Draft

What Peirce Saw in Galileo

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On 6 December 1891, Peirce found a letter from August Lowell asking him to deliver a series of 12 lectures on the history of science at the Lowell Institute in the autumn of 1892. He accepted with alacrity because the subject fascinated him but also because it came at a time when his finances were in some disarray. Here is how he put it to Lowell: "I lately reported on a chemical process for a man in Wall Street who was to pay me $500 cash and a share in the patents. He duly gave me a check and the bank returned it as "no good"; so that when you send me the remittance you so kindly offered, it will be most convenient" (Carolyn Eisele (ed.), *Historical Perspectives on Peirce's Logic of Science.* Berlin: Mouton. 1985, p. 142, from a letter dated 20 September 1892).

I should also point out that there was more to this than a check that bounced. Peirce had been appointed to the U.S. Coast (and Geodetic) Survey in 1859, and in 1891 he was asked to resign by the new Superintendent, T.C. Mendenhall. Peirce's letter of resignation is dated 1 October 1891, and the invitation to lecture at the Lowell Institute arrived, most appropriately, at the beginning of December. His resignation was to take effect on 31 December. He was 52 years old.

The outline that Peirce submitted for his lectures was as follows:

Peirce also hoped to make room for "Huygens, Boyle and other great names . . . by compression" (p. 141). But Peirce was hardly a master at compression, and in the case of Galileo he went the other way and expanded his plan to give not one but two lectures.

Peirce's course was successful and attracted attention. So much so that he was offered a contract by James McKeen Cattell, the Editor of the Science series at Putnam's, which he duly signed in 1896, but his commitment was never realized.

From the material that has survived, it would seem that, in the end, Peirce delivered the following twelve lectures in 1893:

Lecture I and II	:	Early History of Science
Lecture III and IV	:	Egyptian Science
Lecture V	:	Chaldean and Greek Astronomy
Lecture VI	:	Pythagoras
Lecture VII	:	Missing
Lecture VIII	:	Archimedes
Lecture IX	:	Post-Hellenic to the Fifteenth Century
Lecture X	:	Copernicus
Lecture XI	:	Galileo Part I
Lecture XII	:	Galileo Part II

"Galileo was not content to be pooh-poohed and snubbed. He knew he was right, and he was determined to make everyone see the facts as he saw them. So one morning before the assembled University, he ascended the famous Leaning Tower, taking with him a 100 lb shot and a 1 lb shot. He balanced them on the edge of the tower, and let them drop together. Together they fell and together they struck the ground.

The simultaneous clang of these weights sounded the death-knell of the old system, and heralded the birth of the new.

But was the change sudden? Were his opponents convinced? Not a jot. Though they had seen with their eyes, and heard with their ears, the full light of heaven shining upon them, they went back muttering and discontented to their musty old volumes . . . We need scarcely blame these men; at least we need not blame them overmuch. To say that they acted as they did is to say that they were human, were narrow-minded, and were apostles of a lost cause . . . Conduct which was excusable then would be unpardonable now, in the light of all this experience to guide us. Are there any now who practically repeat their error and resist new truth? Who cling to any old anchorage of dogma, and refuse to rise with the tide of advancing knowledge? There may be some even now" (Oliver Lodge, *Pioneers of Science* (1893). Reprint New York: Dover, 1960, pp. 90-92).

Lodge's book was reviewed, not very favourably, by Peirce in *The Nation*, and I shall only quote the first lines: "This is a very handsome volume, printed upon the heaviest calendered paper, full of attractive cuts, written in an easy style, dealing

This is, of course, excessive and Peirce is rarely so jingoist, but it is a reminder of how deeply entrenched was the positivism of the age, and how glorious the steam engine appeared. It was difficult to rise above popular conception of science as

an inevitably triumphant march towards progress. Why as late as 1936 in a book (reissued in 1957), a Harvard historian of science, George Sarton, could still characterize science unequivocally and *more geometrico* :

"Definition: Science is systematized positive knowledge or what has been taken as such at different ages and in different places.

Theorem: The acquisition and sytematization of positive knowledge are the only human activities which are truly cumulative and progressive.

Corollary: The history of science is the only history which can illustrate the progress of mankind. In fact, progress has no definite and unquestionable meaning in fields other than the field of science" (George Sarton, *The Study of the History of Science* Cambridge, MA: Harvard University Press, 1936, p. 5).

What did Peirce see when he looked at Galileo? Well, first of all, where did he look? He does not seem to have been aware of the remarkable edition of Galileo's works, the *Edizione Nazionale delle Opere di Galileo Galilei*, that Antonio Favaro had begun editing in 1890, and he relied on secondary sources. He did not read Galileo's *Dialogue on the Two Chief World Systems* or the *Two New Sciences* with the care he took with Kepler's *Commentaries on the Motions of the Planet Mars*. His summary of Galileo's life is based on popular accounts, and his personal appraisal of

Galileo the Astronomer

In spite of his praise for Galileo's contribution to the dissemination of the heliocentric theory, Peirce wanted his hearers to know that "the truth of the Coppernican system did not follow as a necessary consequence of his telescopic discoveries" (p. 267).

