CURRICULUM of LUCIANO PIETRONERO (Aug. 2023)

(For more details see: **www.lucianopietronero.it**)

Born in Roma on 15/12/1949, married, two sons.

Professional positions

1971 Nov.	Laurea in Physics, Univ. of Roma (110+L).
1972-73	CNR fellowship, Univ of Roma and Orsay (F).
1974-75	**Xerox Webster Research Center, N.Y. USA; Associate Scientist.**
1975-83	**Brown Boveri Research Center, Baden (CH). Theoretical Physics Group – Member of the Staff.**
1983-87	**Full Professor of Condensed Matter Theory. University of Groningen, The Netherlands.**
1987- 2020	**Professor of Condensed Matter Physics, University of Roma "La Sapienza"**
1992-95	Director of the Theory Group, Dep. of Physics, Univ. La Sapienza
1995-2001	Director of the INFM Unit, Univ. of Roma La Sapienza. The Unit consists of about 200 scientists in the area of Condensed Matter Physics and it is the largest in Italy.
2001	Founder of the "Centro di Ricerca e Sviluppo" (CRS): Statistical Mechanics and Complexity (SMC)
2001- 2003	Director (Commissario) of the CNR Institute Corbino (IDAC)
2002- 2005	**Member of the Board (CdA) of the Center E. Fermi (Roma). From 2016 member of the "Albo D'Onore " of the Center E. Fermi.**
2004 – 2014	**Founder and director of the CNR Institute of Complex Systems (ISC). The Institute includes in various forms about 200 scientists, including the university associates. In 2014 an International Commission has classified ISC-CNR as World Class and first among the 12 CNR institutes in the area of Physics.**
2010 –	Fellow and member of the Trustees Board at LIMS (London Institute of mathematical Sciences), London UK
2016 –	**Senior Advisor of the World Bank (Washington)**
2017 –	Promotor of the collaboration between Sapienza University and CNEL for the introduction of the Economic Fitness Methods to optimize the industrial development of Italy.
2017 –	**Complexity Hub Vienna, member of the external faculty**
2019 Dec. –	**President of the Enrico Fermi Research Center (www.cref.it), Rome**

This is a new national scientific institution located in the famous building in Via Panisperna where Enrico Fermi and his group made their fantastic discoveries. There is modern museum to honor these fundamental events of the past. But it also represents a great opportunity as **a novel research center to look also at the future**. The strategy is to be particularly original and actual with subjects that can also have an important social impact. In this respect we get inspiration from the spirit of the Start Up companies and we try to define a sort of **Scientific Start Ups**: small size but strong originality with a well defined identity for the new institution. In the WEB site: www.cref.it one can find a variety of new projects. We have also established **joint labs in CREF in collaboration with SONY CSL Research Center and a Think Tank with the IFC-World Bank of Washington.**

We have also established a **PhD school specific to the Fermi Center** and, at the moment, we have 18 PhD students of very high level. Another point we are actively implementing is the internationalization of CREF with a special project submitted to the Ministry. Finally we believe that in Italy the **relation between public research and private companies** is rather critical. Given our experience in private research center we have implemented a series of actions to improve this point and stimulate concrete collaborations in various areas.

Leaves and temporary positions	1982 Summer	Institute of Theoretical Physics, Univ. of S. Barbara, USA
	1982 Fall	Lyman Lab. Of Physics, Harvard Univ., Boston USA
	1999	ICTP, Trieste Extended stages
	1999	Mc Minn Lecturer, Vanderbilt Univ. USA

Main Lectures	1983 -87	Univ. of Groningen, The Netherlands. Advanced Condensed Matter Physics,
	1987 - 2008	Univ. di Roma La Sapienza Solid State Physics,
	1987 - 2008	Various graduate (Ph. D) lectures in the areas of Statistical Physics, Complexity and High Tc Superconductivity
	2005 – 2013	Physics of Complex Systems
	2014 – 2020	General Physics, Mechanics
	2015 - 2020	Superconductivity and Superfluidity

Ph.D and Laurea Thesis

Director of about 170 research Thesis at the level of PhD or Laurea (undergraduate) at the University of Roma La Sapienza, the University of Groningen (NL) and other institutions.

