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Giorgio Piccardi, pioneer of space weather

The relevance of his scientific legacy 50 years after his death. The “chemical test” can be assumed can be a reliable routine index of Sun-Earth relations.

Next year, 2022, will mark the 50 years of Giorgio Piccardi’s death (22 December 1972). This Italian scientist did original researches in the field of Sun-Earth relations with the method of “chemical test”, gaining international notoriety, above all in Russia, where the scientific discipline of Sun-Earth relations has been actively cultivated since the 1930s.

Piccardi was born in Florence on October 13, 1895. He graduated in Chemistry in 1921 from the Florence University, where he became Director of the Institute of Physical Chemistry (**fig. 1**).

The first part of Piccardi’s scientific life was devoted to at that time innovative researches: spectroscopy (especially for rare-earths), interphase and surface phenomena etc. In 1930s his interests took a new direction after observing the inexplicable variability of the results of some chemical reaction performed in aqueous medium under the same physical conditions (temperature, pressure, h but at different time. In order to ascertain that such a strange non-reproducibility had not to be attributed to experimental errors or to chance, Piccardi elaborated the concept of “fluctuating phenomena”, and from 1951 developed a specific “chemical test”.



Fig. 1 - Giorgio Piccardi (1895-1972)

The chemical test

Piccardi focused on the chemical reaction between a hydrochloric solution of bismuth (III) chloride and water, that produces the flocculation of insoluble bismuth oxychloride (basic bismuth chloride):

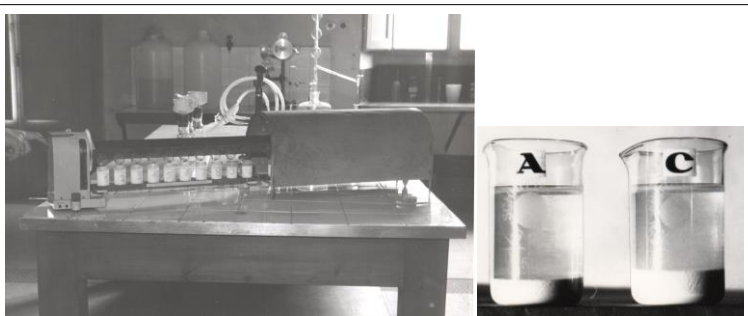


Fig. 2 - Execution of test P: the precipitation of BiOCl is carried out in 2 sets of 10 beakers each, one in open air and the other under a thin copper screen (see text for details).

Series of precipitations are simultaneously carried out in two different ways:

- modifying the chemical system; for example using “activated water”, obtained with agitation of a mercury ball in water (test F and test D);
- modifying the external (spatial) condition; for example using a thin copper screen that acts as a “Faraday cage” (test P) (**fig. 2**).

Referring for simplicity to the P test, a comparison is made between the precipitation rate of BiOCl simultaneously in 2 sets of 10 beakers each, one in open air and the other under a thin copper screen. The precipitation rate is measured comparing the sediment height in 10 couple of beakers of the two sets after a short time and the result is expressed as a percentage of 10 couples examined.

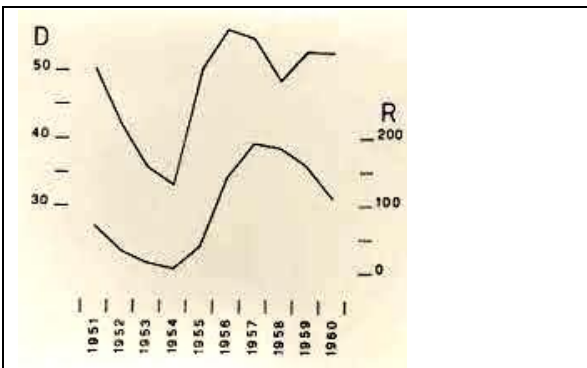


Fig. 3 - Example of correlation between chemical test results and solar activity from 1951 to 1960 (suggested by the parallelism of the two curves): D yearly results of test D (scale at the left); R yearly sunspot number (scale at the right).

The results of routine daily test carried out in Florence by Piccardi from 1951 to 1972 and at Université Libre de Bruxelles by Carmen Capel Boute (1914-2003) from 1956 to 1978 have been submitted to periodical analysis. They show a good correlation with periods of about 11 and 22 years (main sunspots cycles) and with seasonal and annual components (**fig. 3**).

Based on these results, a kind of Piccardi's law can be formulated: *heterogeneous systems out of equilibrium, if complex enough, will respond to any external signal, even of very low-energy level.* Inorganic colloids in evolution, in general, are complex enough to present this property, and colloids in living organisms even more. For such systems, reproducibility is nearly impossible because there is no way to isolate them completely from the rest of the Universe: they all behave thermodynamically as "open systems" that are influenced by external factors that fluctuate incessantly.

