

orbit a planet, not a fixed star: "You correct such a doctrine," while also showing that "they generally told the truth."[66] This last example reemerges in the *Narratio*, with a crucially different twist. There, Kepler goes back to Bruno's speculations about satellites orbiting fixed stars, but this time to say that Galileo's claims about the satellites of Jupiter were credible precisely because they did *not literally* confirm Bruno: "Had the author decided to make up new planets, why, I ask, did he not imagine them infinite [in number] around infinite fixed stars, so as to corroborate Cardinal Cusanus, Bruno, and others, and to say things made credible by their authority?"[67]

Observations that match all too well the philosophers' predictions are either redundant or artifactual (in the same way that *exact* consensus over one specific observation may be a mark of fraud). Whether redundant or artifactual, such observations produce no (new) knowledge and contribute no (new) credit to themselves and to the philosophical arguments that predicted them. But although a discovery that matches only the "spirit" (but not the "letter") of a philosophical prediction cannot count as a proof of the philosophical argument underlying such a partial prediction, it still demonstrates something epistemically relevant about that philosophical argument. It demonstrates its cognitive productivity, its ability to produce hypotheses aligned with at least some of the causes through which nature has generated the newly discovered phenomenon.[68] The notion of prediction that Kepler uses in these texts is therefore quite closer to prophecy than to law-like forecast.[69] It also bears some resemblance to another form of prediction that occupied Kepler for most of his life: astrology.

Notes

1. Jennifer Lackey and Ernest Sosa, eds., *The Epistemology of Testimony* (Oxford: Oxford University Press, 2006); C. A. J. Coady, *Testimony: A Philosophical Study* (Oxford: Clarendon Press, 1992).
2. Peter Huber, *Galileo's Revenge: Junk Science in the Courtroom* (New York: Basic Books, 1991); Kenneth Foster, ed., *Phantom Risk: Scientific Inference and the Law* (Cambridge, Mass.: MIT Press, 1993); Sheila Jasanoff, *Science at the Bar: Law, Science, and Technology in America* (Cambridge, Mass.: Harvard University Press, 1995); Ken Alder, "To Tell the Truth: The Polygraph Exam and the Marketing of American Expertise," *Historical Reflections* 24 (1998): 487–525; Kenneth Foster and Peter Huber, *Judging Science: Scientific Knowledge and the Federal Courts* (Cambridge, Mass.: MIT Press, 1999); Ian Burney, *Bodies of Evidence* (Baltimore: Johns Hopkins University Press, 200); Simon Cole, *Suspect Identities: A History of Fingerprinting and Criminal Identification* (Cambridge, Mass.: Harvard University Press, 2001); Michael Lynch, "'Science Above All Else:' The Inversion of Credibility between Forensic DNA Profiling and Fingerprinting Evidence," in Gary Edmon et al., eds., *Expertise in Law and Regulation* (Aldershot: Ashgate, 2004), 121–135; Tal Golan, *Laws of Men and Laws of Nature: The History of Scientific Expert Testimony in England and America* (Cambridge, Mass.: Harvard University Press, 2004); David Faigman, *Laboratory of Justice* (New York: Owl Books, 2005); Bruce Sales and David Shuman, *Experts in Court* (Washington, DC: APA, 2005); Ian Burney, *Poison, Detection and the Victorian Imagination* (Manchester: Manchester University Press, 2006); Michael Lynch et al., eds., *Truth Machine: The Contentious History of DNA Fingerprinting* (Chicago: University of Chicago Press, 2009).
3. Barbara Shapiro, *Probability and Certainty in Seventeenth Century England* (Princeton: Princeton University Press, 1985); Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump* (Princeton: Princeton University Press, 1985); Julian Martin, *Francis Bacon, the State, and the Reform of Natural Philosophy* (Cambridge: Cambridge University Press, 1992); Barbara Shapiro, *Beyond Reasonable Doubt and Probable Cause* (Berkeley: University of California Press, 1993); Albert van Helden, "Telescopes and Authority from Galileo to Cassini," *Osiris* 9 (1994): 9–29; Rose-Mary Sargent, *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment* (Chicago: University of Chicago Press, 1995), esp. 42–61; Steven Shapin, *A Social History of Truth* (Chicago: University of Chicago Press, 1995); Matthew Jones, "Writing and *Sentiment*: Blaise Pascal, the Vacuum, and the *Pensees*," *Studies in History and Philosophy of Science* 32 (2001): 139–181; Barbara Shapiro, *A Culture of Fact* (Ithaca: Cornell University Press, 1999). The literatures that have studied early modern "science-in-law" rather than "law-in-science" are almost exclusively focused on the medical profession: Silvia de Renzi, "Witness of the Body: Medico-Legal Cases in Seventeenth-Century Rome," *Studies in History and Philosophy of Science* 33 (2002): 219–242; Silvia de Renzi, "Medical Expertise, Bodies, and the Law in Early Modern Courts," *Isis* 98 (2007): 315–322; Alessandro Pastore, *Il medico in tribunale: La perizia medica nella procedura penale d'antico regime* (Bellinzona: Edizioni Casagrande, 1998); and Gianna Pomata, *Contracting a Cure: Patients, Healers, and the Law in Early Modern Bologna* (Baltimore: The Johns Hopkins University Press, 1998).
4. Johannes Kepler, *Phaenomenon singulare, seu mercurius in sole* (Leipzig: Schurer, 1609), reprinted in Johannes Kepler, *Gesammelte Werke*, ed. Max Caspar and Franz Hammer, 20 vols. (Munich: Beck'sche Verlagsbuchhandlung, 1937) (hereafter *KGW*) vol. IV, 79–98, at p. 92.
5. "Ego M. Martinus Bachazek, qui interfui huic observationi, fateor rem ita se habere." Kepler, *Phaenomenon*, 93.
6. "Heinrich Stolle klein Uhrmacher-Gesell / mein handt." Kepler, *Phaenomenon*, 93.
7. "Auriti testes" are mentioned by Scheiner in his 1612 *Accuratior disquisitio*, his second book on the observation of sunspots. Galileo Galilei, *Le opere di Galileo Galilei*, ed. Antonio Favaro, 20 vols. (Florence: Barbera, 1890–1909) (hereafter *GO*) vol. V, 62. Kepler's double designation of his witnesses as both "spectator" and "testis" was to reappear in his *Narratio*. Langbein claims that hearsay witnesses had no value in criminal trials: "Witnesses shall testify from their own true knowledge, declaring the detailed grounds of their knowledge. When they would testify to hearsay, however, that shall be treated as inadequate." John Langbein, *Prosecuting Crime in the Renaissance* (Cambridge, Mass.: Harvard University Press, 1974), 284.
8. *Constitutio Criminalis Carolina* (1532) as translated in Langbein, *Prosecuting Crime*, 284.
9. The fact that the Jesuit is left nameless throughout the book is somewhat puzzling. One interpretation is that Kepler did not mention the Jesuit by name, because he (the Jesuit) did not want to be named in print as an active collaborator of a Protestant.
10. Kepler, *Phaenomenon*, 92–94.
11. "*Testis est JVSTI BYRGII Minister Automatopoeus, qui spectator fuit.*" Kepler, *Phaenomenon*, 93.
12. Both Kepler's book and handwritten report refer to the images of the solar disk projected through the pinholes as "schemata"—a Latin term that refers to images

