**Liceo Linguistico e delle Scienze Umane Leonardo da Vinci di Alba**

# LECTURE and Text by Prof. Paolo Genta, 2011

## About Research and Discovery in the science of Galileo Galilei*

We all know from the books who Galileo Galilei was and why he is deemed as the most important figure of modern science revolution. He established the criteria for "doing science" and grounded close relationship between mathematical thinking, physical observation, measurement, search for proofs confirming hypotheses and data controlling. He showed how physics, as basic model of the new anti-aristotelic science, could properly work in a much more effective and predictable way than the older natural philosophy.
Ever since science had been grounded by Galileo's work and method it grew as the unique form of universal knowledge, able to provide a mathematical representation of reality: nature is a form of order structured by causal relations and laws that can be sought, proven and displayed in form of mathematical models (formulas and equations). This is still for us, modern citizens and laymen of the globalized world of the XXIst century, ***THE model of science***: it grounds on rationalism, calculation, proofs collection and, above all, it provides at the end of the enquiring process, as an ***applied science***, ***industrial technology*** as the most relevant and expected outcome of ***pure research*** enterprise. Galileo made it very clear by himself when he wrote in "The Assayer" (Il Saggiatore): "***Philosophy is written in this grand book, the universe ... It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures***".
The battle of Galileo for defending the new natural philosophy was also the battle for rejecting the old-fashioned way to seeking knowledge about nature by still adopting the perspective of a qualitative and not quantity-based approach: Aristotle and his philosophy of quality were no longer amenable to be used for describing the physical world. Raw mathematical data had to be now the only starting point for accessing the laws of nature itself, and not surely metaphysical hypotheses about spirits, quality of substance, essence, psychical forces inside the objects, finalism and physical movement caused ***for God's sake*** and ***surge*** of love.



Yet we also have to consider that science, and this model of science particularly, do not base in a simplified way on itself alone: science generates itself even from non-scientific contexts. Science is not rarely a matter of relationship with power, of discovering by accident and not on purpose, of emotional attitude of the researchers, often ***defying*** each other in a desperate ***struggle*** for being the first, of living within a "scientific" community and finally of maintaining a degree of academic dignity and pride into that scientific community itself.

So Galileo, for instance, tried hard, very hard, convincing the authorities that the picture of the moon as it could be seen from the telescope for the very first time, was really real and not the outcome of optical aberration or reflections, of ***blurred*** air layers in the atmosphere, of disturbances caused by the medium itself, the telescope.
He swore that the pictures were real: he had to make use of strategic thinking by ***coaxing*** and convincing bishops and ***clergymen*** of the catholic church, the most authoritarian power on earth, that a new perception had been making possible by placing a telescope between naked eyes and physical objects. ***Paul Feyerabend (1924-1994)***, a well famous epistemologist of the UC Berkeley in his "***Against Method: Outline of an anarchistic Theory of Knowledge***" (1975), dedicated a large part of his book discussing the problems of Galileo's perception in the ***context of discovering*** the surface of the moon and Jupiter's satellites. Humans, at that time, were not accustomed to perceive reality through a telescope. What they had not been trained to doing or simply did not even suspect could exist, this wouldn't be worth to be seen and wasn't! They were as blind to the telescope exactly as Aztecs had been blind to the Spanish knights riding their horses a century before: Aztecs believed horses and men were one single ***ghastly*** creature and ***fled in awe and scare*** paralyzed by the vision!
Science is made not only by "mathematical method" but also by things like: intuition, ***serendipity*** (finding solutions by accident and not on purpose), fantasy and ability to ***override the boundaries of time and space***, stubborn struggling for academic primacy, ***incommensurability*** between research programs. A unique ruling method of science – Feyerabend says - does not exist: science is far more a matter of ***anarchism*** and non-rational thinking than we could ever think. Science bases on Feyerabend's well famous claim: ***Anything goes!***

***Galileo Galilei (1564-1642)** Born in Pisa. Physicist, mathematician, astronomer and philosopher, he played a major role in the Scientific Revolution. His achievements include improvements to the telescope and consequent astronomical observations of planet Jupiter, the Moon and many satellites, and the support for Copernicanism as well. Galileo has been called the "father of modern observational astronomy" the "father of modern physics" and "the Father of Modern Science". He supported the heliocentric thesis, which placed the Sun at the center of the universe; yet he was stopped with bitter opposition by some philosophers and clerics, and got denounced to the Roman Inquisition early in 1615. In February 1616, although he had been cleared of any offence, the Catholic Church nevertheless condemned heliocentrism as "false and contrary to the Holy Scripture". Galileo was condemned to house arrest in Arcetri, where he spent the last years of his life in bitter sadness and contrition for having remained unrecognized.

**Notes for the Lecture**

**Thomas Kuhn** (1922-1996),
**Imre Lakatos** (1922-1974),
**Paul Feyerabend** (1924-1994 "**post-positivistic Epistemology**". Galileo's experience not only showed how physics, as the model of new anti-aristotelic science, worked with its method.

Science as Galileo understood it still holds: it is made by hypothesis, facts and experiments, mathematical modeling, search for proofs and contradiction of wrong hypotheses, final theory supported by plenty of research data, and so on: what we have to focus on is instead how really it works effectively within the scientific community.

- Incommensurability (Lakatos)
- Context of discovery VS justification
- Epistemological leap - EPISTEMOLOGYCAL BREAKINGS
- SERENDIPITY: EX. CHIMPS AND POTATOES-EINSTEIN GOING STROLLING-PLAYING PURPOSELESS
- COUNTER-INDUCTION(INDUCTIVELY)
- FREE LIBERTY OF RESEARCHING, BEYOND ANY FIXED CANONICAL PRECONDITION FOR SCIENCE!
- FACTS ARE NOT "NAKED": THEY ARE VIEWED WITHIN A CONTEXT: SOCIAL, POLITICAL, BIOLOGICAL, MENTAL AND CULTURAL FRAMES.
- OUR SCIENCE IS JUST ONE OF THE MANY POSSIBLE ONES: IT SUCCEEDED BY CHANCE over other sciences….

Galileo: His mathematical analyses are a further development of a tradition employed by late scholastic natural philosophers, which Galileo learned when he studied philosophy. Although **he tried to remain loyal to the Catholic Church**, his adherence to experimental results, and their most honest interpretation, led to a rejection of blind allegiance to authority, both philosophical and religious, in matters of science. In broader terms, this aided the separation of science from both philosophy and religion; a major development in human thought. By the standards of his time, Galileo was often willing to change his views in accordance with observation. In order to perform his experiments, Galileo had to set up standards of length and time, so that measurements made on different days and in different laboratories could be compared in a reproducible fashion. This provided a reliable foundation on which to confirm mathematical laws using inductive reasoning. **Feyerabend yet says: ANYTHING GOES!**

Science is an essentially anarchistic enterprise: theoretical anarchism is more humanitarian and more likely to encourage progress than its law-and-order alternatives.

The consistency condition which demands that new hypotheses agree with accepted *theories* is unreasonable because it preserves the older theory, and not the better theory. Hypotheses contradicting well-confirmed theories give us evidence that cannot be obtained in any other way. Proliferation of theories is beneficial for science, while uniformity impairs its critical power. Uniformity also endangers the free development of the individual.