Leader of a generation of young scientists who are protagonists of the condensed matter theory, statistical physics and complexity science scene internationally. Many of these students are mature or young scientists who continued their scientific career and occupy important scientific positions at the national and international level in academic, research institutions and companies. Among these: A.P. Siebesma (Prof. at Delft Univ. and leader at KNMI); R. Kupers (Shell Research and CEO of New Economic Metrics); C. Evertsz (Chiarman of SCiLS and board member of High Tech companies); A.Erzan (Prof. Istanbul Tech. Univ and L'Oreal Prize); A. Vespignani (Prof. Northeastern Univ. and Director of the Network Science Institute); S. Zapperi (Prof. Univ. Milano); M. Munoz (Prof. Univ. Granada Spain); V. Loreto (Prof. Univ. Sapienza Rome and Director SONY Lab. Paris and Rome); M. Marsili (Research Director, ICTP, Trieste); V. Colizza (Research director, INSERM, Paris); G. Caldarelli (Prof. Univ. Venice Ca'Foscari); F. Corberi (prof. Univ. of Salerno); M. Joyce (Prof. Univ. Paris VI); D. Garlaschelli (Prof., IMT Lucca); P. Paci (Senior Scientist, IASI-CNR, Rome); G. De Masi (Principle Scientist, TII Abu Dhabi, UAE); G. Bianconi (Prof. Queen Mary Univ. London); F. Sylos Labini (Senior Scientist, Fermi Center Rome); A. Petri (Senior Scientist, ISC-CNR, Rome), A Gabrielli (Associate Professor, Univ. Roma 3 and Scientific Director at Fermi Center); E. Cappelluti (Research Director, ISM-CNR Trieste), C. Castellano (Research Director, ISC-CNR Rome), L. Boeri (Ass. Prof. Univ. Sapienza, Rome); M. Cristelli (Senior Scientist, CFM, Paris); E. Pugliese (Scientist, JRC-EU Sevilla); A. Tacchella (Senior Scientist, Fermi Center, Rome); L. Napolitano (Scientist, JRC-EU Sevilla); A. Zaccaria (Scientist, ISC-CNR Roma); F. Saracco (Scientist, Fermi Center, Rome); D. Mazzilli (Scientist, Fermi Center, Rome); A. Sbardella (Scientist, Fermi Center, Rome); A. Patelli (Scientist, Fermi Center, Rome).

Publications and Scientific Activity

Author of about 400 scientific papers, mostly in the leading international scientific journals: Phys. Rev. Letters; Rev. Mod. Phys.; Nature; Nature Physics; Nature Scientific Reports; Physics Reports; Phys. Rev. B, E and R; Europhys. Lett.; Physica A; J. of Physics etc.

Joint papers with three Nobel Prizes in different fields: K.A. Müller (High Tc Superconductivity); P.W. Anderson (Complexity) and G. Parisi (Statistical Physics)

Bibliometrics. Google Scholar: Total citations 18,200 ; H-index=65

Author of a monographic volume and editor of several volumes of proceedings.

Broad international experience in academic and industrial enviroments. The scientific activity is of both fundamental and applied nature, with a problem oriented interdisciplinary perspective. Development of novel and original views in most areas of activity.

Invited lecturer at about 200 International Conferences. Currently invited or plenary speaker at the main Conferences and Schools in the fields of Statistical Physics, Complexity and High Tc Superconductivity, among which:
STATPHYS (1989; 2001; 2010); APS General (March) Meeting (1998); EPS Trends in

Physics (1987 and 1990); EPS Cond. Matt. (various); Aspen Institute of Physics (2000); International Conf. on High Tc SC (2003 and 2006); Cargese (various); Erice (various); ICTP (various), ECCS Meeting Vienna (2012), Santa Fe Complexity (2013), Conference on SC Hydrides, Orange Calif. (2017); Super Fluctuations, Padova, July 2022.

