Opinion: *Galileo's Legacy: Avoiding the Myths and Muddles*

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In 1633, at the conclusion of one of history's most famous trials, the Roman Inquisition found Galileo Galilei guilty of "vehement suspicion of heresy"; this was a specific category of religious crime intermediate in seriousness between formal heresy and mild suspicion of heresy. He had committed this alleged crime by defending the idea that the Earth is a planet rotating daily around its own axis and revolving yearly around the Sun; his argument was found in a book published the previous year and titled *Dialogue on the Two Chief World Systems, Ptolemaic and Copernican*. The problem stemmed chiefly from the fact that Galileo was implicitly denying the Catholic Church's beliefs that the Earth's motion contradicted Scripture and Scripture was a scientific authority.

The Trial's Iconic Status

Thus, Galileo became the protagonist of a cause célèbre that continues to our own day. For example, in the eighteenth century, Voltaire opined that the tragedy would bring "eternal disgrace" to the Catholic Church (Voltaire 1877-83, vol.12, p.249); and in the twentieth century, Arthur Koestler labeled it "the greatest scandal in Christendom" (Koestler 1964).

However, there is also irony in this tragedy. For eventually the Church came to recognise that Galileo was right not only about the Earth's motion, but also about the limited authority of Scripture. This recognition came in 1893 when Pope Leo XIII issued an encyclical entitled *Providentissimus Deus*, propounding the Galilean principle that Scripture is not a scientific authority, but only one on questions of faith and morals. Moreover, another acknowledgment came in the period 1979–92, when Pope Saint John Paul II undertook a highly publicised and highly controversial "rehabilitation" of Galileo.

It is not surprising that the Catholic Church would try to appropriate Galileo's legacy. In fact, independently of his epoch-making role in the history and philosophy of religion, his legacy has a second main aspect: Galileo was one of the founders of modern science. That is, science as we know it today emerged in the sixteenth and seventeenth centuries thanks to the discoveries, inventions, ideas, and activities of a group of people like Galileo that also included Nicolaus Copernicus, Johannes Kepler, René Descartes, Christiaan Huygens, and Isaac Newton.

In physics, Galileo pioneered the experimental investigation of motion. He also formulated, clarified, and systematised many of the basic concepts and principles needed for the theoretical analysis of motion, such as an approximation to the law of inertia, a formulation of the relativity of motion, and the composition of motion into distinct components. And he discovered the laws of fall-

ing bodies, including free fall, descent on inclined planes, pendulums, and projectiles.

In astronomy, Galileo introduced the telescope as an instrument for systematic observation. He made a number of crucial observational discoveries, such as mountains of the Moon, satellites of Jupiter, phases of Venus, and sunspots. And he understood the cosmological significance of these observational facts and gave essentially correct interpretations of many of them; that is, he provided a robust confirmation of the theory that the Earth moves, daily around its own axis and yearly around the Sun.

With regard to scientific method, Galileo pioneered several important practices. For example, he was a leader in the use of artificial instruments (like the telescope) to learn new facts about the world; this is to be contrasted to the use of instruments like the compass for practical purposes. Moreover, he pioneered the active intervention into and exploratory manipulation of physical phenomena in order to gain access to aspects of nature that are not detectable without such experimentation; this is the essence of the experimental method, as distinct from a merely observational approach. He also contributed to the establishment and extension of other more traditional, but little used, methodological practices, such as the use of a quantitative and mathematical approach in the study of motion. He contributed to the explicit formulation and clarification of important methodological principles, such as the setting aside of biblical assertions and religious authority in scientific inquiry. And he was also an inventor, making significant contributions to the devising and improvement of such instruments as the telescope, microscope, thermometer, and pendulum clock.

Finally, there is a third aspect to Galileo's legacy. In fact, the historical circumstances of his time and his own personal inclinations made him into a kind of philosopher. Of course, he was not a systematic metaphysician who speculated about the eternal problems of being and nothingness. Instead he was a concrete-oriented and practical-oriented critical thinker who not only was engaged in a quest for knowledge of nature, but also reflected on questions about the nature of knowledge. In the eloquent words of Owen Gingerich, for Galileo "what was at issue was both the truth of nature and the nature of truth" (Gingerich 1982, p.133). Or, as I would put it, Galileo was like the ancient Greek philosopher Socrates, their main difference being that Socrates reflected on moral or ethical questions of good and evil and the meaning of life. Thus, just as many regard Socrates as the Father of Western Philosophy, we may regard Galileo as the Socrates of methodology and epistemology.

