Cosimo De Giorgi and the development of natural sciences in the South of Italy

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Abstract: Though the development of natural sciences, and in particular of modern physics, is usually associated with the use of refined mathematical methods, a rigorous scientific knowledge has been sometimes obtained through rather qualitative and empirical approaches instead of purely quantitative methods based on mathematical formalism. Actually, mathematical developments not yet existent have been driven sometimes through qualitative and intuitive approaches based on empirical data and historical series. As examples of this scientific methodology, I will discuss two figures of physicists, Michael Faraday (1791-1867) and Cosimo De Giorgi (1842-1922): the one (Faraday) at the hearth and the other (De Giorgi) at the southern periphery of Europe. Though with largely different scientific relevance and impact, they were both characterized by a qualitative, descriptive and intuitive scientific approach in front of the prevailing mathematization of physics. In particular, Faraday anticipated new mathematical methods, especially geometrical and topological. Similarly, De Giorgi, a brilliant geophysicist, used new statistical methods for the treatment of large empirical, meteorological and seismic databases.

Keywords: Cosimo De Giorgi, Michael Faraday, Phenomenological approach to natural sciences in ’800 and early ’900

1. Introduction

Notwithstanding the general acceptance of Galilei’s viewpoint in the tradition of modern science, we cannot say that modern science has been realized, without exception, by accepting such point of view which denies that scientific rigor can be also achieved without making recourse to instruments and methods proper to mathematics (Galilei 1998, pp. 220-227). A qualitative approach, instead of a totally mathematical quantitative one, could even in fact sometimes turn out more fertile. This naturalistic approach, though non-quantitatively orientated, can then succeed in enriching scientific explanation by inferences, analogies and metaphors to substitute mathematical formalisms with data bases and historical series connecting one another, even anticipating mathematical developments, though in still qualitative form (Truesdell 1968, pp. 175-183).

By the way, let us consider two different scientists, belonging to different traditions but both active in Europe: Michael Faraday (1791-1867) in Great Britain and Cosimo

De Giorgi (1842-1922) in Italy in the middle of the XIX Century, to be true the one more in the first and the other more in the second half. Both endowed with a strong orientation towards the practical use of science for the welfare of humanity, they were still also fond of the pure discovery of natural truths through the untiring reading of natural phenomena as fundamental inspirer of science besides every risk of hypostatization and dogmatism of scientific knowledge.

2. Michael Faraday

Let us start from the first example, certainly better known, as initiator of the electromagnetic field theory on rather phenomenological-qualitative and dynamical-relational than mathematical-quantitative bases. Yet he succeeded in anticipating, though in qualitative rather than quantitative forms, the following mathematical conception of field theory (Truesdell 1968, pp. 179-182). In fact, Faraday considered a true mistake the mathematicians' claim to anticipate facts through pure mathematical abstraction, identified with physical reality with regard to experiment and empirical generalization.

Substantially, Faraday put the experiment before and higher than mathematics, due to the scientific experimental style he had learned from his teacher Humphry Davy. This one in particular pushed him to always accept the verdict of experience, against rationalistic pretension to know nature by a purely intellectual and formal, mathematical way in front of concrete experience: theoretical, especially mathematical, anticipations could easily risk to fail in front of experimental new and independent facts. Faraday was sure of that, believing that he could develop a theory of electromagnetic induction alternative to Ampère's more mathematical though physically equivalent generally accepted (Gooding 1992, pp. 121-122; De Frenza 2002, pp. 249-275).

According to some critics, Faraday did not understand this equivalence just for he was an anti-mathematician ignorant of mathematics, but this charge was considered by the main follower of Faraday's work and of his field theory, J.C. Maxwell, unjustified (Gooding 1992, pp. 123-124). He instead considered Faraday a first class mathematician, whose mathematical work would turn out in the future extremely fertile. Anyway we are in front of a great physicist who, though he preferred to express himself in a physical-qualitative language rather than in a quantitative one, was endowed with a special mathematical intuition of not too formal geometric-topological kind, which led him almost infallibly in the new research fields, in particular the one which would be named classical electromagnetism (Gooding 1992, pp. 125-130).

