

MASSIMO MATERASSI'S CURRICULUM VITÆ

October 30, 2017

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¹PP Pure Physics, SW Space physics and Space weather, ME Mathematical Ecology.

²PP Pure Physics, SW Space physics and Space weather, ME Mathematical Ecology.

³PP Pure Physics, SW Space physics and Space weather, ME Mathematical Ecology.

1 Personal Information

Name: Massimo Materassi.

Nationality: Italian.

Date and place of birth: April 27, 1970, Florence (ITALY).

Languages:

Italian: native speaker. English: fluent. Latin: school knowledge. Elements of Polish, Spanish and Russian.

Affiliation:

Istituto dei Sistemi Complessi del Consiglio Nazionale delle Ricerche (Institute for Complex Systems of the National Research Council), ISC-CNR, webpage: www.isc.cnr.it. Personal webpage: www.materassiphysics.com.

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2 Research interests

Due to my theoretical background, I always approach my work trying to unveil and exploit the underlying symmetries of the dynamics governing the system at hand.

2.1 Fundamental Physics: irreversibility

If the fundamental interactions of Nature may be cast into an *Action Principle* framework, i.e. if the fundamental forces are “conservative” ones, why should dissipation and irreversibility characterize every macroscopic physical system?

What are the “fundamental motivations” for *entropy* to enter the play?

Can the answers to such questions “explain” the phenomena of complexity, life and evolution in terms of the “traditional” tools of theoretical physicists?

Topics:

- *Metriplectic algebra.*
- *Stochasticity in the dynamics of continua.*
- *Information theory in dynamics.*

2.2 Space Physics: complexity in near-Earth plasma

The Sun-Earth interaction determines the dynamics of the near-Earth plasma as a complex system, organized in “spheres” separated by, and interacting through, “pauses”.

What are the causal relationships between the different phenomena taking place in this environment? To which extent can the ionospheric effects be predicted observing the Solar Wind or the near-Earth space?

How can the ionospheric turbulence be characterized and what can its effects on radio communication teach on its local dynamics?

Topics:

- *Space Weather and the Sun-Earth connection.*
- *Magnetic reconnection.*
- *Multifractal formalism for turbulence. Statistical aspects of multi-scale dynamics in turbulence.*
- *Ionospheric turbulence and radio scintillation.*

2.3 Mathematical ecology

Ecology gives scientists the chance to observe systems formed by highly interacting sub-systems at an energy and size scale very far from those of fundamental Physics. It is then of great interest to see to which extent the fundamental tools of Theoretical Physics (dynamical system formalism, analytical mechanics, conservation laws and issues of symmetry) may be of use in this field.

Topics:

- *Prey-predator dynamics with scavenging.*
- *Trophic web dynamics algebrization.*
- *Growth and competition model of marine vegetal population.*

3 Attributions and education

Referee of: “Annals of Geophysics”, “Advances in Space Research”, “Annales Geophysicæ”, “Journal of Atmospheric and Solar-Terrestrial Physics”, “Radio Science”, “Transactions on Geoscience and Remote Sensing”, “Modern Physics Letters B”, “Nonlinear Science and Numerical Simulation”, “Scientia Iranica”, “Space Weather”, “Journal of Physics A”, “Journal of Geophysical Research”.

Referee for the National Science Foundation of the United States of America.

December, 2014:

Italian National Delegate to Commission G in URSI (Union Radio-Scientifique Internationale).

November 10, 2014 - March 2016:

Delegate of the Institute for Complex Systems of the National Research Centre in the Outreach Working Group of the CNR Area of Florence.

October 2014:

Member of the Foundation Assembly of the “Space Weather Italian Community (SWICO)”.

October 2011 - November 2012:

Project Manager of the Project “Inter-Satellite & In Situ Plasmaspheric Monitoring and Modelling” (ISIS), ESA Contract 4000103331/11/NL/WE between ESA and ISC-CNR.

From December 28, 2001:

Researcher with permanent position at the Italian CNR Consiglio Nazionale delle Ricerche (National Research Council).

From March 12, 2001:

Qualified teacher of Physics at the Italian State High School (Ministero dell’Istruzione, dell’Università e della Ricerca) with a permanent position.

PhD:

PhD in Theoretical Physics at the University of Perugia (www.unipg.it), obtained on February 14, 2000.

Title of PhD thesis:

Quasi thermal emissions in string theory and Hawking effect.

PhD supervisor: Prof. Giorgio Immirzi, University of Perugia.