The recent activity on **Economic Fitness and Complexity** has raised a large interest internationally: Invitation to the Plenary conference in Hong Kong of the Institute of New Economic Thinking (INET) funded by G. Soros, G. Stglitz et al. (2013). RiskMinds (main international conference on Risk Management), Amsterdam (2014); Alibaba and China Complexity meetings, Hangzhou (2013-2014); Santa Fe program on Economic Complexity (2013); J. Stiglitz Task Force on Industrialization, Amman (2014); INET meetings in Hong Kong (2013); Toronto (2014) and Paris (2015); IIASA Vienna Conference (2015); Para Limes Nanyang Univ. Singapore (2015); OECD GLOCOMNET, Paris (2015). OECD Meeting on Global System Science (2016), SPIE San Francisco Conf. (2016), ETH Risk Center Conference, Zurich, April 2016; Sigma-Fi Conference, Corfu' Greece (2017), Economic Growth Forum, Astana, Kazakhastan, Nov. 2017; Economic Fitness Seminar, Economic Fitness and Complexity, IFC-World Bank Washington (2017); Net-Sci: Int. Conf. on Network Science, Hangzhou, China, Jan. 2018; State Information Center of China meeting, Beijing, China, Jan. 2018; GENERALI Strategic Meeting, Verona, Jan. 2018; Complexity Meeting, CSH Vienna, May 2018; JRC-EU Sevilla Meeting, May 2018; JRC Science Lecture, Brussel, June 2018; Mondragone Intern. Economic Seminar, FUET, Rome Tor Vergata, June 2019; SPRU Sussex Conference on Economics and Innovation July 2019; Bielefeld Conference on Complexity, July 2019; Como Summer School on Complexity and Ecosystems, July 2019; Tsinghua Conference on Innovation and Economic Development, Beijing, Aug. 2019. Global innovation Forum, Yerevan, Oct. 2029; JRC-EU Tutorial on Economic Fitness and Complexity, Nov. 2020; Lipari School on Complex Networks, July 2021; CCS Econophysics, Lyon, Oct. 2021; SOAS Meeting, London, March 2022; CIMEO Economic Meeting, Sapienza, Rome, June 2022; Complexity Science Hub Meeting, Vienna, June 2022; Festival dell'Economia, Trento, June 2022; CAAI Cloud Forum: Computational Macroeconomcs in the Digital Intelligence Era, China December 2022;

Assignments and Awards

- **Enrico Fermi Prize, Italian Physical Society (2008). Main prize of the Italian Physical Society.**
- **Fellow of the American Physical Society (1990)**
- **Member of the Academia Europaea for the Section B3 (Physics and Engineering Sciences) from Nov. 2011**
- **Member of the EU Academy from 2012**
- **Coordinator of the CNR Panel for the unification of the INFM (500 people) with the CNR Physics department (700 people) in 2008. The present structure of the CNR Physics department was designed and implemented by this panel with the foundation of three new institutes and the reorganization of several others.**
- Member of the editorial board of: Physica A; Il Nuovo Cimento D: Int. J. of Fractals; Europhysics Letters (1994-97). Guest Editor of "Entropy" Special Issue (2018); Guest Editor of J. of Physics Complexity; Special Issue on Economic Fitness and Complexity (2022).
- Member of the IUPAP Commission on Condensed Matter (1987-93)
- Consultant: IBM Zurich laboratories (1992); IBM T.J. Watson Laboratories, Yorktown Heights USA (1994); London School of Economics (2003)
- Member of the International SISSA (Trieste) Evaluation Committee (1994-2007)
- Int. Eval. Committee of the Bogoliubov Lab. of Theoretical Physics, Dubna, Russia (1995-97)
- International Evaluation Committee of the Max Planck Institute for Complex Systems, Dresden (2003-2010).
- Member of the Steering Committee of the Institute of Mathematical Sciences of the Imperial College, London (2007)
- **European Research Council Advanced Grants. Member of the Panel for Condensed Matter Physics (PE3) for 2008, 2010, 2012 and 2015**

- Member of the Academic Advisory Board of Collegium Budapest (2010-2012)
- **Consultant of Boston Consulting Group - New York (2013-2014)**
- **Consultant of Royal Dutch Shell - The Netherlands (2014)**
- **Consultant of The Institute of New Economic Thinking - New York (2013-2015)**
- **Member of the Stiglitz's Task Force on Industrialization (2014)**
- **Consultant of the Institute for Public Policy Research: report on the status of industrialization for the UK Government (2014)**
- **Senior Scientist and Co-director of the Alibaba Complexity Institute, Hangzhou Business School, Hangzhou (China) (2015-2018).**
- **Senior Advisor of the IFC-World Bank (Washington); 4 other members of the group have been also appointed Consultants in order to implement and adopt the methodology of Economic Fitness in the WB (since 2016)**
- **Since Dec. 2019 President of the Fermi Center: www.cref.it.**

Activities and Projects

Director of the PIL research group of the Physics Department, University of Roma, La Sapienza (1987-2020). The group consists of scientists from various institutions: University; CNR; Fermi Center; European and national contracts. In total there are about 30 scientists of which: 6 permanent; 15 with contracts of various types from 2 to 5 years; 4 Ph D students and a variable number of undergraduate thesis students.

