THE VOLT WHEN THERE WAS NO VOLT

Alessandro Volta's handling of the "force" of electricity and "unison" measurement of electrical tension

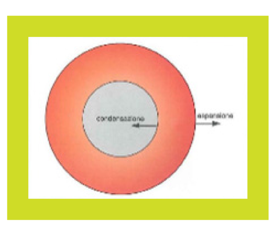
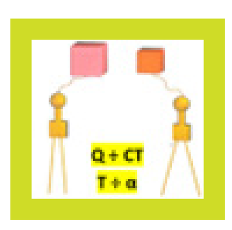
Lucio Fregonese | *lucio.fregonese@unipv.it*
Physics Department "A. Volta" and University History Museum | Pavia University

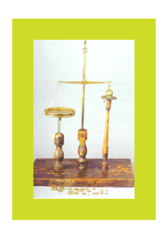
Alessandro Volta (1745-1827) is famous today because, among other things, his name appears in the denomination of the standard unit of potential difference, the **volt**, introduced in 1881 to acknowledge his pioneering efforts to establish consistent, comparable and standardized measurements of electrical "force", which he identified in the notion of **electrical tension (T)**.

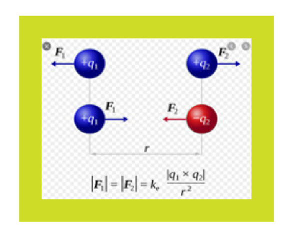
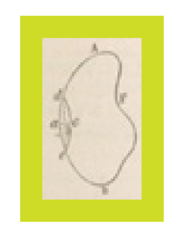
The research highlights the fact that such efforts took place when a commonly accepted **"standard model" was not yet available** to conceptualize electricity and its forces as well as the connections of both with the notions of matter and force as established in the different physical areas of mechanics and gravitation. The problem must then be correctly approached as an attempt to reconstruct the specific and still heterogeneous conceptual models and programs which Volta and his contemporaries elaborated to interpret electricity.

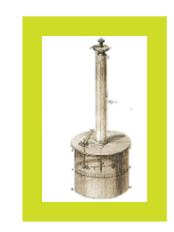
The investigation shows how Volta's wide and complex fundamental theory of electricity was dynamically interrelated not only with instruments and experiments but also with systematic metrological concerns and outputs, which he based on his key instrument, the **straw electrometer**, and on a law for tension **Q ÷ CT** (**Q** = quantity, **C** = capacity) which was to have a close formal analogue in the modern theory of electrostatic potential.

A similar four-level dynamic is identified in the important and nearly contemporary case of **Charles Augustin Coulomb** (1736-1806), although with very different components. Later powerfully developed in modern electrostatics, his alternative approach was at the moment still problematic and less influential due to mathematical difficulties, **erratic behaviour** of his key instrument, the **torsion balance**, and less systematic and applicable metrological concerns.

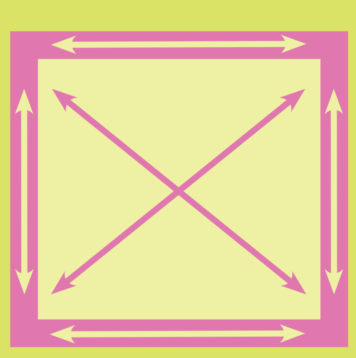








FUNDAMENTAL THEORY	1769 -1787 **Matter** | ponderable, electrically active, microstructure: particles made of point particles **Electrical fluid** | one, imponderable, no microstructure **Elastic "force"** | fluid-fluid action, producing expansive tension, relationship Q ÷ CT between quantity Q, tension T, capacity C of the electrified system **Attractive force** | matter-fluid elementary actions, producing fluid condensation and all known phenomena by summation of elementary contributions	1785-1788 **Matter** | ponderable, electrically inert, no microstructure **Electrical fluids** | two, imponderable, made of "elements" q_1, q_2 **Repulsive forces** | fluid x - fluid x elementary mechanical actions $f_{11} \div q_1q_1/r^2$, $f_{22} \div q_2q_2/r^2$, producing macroscopic repulsion F_R by summation of the elementary contributions **Attractive forces** | fluid x - fluid y elementary mechanical actions $f_{12} \div q_1q_2/r^2$, $f_{21} \div q_2q_1/r^2$, producing macroscopic attraction F_A by summation of the elementary contributions
INSTRUMENTS	**Straw electrometer** | linear relationship T ÷ α between tension T and angular separation α of the measuring index **Electrometric balance** | fixes reproducible unit of tension T	**Torsion balance** | measurement of macroscopic mechanical forces F produced by all the elements q_1- q_1 , q_2- q_2 , q_1- q_2 **Proof plane** | takes q ÷ local surface density **σ** of fluid, q is measured with the torsion balance
EXPERIMENTS	Many, consistent behaviour of straw electrometers	Many, erratic behaviour of the torsion balance as highlighted by contemporary reports and historical investigation
METROLOGY	Systematic concern, consistency (quantitative measurement of electrical tension with linear electrometers, referred to an absolute unit of tension T. In recognition, the volt was entitled to him in 1881)	Partial concern (but important connection electrical metrology - mechanical metrology), problematic status (erratic behavior of the torsion balance)



The analysis affords many possible applications: grounds for historical-conceptual clarification, parallels with contemporary physics (equally characterized by a fruitful interplay between fundamental physics, experimental physics, instrument design, metrology). Interesting applications can follow in many fields: physics education, physics communication, museum exhibitions and other applications, including the forthcoming bicentennial commemoration of Volta's death in 2027.

Bibliografia

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