In short, Galileo's legacy clearly has a three-fold character, relating to science, religion, and philosophy. These three things are such major and crucial cultural elements, and their interaction has such significant cultural ramifications, that we may also speak more generally of his cultural legacy.

All aspects of Galileo's cultural legacy can be illuminated by focusing on his trial by the Inquisition, stressing its intellectual developments and issues, and elaborating, in turn, its background, proceedings, aftermath, and significance. However, before articulating the background, it is important to have a methodological discussion outlining the multifaceted and balanced approach that is necessary to avoid common pitfalls. This approach requires a mastery of a number of distinctions, which, however, must not be turned into separ-

ations. It also requires an awareness of the non-intellectual factors, which cannot be totally neglected, even as one stresses intellectual aspects.

A New Approach to Galileo's Trial

The most common view about the trial of Galileo is that it epitomises the conflict between enlightened science and obscurantist religion. The incompatibility thesis is very widespread. For example, various formulations of it have been advanced by such scientific, philosophical, and cultural icons as Voltaire, Bertrand Russell, Albert Einstein, and Karl Popper. However, I believe that such a thesis is erroneous, misleading, and simplistic.

For the moment, one main reason for identifying this first anti-clerical myth about the trial is that it may be usefully contrasted to a second myth at the opposite extreme. It seems that some found it appropriate to fight an objectionable myth by constructing another.

The opposite anti-Galilean myth maintains that Galileo deserved condemnation because he violated not only various ecclesiastical norms, but also various rules of scientific methodology and logical reasoning; he is thus portrayed as a master of cunning and knavery, and it is difficult to find a misdeed of which the proponents of this myth have not accused him. The history of this myth too has its own fascination; it too includes illustrious names, such as French physicist, philosopher, and historian Pierre Duhem, German playwright Bertolt Brecht, Hungarian intellectual Arthur Koestler, and Austrian-American philosopher Paul Feyerabend.

These two opposite myths are useful as reference points in order to orient oneself in the study of the controversy, since it is impossible to evaluate the trial adequately unless one admits that both of these accounts are mythological and thus rejects both. However, avoiding them is easier said than done. For example, one cannot simply follow a mechanical approach of mediating a compromise by dividing in half the difference that separates them. A helpful way of proceeding is to read the relevant texts and documents with care and with an awareness of a number of crucial conceptual distinctions.

To begin with, the controversy was at least two-sided: it involved partly *scientific issues* about physical facts, natural phenomena, and astronomical and cosmological matters; and it also involved *methodological* and *epistemological questions* about what truth is and the proper way to search for it, and about what knowledge is and how to acquire it. The overarching scientific issue was whether the Earth stands still at the centre of the universe, with all heavenly bodies revolving around it, or whether the Earth is itself a heavenly body that rotates on its axis every day and revolves around the Sun once a year.

The epistemological and methodological issues were several. First, there was the question of whether physical truth has to be directly observable, or whether any significant phenomenon (e.g., the Earth's motion) can be true even though our senses cannot detect it directly, but can detect only its effects; remember that even today the Earth's motion cannot be seen directly by an observer on Earth. Second, there was the question of whether artificial instruments like the telescope have any legitimate role in the search for truth, or whether the proper way to proceed is to use only the natural senses; in fact, the telescope was the first artificial instrument ever used to learn novel scientific or philosophical truths about the world. A third issue of this sort involved the question of the role of the

Bible in scientific inquiry, whether its assertions about natural phenomena have any authority, or whether the search for truth about nature ought to be conducted completely independently of the claims contained in the Bible; this was not only a methodological or epistemological issue, but also a theological or hermeneutical one, and it was the paramount issue in the trial, since it was widely believed that the new geokinetic theory contradicted the Bible.

A fourth issue was the question of the nature of hypotheses and their role in the search for truth: whether they are merely instruments for mathematical calculation and observational prediction that can be only more or less convenient but neither true nor false, or whether they are assumptions about physical reality that are more or less probable and potentially true or false but not yet known with certainty; here, this problem stemmed from the fact that even the anti-Copernicans admitted that one could explain the motion of the heavenly bodies by means of the hypothesis of the Earth's motion, but they took this as a sign of its instrumental convenience and not of its truth, potential truth, or probable truth.

Let us call these four central issues, respectively, the problems of the observability of truth; the legitimacy of artificial instruments; the scientific authority of the Bible; and the role of hypotheses (or the problem of instrumentalism vs. realism).

