

The Scientific Method

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Students of the natural sciences are traditionally trained to make sense of various experimental data organized into some collective body of hypotheses that lead to what we then call theories. The students therefore learn *what* the sciences have achieved with regard to our understanding of the natural world. They are less exposed to *how* that scientific knowledge has been collected, analyzed, discussed, and finally accepted - albeit always temporarily - by the scientific community. The *modus operandi* of scientists, in other words the application of the *scientific method* - with all its strengths and rules of engagement - is rarely taught in the classroom.

This series of lectures – open to both undergraduate and graduate students of all natural sciences – attempts to fill this educational gap. After a brief history of the scientific method, the lectures will address fundamental concepts such as objective reality versus approximate description of natural phenomena; the role of the observer; the difference between principles, axioms, hypothesis and theory, and what makes the latter falsifiable; the “absence of democracy” in the pursuit of scientific truths, and the fundamental role of experimental evidence in scientific knowledge. Several examples, taken from well-known and easy-to-follow scientific facts, will be used to elucidate the above concepts. The lectures will be structured around open discussions with active students’ participation to stimulate critical thinking.

Course Outline

1. Objective reality, first principles and logic
2. The objective of the scientific method
3. Science and metaphysics
4. Mathematics: the language of science
5. Some examples from the history of science
6. Axioms, principles, hypotheses
7. Theories of objective realities

8. Validity of theories, predictions, falsifiability
9. Distinguishing between different theories
10. Science in the news

Suggested reading:

Pierre Duhem, *Essays in the history and philosophy of science* (Hackett Pub. Co. 1996)

Thomas Kuhn, *The structure of scientific revolutions*, (U. Chicago Press, 1962)

Samir Okasha, *Philosophy of science: a very short introduction* (Oxford U. Press, 2002)

Karl Popper, *The logic of scientific discovery* (Routledge, 1959)