as well as sketches—so it's not clear whether the witnesses witnessed the projection of the sun on a piece of paper or a drawing of such a projection.

13. *Constitutio Criminalis Carolina* (1532) as translated in Langbein, *Prosecuting Crime*, 285: "We want the complainant to have his articles that he wishes to prove by witness properly written up and transmitted to the judge, along with the witnesses' names and addresses, in order that thereafter witness-testimony be taken in necessary and appropriate manner by several of the judgment-givers or by other proper delegates."
14. Kepler, *Phaenomenon*, 93–94.
15. Still, both had tried to witness, an attempt that Kepler plays down because, if played up, would have made them look like negative witnesses, that is, people who did not see what Kepler was seeing.
16. Johannes Kepler, *Narratio de observatis a se quatuor Iovis satellibus erronibus* (Frankfurt: Palthenius, 1611), reproduced in *KGW*, vol. IV, 315–325. Though the book carries a publication date of 1611, it was already circulating in the fall of 1610.
17. Johannes Kepler, "Ad lectorem admonitio," in *Dissertatio cun nuncio sidereo* (Prague: Sedesanus, 1610), in *KGW*, vol. IV, 286–287.
18. On why Kepler endorsed Galileo's discovery without being able to replicate them see Mario Biagioli, *Galileo's Instruments of Credit* (Chicago: University of Chicago Press, 2007), 27–44.
19. Kepler, *Narratio*, 318.
20. Kepler, *Narratio*, 320.
21. Kepler, *Narratio*, 319.
22. Kepler, *Narratio*, 319–320, 322 and Albert van Helden "Telescopes and Authority from Galileo to Cassini," *Osiris* 9 (1993): 12.
23. Kepler, *Narratio*, 322.
24. Kepler, *Narratio*, 322.
25. See the minutes of the depositions of Ferdinando Ximenes and Giannozzo Attavanti by the Congregation of the Holy Office in Maurice Finocchiaro, *The Galileo Affair: A Documentary History* (Berkeley: University of California Press, 1989), 141, 143. Both Ximenes and Attavanti are asked whether they know the cause of the summons, and both respond negatively. When Galileo is asked the same question on April 12, 1633, he responds that "I imagine that the reason why I have been ordered to present myself to the Holy Office in Rome is to account for my recently printed book." Interestingly, the inquisitor does not confirm this but asks back "that he explain the character of the book on account of which *he thinks* he was ordered to come to Rome." Ibid., 256–257. Quite likely, the inquisitor's decision not to confirm the cause of the summons is to deny Galileo any information that may guide his response.
26. *Constitutio Criminalis Carolina* (1532) as translated in Langbein, *Prosecuting Crime*, 270.
27. "In the previous articles it is plainly set forth how someone who confesses under torture or threat of torture to an unsolved crime shall be questioned about all the circumstances of the said crime and how on that basis subsequent investigation shall take place, In order thus to get to the truth... that would, however, probably be frustrated when the said circumstances of the crime were previously told to the prisoner upon arrest or examination and he thereupon examined. For that reason we want judges to take precautions against such happening; instead we want nothing to be put to the accused before or during examination other than according to the manner plainly written out in the articles just concluded," *Constitutio Criminalis Carolina* (1532) as translated in Langbein, *Prosecuting Crime*, 282.