Economic Fitness and Complexity:

- **Applications of Statistical Physics to Economics and Finance.** Introduction of Self-organization and Nonstationarity in workable Agent Based Models (2008-2010), G. Caldarelli, V. Alfi, M. Cristelli, A. Zaccaria).
- **New Metrics to measure Intangibles in Fundamental Economics.** This represents a ground breaking quantitative scientific approach to macroeconomics. It is based on the definition and concrete calculation of new intangible properties like the Fitness of countries and the Complexity of Products. These properties are computed from an algorithm inspired to the Google page-rank problem. For economics, however, the nature of the problem is very different from the Google case and the algorithm has to be non linear and related to a **bipartite network**. The fixed point of this iteration leads to a metric for intangible properties like the Fitness of Countries and the Complexity of products. These can then be compared to monetary properties like the GDP and this comparison reveals **hidden information on the competitiveness of countries** and leads to a completely novel perspective for the forecasting of the GDP growth as well as for the risk analysis. It leads also to a new scheme for the optimization of the growth of a country. This work has attracted great attention in the scientific, policy making and business areas and recently it was the object of a **Nature Editorial**: http://www.nature.com/news/physicists-make-weather-forecasts-for-economies-1.16963 More recently there was another another editorial by Nature in relation to our paper in Nature Physiscs (2018): http://www.phys.uniroma1.it/fisica/archivionotizie/forecasting-economic-growth-complex-systems-physics

The approach has been now extended to Patents and Technologies as well as the Scientific Activity. This leads to three interrelated networks which provide a large number of new information for countries and companies.
Recently the **IFC-World Bank** has adopted the method of EC and Fitness for its strategic country analysis for the analysis of more than 70 countries. The method of the Economic Fitness is being implemented in the WB Website as one of their official methods. In a few days it will be possibile also to download the Fitness data:
https://datacatalog.worldbank.org/dataset/economic-fitness
In 2021 the IFC-World Bank has produced a detailed document in which the **development of various African countries** is planned with the extensive use of the **Economic Fitness** methodology. https://www.ifc.org/wps/wcm/connect/fb4761f5-809b-4685-8fd7-24bd23bad6d3/EMCompass-Note-88-West-African-Industrial-Development.pdf?MOD=AJPERES&CVID=ngxrg.e

Dec. 18, 2020. Podcast with the Chief Economist of **Boston Consulting Group** Philip Carlsson-Szlezak on Growth Forecasts: https://bcghendersoninstitute.com/economic-complexity-and-growth-forecasts-a-conversation-with-luciano-pietronero-b9be1e1c0d0c

In **July 2021 the JRC-EU Commission** has officially adopted the methodology of the **Economic Fitness to analyze and evaluate the Projects of the Recovery Fund (PNRR)**.
Nel sito WEB: https://publications.jrc.ec.europa.eu/repository/handle/JRC124939
si può scaricare un documento generale metodologico insieme alle analisi preliminari di tutti i 27 paesi della EU.

The method is being also considered for industrial planning by China government (State Information Center) and by the Italian Government (CNEL and MISE), JRC of EU Commission and by various other policy making institutions of UK, Kazakastan and others. Actually the Fitness method permits to understand the fantastic industrial growth of China, while most of the standard economic analysis prediced a "hard landing" since more than 20 years: https://www.quora.com/profile/Godfree-Roberts
Very recently we are developing an effort to extend these methodologies and tools to the **dynamics of information in social networks** and we just submitted a FET project on this subject.

Jan 2019: LP Guest Editor of the Special Issue on "Economic Fitness and Complexity" of the International Journal "Entropy".
The Journal is open source and there are already 25 papers published that can be consulted free: https://www.mdpi.com/journal/entropy/special_issues/Economic_Complexity

Dec. 2022: LP Guest Editor of the Special Issue of Journal of Physics, Complexity on: "Economic Fitness and Artificial Intellingence". In preparation.
Economic Complexity and the **Fitness Method** has developed into a broad novel framework for the analysis and forecasting of the industrial competitiveness of countries and regions for all industrial sectors at different levels of granularity. It represents the scientific basis for the area of Economic Complexity which is developing as a novel, scientifically based approach, to the economic analysis.
Bloomberg Views (2018): "*New research has demonstrated that the "fitness" technique systematically outperforms standard methods, despite requiring much less data*".