Undergraduate:

Università degli Studi di Firenze (University of Florence), Florence (Italy), 1989/90 - 1995/96.

Laurea degree in Physics (roughly equivalent to M.Sc.).

First honour marks, 110/110 *cum laude*, University of Firenze, July 15, 1996.

Title of the M.Sc. thesis:

Variabili canoniche collettive e relative per un campo di Klein-Gordon classico (Canonical collective and relative variables for a classical Klein-Gordon field).

M.Sc. Supervisor: Prof. Giorgio Longhi, University of Florence.

4 Academic and research references

Dr Giuseppe Consolini, Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, via Fosso del Cavaliere 100, I-00133 Roma, Italy, e-mail: giuseppe.consolini@iaps.inaf.it.

Dr Emanuele Tassi, Centre de Physique Théorique, CNRS, Aix-Marseille Universités, Campus de Luminy, Marseille, France, tel. +33 (0)4-91269512, e-mail: tassi@cpt.univ-mrs.fr.

Prof Cathryn C. N. Mitchell, Department of Electric and Electronic Engineering of the University of Bath, BA2 7AY, United Kingdom, tel. +44 (0)1225 386610, e-mail: C.N.Mitchell@bath.ac.uk.

Dr Paolo Spalla, retired from Istituto di Fisica Applicata “Nello Carrara”, C.N.R. di Firenze, Sesto Fiorentino, Italy, tel. 0039-349-3516003, e-mail: paolo-horse@gmail.com.

Prof Giorgio Longhi, retired from Università degli studi di Firenze, via Sansone 1, 50019 Sesto Fiorentino, Italy tel. 0039-055-4572312, e-mail: longhi@fi.infn.it.

5 Scientific collaborations

IAPS-INAF (Dr G. Consolini): aspects of complexity in space plasma dynamics.

ISC-CNR (Dr S. Focardi): phase space analysis of ecological systems.

CPT-University of Marseille (Dr E. Tassi): dissipative regimes of plasmas and metriplectic framework.

University of Turin, Italy (Prof S. Dalmazzone): ecological modelling of marine vegetal population.

CBK-PAN, Poland (Dr M. Grzesiak): ionospheric scintillation and turbulence.

University of Bath, UK (Dr B. Forte, Dr C. Mitchell): ionospheric scintillation and tomography. Information theory in dynamical systems.

INGV in Roma (Dr P. De Michelis, Dr G. De Franceschi): ionospheric scintillation and space weather, plasma turbulence in the near-Earth space.

6 Operative projects

- “Response of the equatorial electrodynamics to geomagnetic pulsations”, bilateral project between CNR (Italy) and ASRT (Academy of Scientific Research and Technology, Egypt). Role: *Principal Investigator*. SW.
- “Observing, Modelling And Testing Synergies And Trade-Offs For The Adaptive Management Of Multiple Impacts In Coastal Systems (TETRIS)”, PRIN 2010-2011 - “Research Programmes of National Interest”. Role: *researcher in the node of ISC-CNR Florence*. ME.
- “Inter-Satellite & In Situ Plasmaspheric Monitoring and Modelling (ISIS)”. Cooperating bodies: ISC-CNR, INGV, TAS-I. Role: *Project Manager*. SW.
- “Training Research and Application Network to Support the Mitigation of Ionospheric Threats (TRANSMIT)”. Consortium: University of Nottingham (UoN), UK (Prime); Politecnico di Torino (PoliTo), Italy; Space Research Centre (SRC), Poland; Technical University Berlin (TUB), Germany; University of Bath (UoB), UK; University of Nova Gorica (UNG), Slovenia; University of Zagreb (UoZ), Croatia; German Aerospace Center (DLR), Germany; IEEA, France; INGV, Italy. Role: *scientific advisor and teacher*. SW.

- ITER consortium (International Thermonuclear Experimental Reactor), project involving ISC through the ENEA collaboration with EURATOM, see webpage: <http://www.iter.org/default.aspx>. Role: *researcher*. PP.
- ROSA (Radio Occultation for Sounding the Atmosphere), project of the Italian Space Agency ASI, involving ISC-CNR and IFAC-CNR, webpage: <http://www.asi.it/Rosa/RosaEN/ROSA.htm>. Role: *researcher*. SW.