28. Kepler to Galileo, August 9, 1610, in *GO*, vol. X, 416: "*In te uno recumbit tota observationis authoritas.*"
29. Kepler was growing so desperate so as to consider using Martinus Horky's vituperative attack on Galileo's discovery of the satellites of Jupiter, simply because (obviously without its author's knowledge) it reported observations for April 24 and 25 that matched (and thus confirmed) those of Galileo for those same days (Kepler to Galileo, August 9, 1610, *GO*, vol. X, 416).
30. Kepler to Galileo, August 9, 1610, *GO*, vol. X, 415: "*Et vero non problema philosophicum, sed questio iuridica facti est, an studio Galilaeus orbem deluserint.*"
31. One issue that links the acceptance of matters of fact and the acceptance of philosophical arguments is credibility. In the case of matters of fact, Kepler aligns himself with Roman law. A person who makes a statement of fact should be deemed truthful unless the opponent can disprove it. The burden of proof is on the accuser. Translating this principle to Galileo's case, Kepler criticized those who assailed Galileo's credibility without doing any work to prove him wrong.
32. Kepler, *Narratio*, 317.
33. Kepler had foreseen this problem (*Dissertatio*, 290).
34. Max Caspar, *Kepler* (London: Adelard, 1959), 240–258.
35. Kepler, *Narratio*, 317. See similar claims in the *Dissertatio*, 304–305.
36. The use of terms like "secret reasons" (and their casting in opposition to what the "masses" can understand) signals Kepler's sympathy for exclusive, Pythagorean-style notions of knowledge—a trait shared by Copernicus himself.
37. "*Quia haec via iuris est, ut quilibet praesumatur bonus, dum contrarium non probetur,*" Kepler to Galileo, August 9, 1610, *GO*, vol. X, 415. Comparable claims are in *Dissertatio*, 290.
38. "*Quanto magis si circumstantiae fidem fecerint?*" Kepler to Galileo, August 9, 1610, *GO*, vol. X, 415.
39. Kepler, *Dissertatio*, 290.
40. Shapin and Schaffer, *Leviathan and the Air Pump*, discusses Boyle's dismissal of the testimony "of ignorant divers, whom prejudicate opinions may much sway, and whose very sensations, as those of other vulgar men, may be influenced by the predispositions, and so many other circumstances, that they may easily give occasion to mistakes" (218).
41. Kepler, *Narratio*, 317.
42. "It was a pleasure, Galileo, to discuss with you in these terms, that is, philosophically, about the new doubts that you have triggered with your observations." Kepler, *Dissertatio*, 310.
43. It also includes what, in the "Defence of Tycho," he calls "astronomical hypotheses." These are substantially less hypothetical than the term might suggest, and are, in turn, opposed to mathematical hypotheses. Nicholas Jardine, *The Birth of History and Philosophy of Science: Kepler's Defence of Tycho Against Ursus with Essays on Its Provenance and Significance* (Cambridge: Cambridge University Press, 1984), 211–257; Rhonda Martens, *Kepler's Philosophy and the New Astronomy* (Princeton: Princeton University Press, 2000), 57–68.
44. Kepler, *Dissertatio*, 304–305.
45. Ibid.
46. Kepler, *Dissertatio*, 293, 304–305. This additional credibility has to be "paid back" by the discoverer with the credit s/he owes to those who had predicted it. Kepler owes Plato as much as Columbus owes older geographers. Galileo too owes credit to the Copernicans who have preceded him: "You, Galileo, should not deprive our predecessors of the glory they deserve for this, for having told you that things had to be the way you say you have just discovered with your eyes." *Dissertatio*, in

KGW, vol. IV, 306. Kepler seems to suggest that the credit should in fact be shared between the "discoverer" and the "predictor"—between Plato and Kepler, Ptolemy and Columbus, Kepler and Galileo.

