

March 2022

CURRICULUM VITAE

Paolo Emilio Strolin

Summary

I was born in Reggio Emilia (Italy) in 1939. I have a Laurea in Engineering (1963) and one in Physics (1968). In 1963, I had a Fellowship with the Condensed Matter Physics Group of the Laboratorio Ricerche Elettroniche Olivetti, Milan. From 1964 till 1975 I was a CERN Staff Member as a Research Physicist, in the Accelerator and then in the Particle Physics Division. After about one year as a Scientific Associate with FOM-Netherlands, I had a tenured research position at ETH-Zurich, with a level corresponding to Associate Professor. From 1980 until 2010, I have been a Full Professor of Physics at the University of Naples Federico II. At present, I am a Professor Emeritus. Since my arrival in Naples, I am associated to INFN (*Istituto Nazionale di Fisica Nucleare*).

At the University and INFN of Naples, I have built up a group active in neutrino physics, as well as in multidisciplinary research. In recent years, I have formed another group dedicated to muography, with applications to volcanoes and to archaeology. I have supervised more than 80 Laurea and PhD theses.

My research activities have covered accelerator physics, experimental particle physics and interdisciplinary research. They have produced about 170 publications on international scientific journals, as well as presentations at international conferences and lectures at national and international Schools on Particle Physics.

I have had several responsibilities in the management of Institutions and as a member or chairperson of Committees for the definition of scientific policies at the national and at the international level. I have promoted international cooperation.

I have always dedicated time and efforts to educational activities, at present carried out in the framework of the *Science and School* non-profit Association.

Scientific activity

I have built the neutrino group in Napoli starting with the *CHARM II* experiment (1983-94) at CERN on the study of the scattering of muon neutrinos and anti-neutrinos on electrons for a measurement of the electro-weak parameters from a purely leptonic process, as well as on the study of other neutrino induced processes such as precision measurement of the inverse muon decay, first observation of “leptonic trident” production by neutrinos and search for muon to electron neutrino oscillation. The experimental apparatus - more than 40 meter long - was basically consisting of calorimeter equipped with limited streamer tubes and having glass plates as a passive material, so optimized for electron detection. It was followed by a magnetic spectrometer.

I have been among the main proponents and the Spokesperson of the *CHORUS* experiment (1990-2007) at CERN for the search of “oscillation” of muon neutrinos to tau neutrinos, due to a non-zero neutrino mass in a range compatible with being a sizeable constituent of the Dark Matter in the Universe, as theoretically plausible at those times. The experiment has also produced results on the physics of particles with “charmed” quarks. *CHORUS* has been performed by a collaboration consisting of about 130 physicists from Europe and Japan. The experimental apparatus was consisting of nuclear emulsion as active neutrino target, combined with electronic

detectors to localize neutrino interactions in emulsion and to contribute to the event reconstruction.

I have been one of the three original proponents and the first Spokesperson of the *OPERA* experiment (1997 till now) in the long baseline neutrino beam from *CERN* to the *Gran Sasso National Laboratory* for the search of tau neutrino appearance in the low neutrino mass range indicated by the *Super-KamiokaNDE* experiment in Japan. The neutrino active target was a 1.3 kton Emulsion Cloud Chamber (ECC), a highly modular detector built up with - as basic units - “bricks” consisting of emulsion sheets and lead plates. The ECC is combined with electronic trackers and magnetic spectrometers, to localize neutrino interactions in emulsion and to contribute to the event reconstruction. The experiment was carried out by a collaboration of about 170 physicists from Europe and Japan. *OPERA* has produced the definite proof of muon to tau neutrino oscillation, by the direct observation of the appearance of tau neutrinos in the CNGS muon neutrino beam with more than 5σ statistical significance. The data analysis is being completed, also covering other aspects of neutrino physics.

With *CHORUS* and, above all, *OPERA* a nuclear emulsion laboratory has been set up in Naples. For the heavy scanning requirements of *OPERA*, a new generation of high-speed automated microscopes has been developed in Europe and Japan. The Napoli group contributed to the development of the so-called *European Scanning System* and is currently carrying out R&D on scanning systems with higher performance.

The expertise acquired in nuclear emulsion has led to interdisciplinary applications of the technique, in particular muography.

I have also been involved in the studies for experimentation at future facilities for neutrino physics by accelerators, such as Neutrino Factories.

In 2008, I have initiated the involvement in muography (conceptually similar to radiography, with muon instead of X-rays) of internal structures of volcanoes’ edifices, using muons naturally generated by interactions of cosmic rays in the Earth’s atmosphere. An electronic muon detector of a new generation was developed in the frame of the *MU-RAY* experiment. The detector is based on the use of plastic scintillator strips, wavelength-shifting fibres and Silicon photomultipliers. After tests at Mt. Vesuvius, at the Puy de Dôme a combined measurement with the Resistive Plate Chamber detector of the French *TOMUVOL* Collaboration has led to a better understanding of the background, which constitutes the most relevant limitation in volcano muography. *MU-RAY* has led to the *MURAVES* project for the very challenging muography of Mt. Vesuvius, jointly carried out by the Italian National Institutes for nuclear and particle physics (*INFN*) and for geophysics and volcanology (*INGV*). In addition, using the nuclear emulsion technique for muon detection a first image of the internal structure of the crater region of the Stromboli volcano was produced.