7 Publications⁴

7.1 Refereed papers on journals

1. Longhi, G., Materassi, M., "A canonical realization of the BMS algebra", (1999) *Journal of Mathematical Physics*, 40 (1), pp. 480-500. PP.
2. Longhi, G., Materassi, M., "Collective and relative variables for a classical Klein-Gordon field", (1999) *International Journal of Modern Physics A*, 14 (21), pp. 3387-3420. PP.
3. Lusanna, L., Materassi, M., "A canonical decomposition in collective and relative variables of a Klein-Gordon field in the rest-frame Wigner-covariant instant form", (2000) *International Journal of Modern Physics A*, 15 (18), pp. 2821-2916. PP.
4. Materassi, M., "Conformal nature of the Hawking radiation", (2000) *Journal of High Energy Physics*, 4 (4), pp. XLI-13. PP.
5. De Franceschi, G., Alfonsi, L., Perrone, L., Materassi, M., "Report on the long term trend of the critical frequency of the F2 layer at high latitudes", (2002) *Acta Geodaetica et Geophysica Hungarica*, 37 (2-3), pp. 297-302. SW.
6. Alfonsi, L., De Franceschi, G., Perrone, L., Materassi, M., "Long-term trends of the critical frequency of the F2 layer at northern and southern high latitude regions", (2002) *Physics and Chemistry of the Earth*, 27 (6-8), pp. 607-612. SW.
7. Materassi, M., Mitchell, C.N., Spencer, P.S.J., "Ionospheric Imaging of the Northern Crest of the Equatorial Anomaly", (2003) *Journal of Atmospheric and Solar-Terrestrial Physics*, 65 (16-18), pp. 1393-1400. SW.
8. Wernik, A.W., Alfonsi, L., Materassi, M., "Ionospheric irregularities, scintillation and its effect on systems", (2004) *Acta Geophysica Polonica*, 52 (2), pp. 237-249. SW.
9. Materassi, M., Mitchell, C.N., "Imaging of the Equatorial Ionosphere", (2005) *Annals of Geophysics*, 48 (3), pp. 477-482. SW.

⁴PP Pure Physics, SW Space physics and Space weather, ME Mathematical Ecology.

10. Materassi, M., Mitchell, C.N., "A Simulation Study into Constructing of the Sample Space for Ionospheric Imaging", (2005) *Journal of Atmospheric and Solar-Terrestrial Physics*, 67 (12 SPEC. ISS.), pp. 1085-1091. SW.
11. Yordanova, E., Bergman, J., Consolini, G., Kretzschmar, M., Materassi, M., Popielawska, B., Roca-Sogorb, M., Stasiewicz, K., Wernik, A.W., "Anisotropic scaling features and complexity in magnetospheric-cusp: a case study", (2005) *Nonlinear Processes in Geophysics*, 12 (6), pp. 817-825. SW, PP.
12. Materassi, M., Wernik, A.W., Yordanova, E., "Statistics in the p-model", (2006) *Chaos, Solitons and Fractals*, 30 (3), pp. 642-655. SW, PP.
13. Zapfe, B.D., Materassi, M., Mitchell, C.N., Spalla, P., "Imaging of the Equatorial Anomaly over South America - A simulation study of total electron content", (2006) *Journal of Atmospheric and Solar-Terrestrial Physics*, 68 (16), pp. 1819-1833. SW.
14. Materassi, M., Mitchell, C.N., "Wavelet analysis of GPS amplitude scintillation: a case study" (2007) *Radio Sci.*, 42 (1). SW.
15. Materassi, M., Wernik, A., Yordanova, E., "Determining the verse of magnetic turbulent cascades in the Earth's magnetospheric cusp via transfer entropy analysis: Preliminary results", (2007) *Nonlin Processes Geophys*, 14, p. 153. SW, PP.
16. Wernik, A.W., Alfonsi, L., Materassi, M., "Scintillation modeling using in situ data", (2007) *Radio Sci.*, 42. SW.
17. Materassi, M., Consolini, G., "Magnetic reconnection rate in space plasmas: a fractal approach", (2007) *Physical Review Letters*, 99 (17), art. no. 175002. SW, PP.
18. Materassi, M., Consolini, G., "Turning the resistive MHD into a stochastic field theory", (2008) *Nonlinear Processes in Geophysics*, 15 (4), pp. 701-709. PP.
19. Materassi, M., Alfonsi, L., De Franceschi, G., Romano, V., Mitchell, C., Spalla, P., "Detrend effect on the scalograms of GPS power scintillation", (2009) *Advances in Space Research*, 43 (11), pp. 1740-1748. SW.
20. Y. Beniguel, V. Romano, L. Alfonsi, M. Aquino, A. Bourdillon, P. Cannon, G. De Franceschi, S. Dubey, B. Forte, V. Gherm, N. Jakowski, M. Materassi, T. Noack, M. Pożoga, N. Rogers, P. Spalla, H. J. Strangeways, E. M. Warrington, A. Wernik, V. Wilken, N. Zernov, "Ionospheric scintillation monitoring and modelling", *Annals of Geophysics*, 52, 391 (2009). SW.