The adequate methodology for experimental research has to take time into account as an irreversible coordinate bound to the conditions in the surrounding space (atmospheric, corpuscular radiation cosmic rays etc.).

The "solar hypothesis"

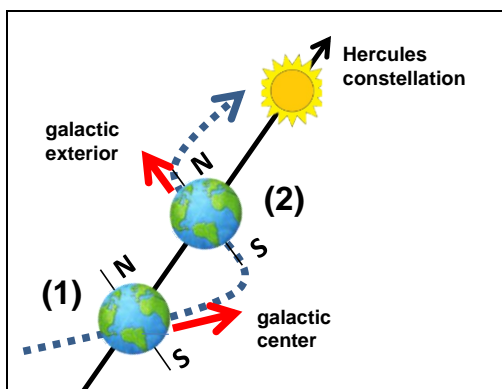


Fig. 4 "solar hypothesis": (1) around the spring equinox the Earth moves in its equatorial plane at the maximum speed (45 km/s) towards the galactic center; (2) around the fall equinox: the Earth moves with North Pole in front at the minimum speed (24 km/s) towards the galactic exterior.

We know that the Sun moves towards the constellation Hercules with a uniform and rectilinear motion (constant for us: 19-20 km/s) and that the Earth turns about the Sun at an approximate average speed of 30 km/s. From the combination of these two motions, one rectilinear and uniform, the other circular and roughly uniform, a helicoidal trajectory results. This is the helicoidal motion of the Earth in the Galaxy, referred to the neighboring stars. From this fact an elementary calculation or a simple graph (**fig. 4**) shows that:

- around the spring equinox (21 March) the Earth moves in its equatorial plane at the maximum speed (45 km/s) towards the galactic center;
- around the fall equinox (21 September) the Earth moves, if not along its axis, then in a direction not too far removed from that of the North Pole at the minimum speed (24 km/s) toward the galactic exterior.

The Earth is displaced with the Northern hemisphere leading, except during a small part of the month of March. In this period, and only in this period, the Earth is directed approximately, at maximum speed, towards the galactic center, along the lines of force of a radial field and perpendicular to the lines of force of a dipolar galactic field.

If space were empty of fields of matter and inactive, a consideration of this type would be of no importance. But we know that both matter and fields exist in space. For this reason, the displacement of a body such as the Earth in one direction or another is not inconsequential. Its general physical conditions must vary in the course of a year.

The idea that the helicoidal motion of the Earth in the Galaxy brings with it a regularly recurrent modification of the Earth's general physical conditions, with a non-sinusoidal rhythm going from March to March of the next year was indicated by Piccardi as “solar hypothesis”. Also this spatial condition was experienced by chemical tests.

An animated model of the helicoidal motion of the Earth in the Galaxy is shown in fig. 1.

A new space weather index

Piccardi's researches demonstrate that many inorganic and organic colloids in aqueous medium during their evolution are capable of responding as well as traditional physical factors that can be kept under control (temperature, pressure etc.) and to spatial factors (electromagnetic and corpuscular radiation of solar and cosmic origin) that cannot.

Some of these spatial factors are mainly produced by solar explosive events (solar storms: flare and coronal magnetic ejections) that induce massive geophysical phenomena (polar aurorae, magnetic storms etc.) and potentially dangerous effects on our technological infrastructures (satellites, radio communications, power plants etc.).

Therefore, Piccardi's chemical test, based on the evolution of a very sensible colloid, can serve as a routine revealer of spatial conditions, especially those of solar origin. In this sense, Piccardi may be considered a pioneer of the space weather, a relatively new scientific discipline that considers, on theoretical and practical basis, the terrestrial effects of ever changing spatial conditions.

Finally, it is worth remembering the close collaboration of Piccardi in the 1960s with many Russian scientists operating in the same field, in particular with Alexander Tchijevsky (А.Л. Чижевский) (1897-1964). The book of Piccardi *The Chemical Basis of Medical Climatology* published in Usa in 1962 was translated into Russian in 1967 (fig. 5). The name of Piccardi is also often cited in books and articles of Russian authors, as B.M. Vladimirk (Б.М. Владимирский).

It is to be hoped that the name of Gorgio Piccardi is not forgotten.

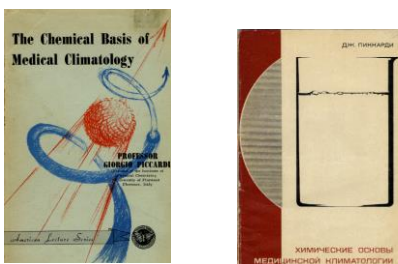


Fig. 5 - G. Piccardi: *The Chemical Basis of Medical Climatology*: U.S. edition, 1962; Russian edition: Пиккарди Дж., *Химические основы медицинской климатологии*, 1967

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