The electronic muon detector developed by *MU-RAY* is applicable to other fields, such as the study of geological structures, civil engineering and archaeology. The muography of underground structures in Mt. Echia, the site of the earliest settlement of the city of Naples, has shown that the capability of discovering unknown cavities by a detector that is suitable for a widespread utilisation.

In recent years, I have also participated in the initial phase of an innovative research program for a directional search of Dark Matter by the use of a new fine-grained nuclear emulsion (the so called nano-emulsion), capable of observing the direction of the nuclear recoils to achieve a substantial progress in background suppression.

Early scientific activities in particle and accelerator physics have mainly covered: studies for the design of the *CERN Super Proton Synchrotron (SPS)* and participation to the realization of the *Intersecting Storage Rings (ISR)* proton-proton collider at *CERN*; CP violation at the *CERN Proton Synchrotron (PS)*; proton-proton elastic scattering, inclusive inelastic diffraction $pp = pX$,

observation of double diffractive dissociation and evidence of double Pomeron exchange at the *ISR*; production of muon pairs with high invariant mass in an intense pion beam at *CERN*, for the study of the pion structure functions; production of the Y meson and of mesons with “open beauty” by pions; first studies for proton-antiproton physics at *CERN*; participation in the definition of the physics program at the *CERN Large Electron-Positron (LEP)* collider.

Responsibilities in the University and in Research Institutions

Director of the *Physics Department* of the *University of Napoli Federico II*.

Vice-President of the *Réseau Méditerranéen des Ecoles d'Ingénieurs (RMEI)*, which groups more than 100 technical and scientific universities in 16 countries around the Mediterranean Sea.

Chairman of the *Commissione Scientifica Nazionale II* of INFN for experiments in astroparticle physics, neutrino physics, searches for gravitational waves and in general non-accelerator particle physics. Director of the *Napoli Section of INFN*. Member of the *INFN Board of Directors*.

Member of the *Scientific Policy Committee (SPC)* of CERN, as well as of the following Scientific Committees: Intersecting Storage Rings physics (*ISRC*); Large Electron-Positron Collider physics (*LEPC*); fixed target and proton-antiproton collider physics with the Super Proton Synchrotron (*SPSLC*).

Member of the *European Committee for Future Accelerators (ECFA)*.

Educational activities

I have promoted interest in Science among students and the general public, through articles, publications and educational programs giving special attention to High Schools. In the framework of the *Istituto Italiano di Studi Filosofici* (Napoli), I have been organising seminars on modern physics. I have regularly delivered seminars in High Schools.

I have founded the *Science and School* non-profit Association [www.scienzaescuola.eu], of which I am the president. Various educational projects are being carried out, from the local to the international level and collaborating with scientific Institutions. *Science and School* aims at the dissemination of modern science and promotes the acquisition of international experiences by high school students. Various educational projects are being carried out, from the local to the international level and collaborating with various scientific Institutions. The *NEMO (Network Educational Museums Online)* project, carried out in collaboration with a network of schools, aims at the recovery of the remarkable heritage of historic scientific instruments still available in Neapolitan High Schools and at the creation of an overall virtual Museum. Educational materials have been produced and made available on the Web (www.scienzaescuola.eu/index.php/scienza-moderna/saggi-tematici).

I have been in the Board of the Founder Members of the *Foundation IDIS - Città della Scienza* (Napoli). I have been a member of the Scientific Committee of the *Istituto Italiano Studi Filosofici*.

Organization of Conferences

I have been Chairman of the VIII International Conference on *Physics in Collision* (Capri, 1988), Director of the *CERN-JINR European School of High Energy Physics* (Sorrento-S.Agnello, 1994), Chairman of the XVI *International Workshop on Weak Interactions and Neutrinos* (Capri, 1997) and co-Director of the *Enrico Fermi International School on Neutrino Physics* (Varenna, 2002). In 1994-95 I have co-organised three *Napoli Thinkshops in Physics and Astrophysics*. The

second *International Conference on Calorimetry in High Energy Physics* (Capri, 1991) was organised by my group.

I have organized the *MU-RAY International Workshop* (Napoli, 2008) and the *International Workshop on muon radiography of volcanoes* (Napoli, 2010). I have been one of the promoters of the series of International Workshops on *Muon and Neutrino Radiography (MNR)*, which has started in 2012. I have promoted international cooperation in the field of Earth Science studies by elementary particles, namely muons and neutrinos. I have co-organized the International Workshop *Muographers 2014* in Tokyo, where a cooperation agreement has been signed between *INFN* and the *Earthquake Research Institute (ERI)* of the University of Tokyo, followed by a similar agreement between *INGV* and *ERI*. I have contributed to the promotion and definition of the *ISAPP Summer Institute: using particle physics to understand and image the Earth* (Gran Sasso Science Institute, 2016).

I have been the main organiser of the *Mediterranean Workshop 2017*, held in Naples to promote cooperation among Mediterranean countries. The workshop has involved universities and research institutions of the Campania Region, together with Mediterranean Networks.

I have contributed to the organisation of other conferences in various roles, mainly as a member of Advisory Committees or Convenor.

SCIENTIFIC PUBLICATIONS

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