47. Kepler, *Dissertatio*, 292–293. There Kepler gives credit to Porta for having been the first to propose the optical scheme of the Dutch or Galilan telescope and to himself for having been the first to give a qualitative description of how that combination of lenses could produce enlargement.
48. Kepler, *Dissertatio*, "Ad lectorem admonitio," 287.
49. Kepler, *Narratio*, 317.
50. On Galileo's textual and pictorial narrative strategies, see Biagioli, *Galileo's Instruments of Credit*, 77–134.
51. Kepler to Galileo, August 9, 1610, *GO*, vol. X, 415.
52. Kepler, *Narratio*, 318: *"An non ingenua est confessio rerum observatarum, qua credibilium, qua incredibilium."*
53. Kepler, *Narratio*, 318; Jardine, *The Birth of History and Philosophy of Science*, 140.
54. Kepler, *Narratio*, 317.
55. In the postscript to the *Dissertatio*, Kepler jokes that the catalogue of the last Frankfurt book fair lists a new book by Thomas Gephyrandrus on his success at squaring the circle. Although both Gephyrandrus's claims and Galileo's are unheard of, Kepler finds the latter credible and the former absurd. As he puts it: "This was not an issue of trusting my eyes, and reason shut down my ears as soon as soon as the news arrived."
56. Kepler, *Narratio*, 318.
57. Ibid., 317.
58. Credibility and trust, therefore, seem to be negative constructs that Kepler relates to improbability and partiality rather than full consensus or verisimilitude. Sincere claims need to be somewhat incredible. Full consensus is suspect as it suggests an automatic matching of expectations. A person's credibility is related not so much to good values but to how much that person would have to lose by lying; information helps credibility insofar as it contain some difference (a lot of circumstantial detail might mean that someone is trying too hard to go mimetic). Credibility seems to be a function of the improbability of the claim and of the improbability of the reporter's cheating.
59. In his previous *Defence of Tycho*, Kepler compared the seamlessness of a liar's narrative to the accidental dovetailing of two false hypotheses that happen to yield true consequences but only once and by accident, not reliably and on different occasions. When a liar's narrative seems to fit the facts, it is by accident. Its smoothness is precisely a mark of it being false.
60. James Voelkel, "Publish or Perish: Legal Contingencies and the Publication of Kepler's Astronomia Nova," *Science in Context* 12 (1999): 33–59.
61. Shapin and Schaffer, *Leviathan and the Air Pump*, 64–69.
62. Kepler, *Narratio*, 318.
63. Steven Shapin, *A Social History of Truth* (Chicago: University of Chicago Press, 1995), 107–119.
64. Acknowledging problems in the observational context is not a way to avoid giving someone the lie but rather to recognize the truth of the fact. This may perhaps be connected to Kepler's openness to using witnesses from different social and religious backgrounds (as shown in the *Phenomenon singulare*). If a phenomenon was witnessed and drew consensus only by one specific socioreligious group, then that may have made it look like a setup. It's not that he trusts everybody, but rather that he would not trust homogeneity of consensus.
65. Kepler, *Narratio*, 318.

66. Kepler, *Dissertatio*, 305.
67. Kepler, *Narratio*, 317.
68. Symmetrically, a philosophical prediction cannot count as a priori proof of the existence of an object whose discovery it did not predict with precision, but it can nevertheless lend credibility to that discovery by providing arguments about its plausible existence as well as by showing that, by the very fact of its differing from the prediction, it does not bear the mark of a forgery. Kepler's logic differentiates between partiality and imperfection.
69. My point is based on the logic of Kepler's arguments rather than on the terms he uses, but it is perhaps telling that he does use the term "prophet" to refer to his friend Johannes Pistorius's prediction that somebody would have come along with a device that could have improved on the accuracy of Tycho Brahe's observations: *"At nunc demum video verun in parte vatem fuisse Pistorium," Dissertatio*, 295. Also in the *Dissertatio*, after referring to Plato's narrative of Atlantis as a "fable," Kepler presents Seneca's poetic prediction of the discovery of a new world as *"versiculos fatidicos."* Ibid., 304.