Let us briefly remind ourselves of what these discoveries were.

1. There are mountains on the Moon.
2. The stars are innumerable.
3. The Milky Way is made or starlets.
4. The planets appear as perfectly round globes.
5. The planets are stripped of their sparkling rays.
6. Jupiter has four satellites.
7. Venus has phases similar to those of the Moon.
8. The sun is covered with spots.
9. Saturn has two satellites.

With the exception of the seventh, erroneous claim that Saturn has satellites (Galileo was observing the rings of Saturn when they are tilted in such a way that they can be mistaken at both ends), these discoveries are momentous and won Galileo the applause of Rome where he was received triumphantly in May 1611. In a letter to Cosimo II, the Granduke of Tuscany, Cardinal Francesco del Monte reasoned. On the other hand, I am equally satisfied that men often think they have acted from reason, and will tell themselves what their reasoning was, when they have not reasoned at all, their fancied process having been all made up afterward" (**The Proper Treatment of Hypotheses**, in Eisele, pp. 890-891).

Most of you here are familiar with Peirce's fascinating treatment of the ways and byways that the human mind uses to arrive at some idea of what the world is all about. This process of reasoning is called **abduction**, and Peirce describes it in particulary clear and vivid way in ***The Proper Treatment of Hypotheses*** from which I have already quoted: "Abduction is that kind of operation which suggests a statement is in no wise contained in the data from which it sets out. There is a more familiar name for it than abduction; for it is neither more nor less than guessing. A given object presents an extraordinary combination of characters of which we should like to have an explanation. That there is any explanation of them is a pure assumption; and if there be, it is some one hidden fact which explains them; while there are, perhaps, a million other possible ways of explaining them, if they were not all unfortunately, false. A man is found in the streets of New York stabbed in the back. The chief of police might open a directory and put his finger on any name and guess that that is the name of the murderer. How much would such a guess be worth? But the number of names in the directory does not approach the multitude of possible laws of attraction which would have accounted for Kepler's laws of planetary motion, and, in advance of verification by predications of perturbations etc., would have accounted for them to perfection. Newton, you will say, assumed that the law would be a simple one. But what was that but piling guess on guess?

I see. The truth is that the whole fabric of our knowledge is one matted felt of pure hypothesis confirmed and refined by induction. Not the smallest advance can be made in knowledge beyond the stage of vacant staring, without making an abduction at every step.

When a chicken first emerges from the shell, it does not try fifty random ways of appeasing its hunger, but within five minutes is picking up food, choosing as it picks, and picking what it aims to pick. That is not reasoning, because (it is not done deliberately; but in every respect but that), it is just like abductive inference. In man, two broad instincts common to all animals, the instinct for getting food, and the instinct for reproduction, are developed into some degree of rational insight into nature. The instincts connected with getting food require that every animal should have some just ideas of the action of mechanical forces. In man these ideas become abstract and general. **Archimedes and Galileo make right guesses about mechanics almost at once.** Only a few of their notions have to be rejected, because they know how to do their guessing piecemeal and in an orderly sequence. Out of their guesses, corrected by induction and deduction, the science of dynamics has been built. Guided by the ideas of dynamics, physicists have guessed at the constitution of gases, the nature of heat and of sound, and experiment has only corrected errors and measured quantities. By analogous processes, one science suggesting ideas for another, the whole physical side of our theoretical knowledge has grown up out of the original seed of the food-instincts" (*ibid.,* in Eisele, pp. 898-900).

If science is guess-work, it is not only guess-work. To use a latter characterization, we could say that it is a matter of conjecture and refutation. Peirce

A NOTE ON "LIGHT OF NATURE"

In his first lecture on Galileo, Peirce notes that Galileo "*appeals to the Light of Nature*" which he assumes is a way of saying that "we are, as it were, led by the hand, by observing the usual method and procedure of Nature herself, in all her other operations wherein she commonly makes use of the first, simplest, and easiest means" (Eisele, p. 275).

In an undated manuscript that is posterior to 1893, he comments, "It is wonderful how often the light of nature has led men to good theories in physics. Galileo's works affords several striking examples of this" (Eisele, p. 905).

This is how Peirce sees the Light of Nature at work in Galileo's case:

1. Galileo remarks that a falling body moves faster and faster
2. He ask, Why?
3. He **guesses** that the speed is proportional to the distance. "A little reasoning showed him" that this would lead to a result which ordinary experience refutes.
4. The **first guess** having been disproved, Galileo next proceeds **to guess** that the velocity of a ball rolling down an inclined plane was proportional to the time elapsed since it started. "This **guess** was really correct".

Instances of Abduction

1) Kepler's discovery of the elliptical path of the planets.

2) Mendelev's Periodic Table.

3) Peirce's hypothesis that the assertion of Jamblicus that Pythagoras was taken prisoner by the Persians under Cambyse is really due to the fact that he had been taken prisoner by the Perseans under Cyrus.

4) Peirce's hypothesis that the first three Egyptian dynasties were not mythical.

5) Peirce's hypothesis that Basil Valentine did not exist.

6) Peirce's hypothesis that the Babylonian were practising astronomy is early as 2 300 B.C.