For the second needed conceptual clarification, one must distinguish between *factual correctness* and *rational correctness*; that is, between being right about the truth of the matter and having the right reasons for believing the truth. Suppose we begin by asking who was right about the scientific issue. It is obvious that Galileo was right and his opponents were wrong, since he preferred the geokinetic to the geostatic view, and today we know for a fact that the Earth does move and is not standing still at the centre of the universe. However, it is equally clear that his being right about this fact does not *necessarily* mean that his motivating reasons were correct, since it is conceivable that although he might have chanced to hit upon the truth, his supporting arguments may have been unsatisfactory. Hence, the evaluation of his arguments is a separate issue.

The next distinction that must be appreciated is also easy when stated in general terms but extremely difficult to apply in practice. It is that *essential correctness* must not be equated with either *total correctness* or *perfect conclusiveness*. Applied to our case, this means that even if Galileo's arguments were essentially correct, as I would hold, the possibility must be allowed that the reasoning of his opponents was not worthless, nor irrelevant, nor completely unsound.

To appreciate the next distinction, let us ask whether Galileo or the Church was right in regard to the epistemological and methodological aspect of the controversy. Since such issues are normally more controversial than scientific ones, this is an area which some like to exploit by trying to argue that the Church's epistemological and philosophical insight was superior to Galileo's. The argument is usually made in the context of a frank and explicit admission that Galileo was unquestionably right on the scientific issue. Thus, these anti-Galilean critics often boast to be displaying even-handedness and balanced judgment by contending that on the one hand Galileo was right from a scientific or factual point of view, but that on the other hand the Church was right from an epistemological or philosophical point of view.

However, such interpretations can be criticised

for their exaggeration, one-sidedness, and superficiality in the analysis of the epistemological component of the affair (Finocchiaro 1997, 2010, 2019).

Finally, one must bear in mind that this episode was *not* merely an *intellectual* affair. Besides the scientific, astronomical, physical, cosmological, epistemological, methodological, theological, hermeneutical, and philosophical issues, and besides the arguments pro and con, there were legal, political, social, economic, personal, and psychological factors involved. To be sure, it would be a mistake to concentrate on these external issues, or even to devote to them equal attention in comparison with the intellectual issues, for the latter constitute the heart of the episode, and so they must have priority. Nevertheless, it would be equally a mistake to neglect the external, or non-intellectual, factors altogether.

Non-intellectual Factors

Beginning with personal or psychological factors, it is easy to see that Galileo had a penchant for controversy, was a master of wit and sarcasm, and wrote with unsurpassed eloquence. Interacting with each other and with his scientific and philosophical virtues, these qualities resulted in his making many enemies and getting involved in many other bitter disputes besides the main one that concerns us here. Typically, these disputes involved questions of priority of invention or discovery, and fundamental disagreements about the occurrence and interpretation of various natural phenomena.

The politics of Galileo's trial has to be understood in the context of the Catholic Counter-Reformation. Martin Luther had started the Protestant Reformation in 1517, and the Catholic Church had convened the Council of Trent in 1545-63. So Galileo's troubles developed and climaxed during a time of violent struggle between Catholics and Protestants. Since he was a Catholic living in a Catholic country, it was also a period when the decisions of that council were being taken seriously and implemented and thus affected him directly. Aside from the question of papal authority, one main issue dividing the two camps was the interpretation of the Bible–both how specific passages were to be interpreted and who was entitled to do the interpreting. The Protestants were inclined toward relatively novel and individualistic or pluralistic interpretations, whereas the Catholics were committed to relatively traditional interpretations by the appropriate authorities.

More specifically, the climax of the trial in 1632-3 took place during the so-called Thirty Years War (1618-48) between Catholics and Protestants. At that particular juncture, Pope Urban VIII, who had earlier been an admirer and supporter of Galileo, was in an especially vulnerable position; thus, not only could he not continue to protect Galileo, but he used Galileo as a scapegoat to reassert, exhibit, and test his authority and power. The problem stemmed from the fact that in 1632 the Catholic side led by the King of Spain and the Bohemian Holy Roman Emperor was disastrously losing the war to the Protestant side led by the King of Sweden, Gustavus Adolphus. Religion was not the only issue in the war, which was being fought also over dynastic rights and territorial disputes. In fact, ever since his election in 1623, the pope's policy had been motivated primarily by political considerations, such as his wish to limit and balance the power of the Hapsburg dynasty which ruled Spain and the Holy Roman Empire.