Dec. 23, 2022. The China Association for Artificial Intelligence (CAAI).
Its events usually reach an online audience between 100,000 and 200,000.
Computational Macroeconomics in the Digital Era: **A special online event around Fitness-Growth Mechanisms.**
WEBsite: **https://www.bilibili.com/video/BV1B84y1s7AF/?vd_source=a0b1bcd72e0af592e24a2124adf07150**
The event was based on three main interventions by L. Pietronero, A. Sbardella and J. Lin, plus a debate. See the lecture by JL is at the end of the debate.
Justin Lin (Founder and Director of the Institute of New Structural Economics, Univ. of Peking and former Chief Economist of the World Bank, Washington))
At minute 1h 45' 32" : Justin Lin: "The Economic Fitness (EFC) provides a Metric to the new Structural Economics (NSE) and, on its turn, NSE provides an economic framework to EFC. Our dream is that this joint effort will lead to sustainable economic growth and a world free of poverty. In particular it will be essential for many of the 17 UN SDG objectives, and especially for the first three: 1. No Poverty; 2. Zero Hunger; 3. Good Health and Well Being".

Main present (and recent) projects (general coordination):

- **Joint projects with SONY CSL and the Fermi Center on the 17 Sustainability Projects (SGD) (2022-2024)**
- **Think Tank on Economic Complexity and Fitness at the Fermi Center in collaboration with IFC-World Bank (2022-2025)**
- **JRC-EU TENDER project to study the economic competitiveness and innovation in the EU regions. (2019-2021).**
- **JRC-EU TENDER project to study the product quality of economic products in**

the EU regions. (2021-2023).

- **Project of national interest CRISIS-LAB (PNR 2012-2019, Budget 9.0 Mio Euros)** directed by L.P. The core of the project is based also on collaborations between ISC-CNR and other economic partners in Italy.
- **Coordination of the EU Strep project GROWTHCOM (2013-2017; Budget 1.5 Mio Euros)**.
- We also contribute as collaborators to various other European and national projects.

Previous Research Projects:

2 Projects MIUR-FIRB coordinated by PIL group

4 Projects MIUR-PRIN (Cofin) in which PIL group was the main partner

7 European Projects (EEC) of which 4 are coordinated by PIL group (underlined): COSIN (2002-2005); DELIS (2003-2006); ECAGENTS (2003-2007); TAGORA (2006-2009); COMPLEXITY-NET (2006-2009); TRIGS (2006-2009);

Among the previous projects we have coordinated the EEC Network: *Fractal Structures and Self-organization* (1997-2003) which included 11 Teams from 8 countries and it has been probably the largest European Network in the field of Statistical Physics.

Areas of activity:

- Solid State and Condensed Matter Theory
- Theory of High Tc superconductivity and related problems
- Statistical Physics, Fractal Growth, Self-Organized Criticality and Complex Structures
- Interdisciplinary applications of Statistical Physics and Complexity ideas in Astrophysics and Cosmology, Seismology, Networks and Socio-economic problems.
- Economic Complexity: Foundation of a new type of Economic science which is data oriented and more scientifically based in the spirit of INET, the Institute for the New Economic Thinking: http://ineteconomics.org/

Chairman of STATPHYS 23 (Genova 9-13 July 2007). This Conference represents the main international event in the field of Statistical Physics. It is organized every three years and it is assigned by the IUPAP Commission. There have been about 1300 participants from 52 countries.

Responsible of the Fermi Center Program on: *Complexity from the Nanometric to the Cosmic Scale (2005- 2014)*

Organizer of about 15 International Conferences in the fields of Statistical Physics, Fractal structures and Self-organized criticality, Complex systems and High Tc Superconductivity.

Co-organizer of the Study Week of the Pontificiae Academiae Scientiarum on "Science for Survival and Sustainable Developments" 12-16 March 1999 with the participation of Pope John Paul II, (Proceedings publ. 2000)

Promotor and Co-director of the ***Erice School Series on Complex Systems***, which started in 2004 and organizes 2-3 schools per year.