3. Cosimo De Giorgi

Well, Faraday was not unique in his time, even if he was the most significant physicist and naturalist who preferred to represent physical phenomena, to comprehend and apply them, without recourse to pure mathematical-formal treatment. As hinted at before, at least another scientist nearer to us historically and culturally, Cosimo De Giorgi, significantly assumed similar attitudes, notwithstanding the historical and cultural differences between them and, definitively, between Faraday's England and De Giorgi's Italy of the second half of the XIX Century. In both cases we are in front of two physicists and naturalists, Faraday chemist and electrician (Williams 1965, pp. 1-531) and De Giorgi meteorologist and seismologist (Ruggiero 2003a, pp. 9-19), both given to the welfare of the humanity also through the applications of scientific knowledge on the base of a strong ethical sense. In the case of Faraday, this was inspired by a strong religious feeling as he was a very devout follower of the Christian Protestant Sandemanian Church (Williams 1965, pp. 1-531). De Giorgi, though a sincere believer, preferred to profess his faith, of which he anyway valued the ethical implications in general, as a private fact not to be confused with ethical implications, as he was less interested in interpretative theoretical developments of philosophical and religious doctrines in general (Galante 1989, pp. 9-57).

Anyway, if Faraday, also ethically inspired, in particular applied his innovative theories and knowledge to the ideation of such useful electromagnetic devices as electric motor, dynamo, transformer and the devices for electrolytic dissociation of chemical substances also of practical interest (Williams 1965, pp. 1-531), De Giorgi conceived a new seismograph to relieve earthquakes, of remarkable efficiency. De Giorgi, in fact was never a pure theoretician (De Simone 2012, pp. 249-258). Definitively, for him scientific research implied the use of mathematics and the mathematical treatment of data according to the typical procedures of his time, essentially as instruments and methods of enquiry, without thinking of submitting those methods, as means of collection and application of data, to independent inquiries. Then, neither as pure object of study to develop current mathematical theories and formulations in agreement with the historical tradition of mathematics apart from applications Nor, as in Faraday, as new and diverse theoretical elaborations, not drawn from pre-existent mathematical tradition, rather from the demand of developing new great scientific applications, which were, particularly for Faraday, electromagnetic and chemical, neither soon recognized nor immediately developed as new mathematics (Truesdell 1968, pp. 179-182).

All that cannot be found in De Giorgi, rather limiting himself to instrumentally use already accepted mathematical resources of consolidated use.

For De Giorgi, it was about to acquire the widest deal of empirical data and historical series, to draw consequences of statistical kind, to solve in particular, as a physician like he was, health, climate and prevention problems, also collecting thermopluviometric and seismic historical series, and also referring to measures suitable to check phenomena and to realize build solutions to reduce seismic damages (Ruggiero 2003b, pp. 11-24).

This De Giorgi's approach to phenomena links up to his attention also to archeology, as shown by his discovery of Lecce's Roman amphitheater, deeply buried at the center of the town. In fact, neither this discovery can be reduced to a mere collection of quantitative data nor to a simple description of manufacts, as it also corresponded to qualitative aspects, in particular historical-aesthetic of finds, irreducible to mere quantitative measures (Ruggiero 2003a, pp. 9-19). Then we also owe De Giorgi precious collections of drawings, both his own and of other people's of buildings and environments, tense to value qualitative aspects, anyway revealing an order and a "cleanliness" (De

Giorgi 1989). Anyway here we find still another convergence with Faraday's quality of the work, tense to catch more qualitative than quantitative, substantially more geometric-topological than analytic and abstract aspects of his objects of study (Williams 1965, pp. 1-531). This value enhancement of geometric-topological forms in the study of phenomena, on the other side, meets another element common to both scientists, and of great importance in their work, though not directly implied in their scientific research activity, even if it was important and moreover functional to the enhancement and development of the same research. It is about their strong engagement in scientific popularization, where the iconic and intuitive, geometric-topological aspect is very relevant as a popularization means, instead of more abstract formal developments.