Just as the political background of the affair involved primarily matters of religious politics, so

the legal background involved essentially questions of ecclesiastical, or "canon," law. In Catholic countries, the activities of intellectuals like Galileo were subject to the jurisdiction of the Congregation of the Index and the Congregation of the Holy Office, or Inquisition.

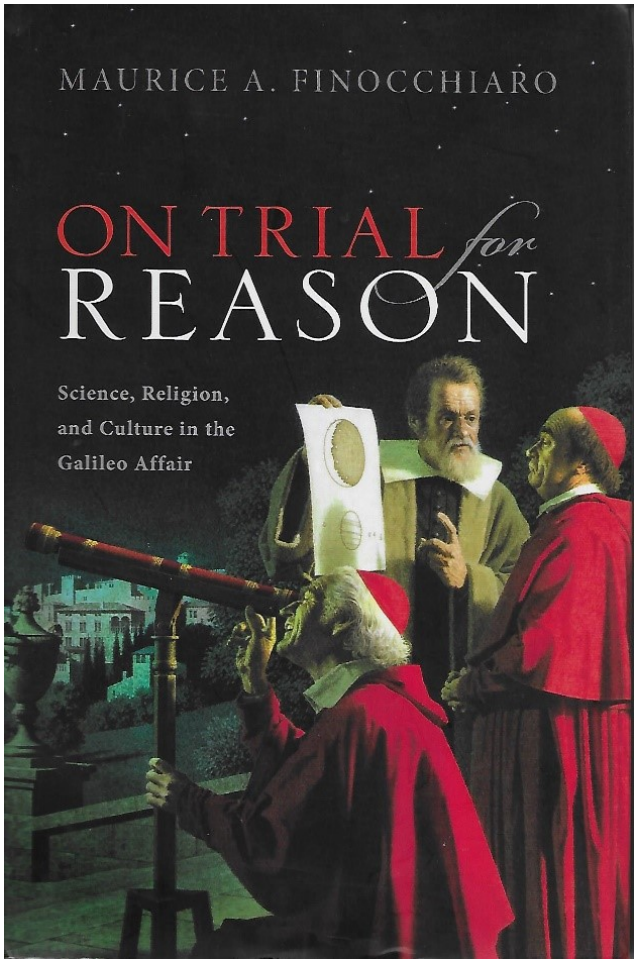
Although the Inquisition dealt with other offences such as witchcraft, it was primarily interested in two main categories of crimes: formal heresy and suspicion of heresy. The term suspicion in this context did not have the modern legal connotation pertaining to allegation and contrasting it to proof. One difference between formal heresy and suspicion of heresy was the seriousness of the offence. Another was whether the culprit, having confessed the incriminating facts, admitted having an evil intention.

Conclusion

To summarise, the cultural legacy of Galileo in science, religion, and philosophy can be effectively elaborated by focusing on his trial (its background, proceedings, aftermath, and significance) and by stressing the intellectual developments and issues. However, a balanced approach must be followed, by avoiding the two opposite extremes exemplified by the anti-Galilean and anti-clerical myths, and by not completely overlooking the non-intellectual factors. There is no easy way of doing this, but it is helpful to distinguish scientific from epistemological (or methodological) issues, factual correctness from rational correctness, essential correctness from total correctness, the several epistemological issues from each other, intellectual from external factors, and the several external factors (personal-psychological, social, economic, political, and legal) from each other. However, these distinct aspects are also interrelated, so the point is not to deny their interaction, but to make sure they are not confused or conflated with one another.

The above argument is extracted from Chapter One of:

Finocchiaro, M.A.: 2019, *On Trial for Reason: Science, Religion and Culture in the Galileo Affair*, Oxford University Press, Oxford.



The argument is also elaborated in:

Finocchiaro, M.A.: 1980, *Galileo and the Art of Reasoning: Rhetorical Foundations of Logic and Scientific Method*, Reidel, Dordrecht

Finocchiaro, M.A.: 1989, *The Galileo Affair: A Documentary History*, University of California Press, Berkeley.

Finocchiaro, M.A.: 2005, *Retrying Galileo: 1633-1992*, University of California Press, Berkeley.

Finocchiaro, M.A.: 2010, *Defending Copernicus and Galileo: Critical Reasoning in the Two Affairs*, Springer, Dordrecht.