Chairman of the general INFM Conference with 1100 participants (Congress Center Roma EUR, 2001)

Previous activities and collaborators:

- **Inertial dragging in General Relativity (with B. Touschek 1972-73)**
- Electronic properties of molecular crystals and electron-phonon interaction in molecular crystals (F. Bassani; C.B. Duke; M.J. Rice; S. Strassler; H.R. Zeller; 1973-1976)
- Ionic conductors and disordered systems (S, Strassler; W.R. Schneider; P. Fulde; H.U. Beyeler; P. Bruesch; H.R. Zeller; 1975-1982) including applied applications for batteries.
- One-dimensional electronic systems and Peierls instability (S. Strassler; H.R. Zeller; 1974-78)
- Electronic transport in synthetic metals and carbon polymers (S.Strassler; 1980-83)
- Theory of surface melting in solids (E. Tosatti; 1979-84)
- Random Walks and polymes statistics (J. Bernasconi; L. Peliti; 1985-88)
- **Physical models of Fractal Growth. Dielectric Breakdown Model (L. Niemeyer; H.J. Wiesmann; W. Schneider 1984-90). This model of 1984 has opened (together with DLA) a vast area of theoretical and applied developments with applications**

in various fields. It provides one of the first and more general physical mechanism for the self-organization of complex structures (Citations: 1262). It provides a first answer to the basic question: Why nature makes fractals?

- Fractal and Multifractal properties in various models and systems (A.P.Siebesma; A. Erzan; E. Tosatti; M. Marsili; G. Paladin 1986-97)
- Nonlinear transport and critical properties in 1-d Charge density Waves (S Strassler; A. Erzan; G. Parisi 1983-92)

- **Theory of Fractal Growth (*Fixed Scale Transformation*) for Laplacian Fractal models (1992-98, C. Eversz; B.B. Mandelbrot; A. Erzan; A. Vespignani; R. Cafiero; G. Caldarelli; S. Sidoretti). Introduction of a new theoretical framework for several problems related to Self-Organized-Critical Phenomena (see also following points). These papers are considered as "The most sophisticated and successful theory (of Fractal growth)" by T.C. Halsey in his review on Phyiscs Today (APS) of November 2000.**
- Generalization of the theory to models with quenched disorder (*Invasion Percolation*) and development of the method of the ***Run Time Statistics*** (W. Schneider; A. Stella; A. Gabrielli; G. Caldarelli; A. Vespignani)
- Development of the method ***Dynamically Driven Renormalization Group*** for problems of Self-organized Criticality (*Sandpile; Self-Organized Criticality*) (S. Zapperi; A. Vespignani; G. Caldarelli; V. Loreto; A. Gabrielli 1993-2003)
- Nonperturbative Renormalization Group theory for the dynamics of rough surfaces (KPZ) (1998-2004) (M. Marsili; C. Castellano; M. Munoz, A. Gabrielli; G. Bianconi). The most recent huge simulations seems to support this theory, in particular the result that the critical dimension in KPZ is infinite.

- **Complexity in Cosmic Structures (1987-2010, P. Coleman; F. Sylos Labini; M. Montuori; M. Joyce; R. Durrer; A. Gabrielli; S. Torquato; Y. Baryshev; J.Lebowitz; P.W. Anderson (Nobel laureate). This interdisciplinary application of modern Statistical Physics to Cosmic Structures (galaxy correlations) led to a broad debate on the foundations of the field** which is reported in detail in the volume: Y. Baryshev e P. Teerikorpi, *Discovery of Cosmic Fractals*, World Scientific, Singapore (2002); Italian translation Boringhieri (2005). These studies have provided a novel perspective in the field which refers to the very foundations of the field and is still extremely lively. One of the impications is that the introduction of complex structures in cosmological models may eliminate the need for dark energy and lead naturally to the acceleration of the supernovae. See for example: http://en.wikipedia.org/wiki/Fractal_cosmology This activity on Fractal cosmology is quoted at Page 1. of the book of S. Weinberg on Cosmlogy (2008). Recently we have proposed that including the complex structure of the galaxy distribution in the source term of Einstein equation can lead to a cosmological dynamics with an apparent acceleration. Therefore the inclusion of the complexity of the mass distribution could eliminate the need of dark energy to explain the acceleration.