Then Faraday, as President of the Royal Institution of London (Jones 1871), organized public meetings of scientific popularization with the participation of people belonging to the most varied social classes on varied physical and natural arguments, with an expositive approach based on experimentation and, in short, on the direct view of phenomena and then on geometric-topological aspects. Nonetheless, De Giorgi dedicated part of his time free from research proper to the explication of the results of the same research through concrete descriptions of the arguments dealt with and explained to the people, in particular with reference to meteorology whose popularization implied descriptions and visual representations, to be also hosted, as natural and technical exhibits, in science museums and collections. Another strong testimony of the importance of visual popularization and of the teaching of science more in general is also represented by De Giorgi's engagement in preparing the natural science cabinet of the new Lecce Technical Institute dedicated to the Salentine naturalist O. G. Costa, which was in fact a true museum of naturalistic finds, even containing a plentiful collection of fossils (Rossi, Ruggiero 2000, pp. 5-8).

Certainly, De Giorgi's approach, like Faraday's, to science had a polyhedric and eclectic character as it turned the overall attention to various naturalistic and technological sectors. It did not stop at the most abstract research and at pure mathematics but, of course with different resources and scientific applications due to differences, more in general, of means and availabilities between the two countries where the two scientists worked. In particular, there was a disproportion between the role as a protagonist exerted by the English science on the industrial development, going from the "thermodynamic" phase of the steam engine to the "electrotechnical" one of the electric motor, of which Faraday was primary actor, and De Giorgi's Italy just unified, a country endowed with great even scientific traditions, but then certainly backward, as devoid of an educational and technological structure comparable to the English and German ones (Baracca, Ruffo, Russo 1979). Anyway it could obtain valuable results even inside the historical limitations of the south of Italy. In any case, we can say that, at variance with other scientists of their time, they succeeded in obtaining those results without engaging at the level of mathematical languages then officially recognized. In case, De Giorgi engaged on the most immediate use of those languages, in particular statistics and traditional geometry, without innovating them, as his scientific aim was different. Faraday instead preferred to innovate the mathematical language in original ways, but his innovations were not yet considered, as they were considered afterwards, as contributions to the mathematical language itself, rather as a development of more intuitive geometric-topological particular sectors. In any case, in more (Faraday) or less (De Giorgi) creative way, mathematics was for both rather an instrument of deepening and comparison with nature and applications than an end to itself.

References

Baracca A., Ruffo S., Russo A. (1979). *Scienza e industria 1848-1915*. Roma-Bari: Laterza.

De Frenza L. (2002). "Le ricerche di Faraday sull'induzione elettrostatica: un confronto a più voci". *Physis*, XXXIX, pp. 249-275.

De Giorgi C. (1989). *La provincia di Lecce. Disegni illustrativi*. Galatina: Congedo.

De Simone E. (2012). *Il sismografo di De Giorgi*, in De Simone E., Ruggiero L., Spedicato M. (a cura di), *Adversis obfirmor. Cosimo De Giorgi tra riletture e nuove scoperte*. Galatina: Edizioni Panico.

Galante L. (1989). *Un intellettuale 'moderato' tra eredità risorgimentali e nuova cultura scientifica*, in De Giorgi C., *La provincia di Lecce. Disegni illustrativi*. Galatina: Congedo.

Galilei G. (1998). *Dialogo sopra i due massimi sistemi del mondo tolemaico e copernicano.* Padova: Antenore.

Gooding D. (1992). "Mathematics and methods in Faraday's experiments". *Physis*, XXIX, pp. 121-147.

Jones H.B. (1871). *The Royal Institution. Its Founders and Its First Professors*. London: Longmans, Green and Co.

Rossi A., Ruggiero L. (2002): *Collezioni scientifiche a Lecce. Memorie dimenticate di un'intensa stagione culturale*. Lecce: Edizioni del Grifo.

Ruggiero L. (2003a). *Cosimo De Giorgi: l'uomo, lo scienziato*, in De Simone E., Ingrosso L. (a cura di), *Epistolario di Cosimo De Giorgi*. Galatina: Edizioni Panico.

Ruggiero L. (2003b). *Cosimo De Giorgi sismologo,* in Rosato G. (a cura di), *Scienza e humanitas in Cosimo De Giorgi*. Galatina: Edizioni Panico.

Truesdell C. (1968). *Essays in the history of mechanics*. Berlin: Springer.

Williams L.P. (1965). *Michael Faraday. A biography.* London: Chapman & Hall.