- Applications of the methods of Complex systems to Self-similar Networks, Information theory and Socio-economic systems (1999-2010, G. Caldarelli; V. Loreto; C. Castellano; C. Cattuto; V. Alfi; F. Coccetti; A. Petri; A. Baldassarri; F. Colaiori; F. Rao; V. Servedio; A. Baronchelli; B. Cerruti)
- New approach to the study of Spatio-temporal correlations of earthquakes (2004-2006, V. Loreto; V. De Rubeis; P. Tosi; V. Beato; S. Zapperi)
- Models and properties of Granular Systems (2004-2006, A. Petri; V. Loreto; S. Zapperi; F. Dalton)

- **High Temperature Superconductivity and related problems**:
- **Charge distribution and properties of High Tc Superconducting cuprates (1999; K.A. Müller (Nobel laureate))**
- **Development of the Theory of Nonadiabatic Superconductivity (1992-2006).**
- **Generalization of the Many Body Theory beyond Migdal's theorem (Born Oppenheimer) for the normal and superconducting state. These studies lead to a new type of complex Fermi liquid with direct relevance to the Cuprate high Tc Superconductors, the Fullerene compounds and MgB2 (1992-2010, S.Strassler; C.**

Grimaldi; E. Cappelluti; P. Paci; G. Bachelet; S. Ciuchi; L.Boeri; O. Andersen). The recent discovery of Superconductivity at 203K (and more) in H3S (2015) could be an example of a material in which the Nonadiabatic effects are important in view of the high phonon frequency due to the light Hydrogen atoms.

Diffusion of Scientific Culture

Author of various articles (not included in the publication list) and interviews related to the diffusion of scientific culture. Invited to several meeting and events about scientific divulgation and organization with particular focus on the planning of innovation and creativity.

Promotor and scientific director of the theater text: *Il Tempo al di la del Mare*, inspired to the debate related to the measurement of the Longitude. Premiere in Roma, Teatro Valle (2001) and then represented for more than one year in the main theaters of Genova, Milano, Napoli, Bologna, Firenze etc.
The modern Ski Technique of Gustav Thoeni explained in detail:
https://www.repubblica.it/tecnologia/2021/06/29/news/la_fisica_dello_sci_ovvero_il_passo_spinta_di_thoeni_spiegato_bene_-308197564/

Two Video interviews with Marco Montemagno:
Dec. 2019: https://www.youtube.com/watch?v=jKvyIdDxQdQ
March. 2021: https://www.youtube.com/watch?v=D51ZSASkkcQ

Selected publications:

- Monography: A. Gabrielli, F. Sylos Labini, M. Joyce, and L. Pietronero Statistical Physics For Cosmic Structures Springer Verlag Inc. (New York-Berlin, 2004)
- L.Pietronero, The mechanics of particles inside a rotating mass shell, Annals of Physics 79, 250-260 (1973).
- L. Niemeyer, L. Pietronero and H.J. Wiesmann: "Fractal Dimension of Dielectric Breakdown" Phys. Rev. Lett. 52, 1033 (1984)
- L.Pietronero, The Fractal Structure of the Universe: Correlations of Galaxies and Clusters and the Average Mass Density, Physica A 144, 257 (1987).
- L.Pietronero, A. Erzan and C. Evertsz, Theory of Fractal Growth Phys. Rev. Lett., 61, 861 (1988).
- M. Di Stasio, K.A. Müller and L. Pietronero: "Nonhomogeneous charge distribution in layered High Tc Superconductors", Phys. Rev. Letters Vol. 64, 2827 (1990).
- P. Coleman and L. Pietronero: "The Fractal Structure of the Universe", Phys. Rep. 213, 311-389 (1992)
- L. Pietronero, A. Vespignani and S. Zapperi: "Renormalization study of Self-Organizad Criticality in Sandpile Models", Phys. Rev. Lett. 72, 1690 (1994)
- C. Grimaldi, L. Pietronero and S. Strässler: "Nonadiabatic Superconductivity: Electron Phonon Interaction beyond Migdal's Theorem" Phys. Rev. Lett. 75, 1158 (1995)
- C. Grimaldi, L. Pietronero and S. Strässler: "Nonadiabatic Superconductivity: Electron Phonon Interaction beyond Migdal's Theorem" Phys. Rev. Lett. 75, 1158 (1995)
- L. Pietronero, S. Strässler and C. Grimaldi: "Nonadiabatic Superconductivity I &II", Phys Rev. B 52, 10516 & 10530 (1995)
- Erzan, L. Pietronero and A. Vespignani: "The Fixed Scale Transformation Approach to Fractal growth" Rev. Mod. Phys. 67, 545-604 (1995)
- Castellano, M. Marsili and L. Pietronero: "Non-perturbative renormalization of the KPZ Growth Dynamics", Phys. Rev. Lett. 80, 4830 (1998)
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