21. Barucci, A., L. Noferini, A. Facchini, D. Fanelli, M. Materassi, “Turbulent fluctuations in coherent radar measurements”, *EPL*, **89** (2010) 20006. Doi: 10.1209/0295-5075/89/20006. PP.
22. Forte B., Materassi M., Alfonsi L., Romano V., De Franceschi G. and Spalla P. (2010), “Optimum parameter for estimating phase fluctuations on transionospheric signals at high latitudes”, *Advances in Space Research*, doi: 10.1016/j.asr.2010.04.033. SW.
23. Materassi, M., “Stochastic Lagrangian for the 2D Visco-Resistive Magneto-Hydrodynamics”, *Plasma Phys. Control. Fusion* **52** (2010) 075004. PP:
24. De Michelis, P., G. Consolini, M. Materassi, R. Tozzi, “An information theory approach to storm-substorm relationship”, *Journal of Geophysical Research*, vol. 116, A08225, doi:10.1029/2011JA016535, 2011. SW, PP.
25. Materassi, M., L. Ciralo, G. Consolini, N. Smith, “Predictive Space Weather: an information theory approach”, *Advances in Space Research* **47** (2011), pp. 877-885, doi:10.1016/j.asr.2010.10.026. SW.
26. Forte, B., M. Materassi, L. Alfonsi, V. Romano, G. De Franceschi, P. Spalla, “Optimum parameter for estimating phase fluctuations on transionospheric signals at high latitudes”, *Advances in Space Research* **47** (2011) 2188-2193. SW.
27. Z. T. Katamzi, N. D. Smith, C. N. Mitchell, P. Spalla, M. Materassi, “Statistical analysis of traveling ionospheric disturbances using TEC observations over more than one solar cycle”, *Journal of Atmospheric and Solar-Terrestrial Physics* vol. 74 January, 2012. p. 64-80. SW.
28. Materassi, M. & Tassi, E. (2012), “Metriplectic Framework for Dissipative Magneto-Hydrodynamics”, *Physica D*, Volume 241, Issue 6, 15 March 2012, Pages 729–734. PP.
29. Materassi, M. & Tassi, E. (2012), “Algebrizing friction: a brief look at the Metriplectic Formalism”, *Intellectual Archive Journal*, Issue of July 2012, Toronto: Shiny World. PP.
30. Jeffrey Baumgardner, Joei Wroten, Michael Mendillo, Carlos Martinis, Cesare Barbieri, Gabriele Umbriaco, Cathryn Mitchell, Joe Kinrade, Massimo Materassi, Luigi Ciralo and Marc Hairston, “Imaging space weather over Europe”, *SPACE WEATHER*, VOL. 11, 1–10, doi:10.1002/swe.20027, 2013. SW.
31. Materassi M., G. Consolini, N. Smith and R. De Marco, “Information Theory Analysis of Cascading Process in a Synthetic Model of Fluid Turbulence”. *Entropy* 2014, **16**, 1272-1286. PP.
32. Materassi, M. “Metriplectic Algebra for Dissipative Fluids in Lagrangian Formulation”. *Entropy* **2015**, 17 (3), 1329-1346. PP.

33. Consolini, G., M. Materassi, M. F. Marcucci, G. Pallocchia, “Statistics of Velocity Gradient Tensor in Space Plasma Turbulent Flows”, *The Astrophysical Journal*, 812:84 (5pp), 2015 October 10, doi:10.1088/0004-637X/812/1/84. PP.
34. Materassi M., G. Consolini, “The Stochastic Tetrad MHD via Functional Formalism”, in press in the Special Issue “Complex Plasma Phenomena in the Laboratory and in the Universe” of the *Journal of Plasma Physics* (2015), volume 81, issue 06. PP.
35. Materassi M., “Entropy as a Metric Generator of Dissipation in Complete Metriplectic Systems”, Special issue *Selected Papers from 2nd International Electronic Conference on Entropy and Its Applications* of *Entropy*, *Entropy* 2016, **18**, 304; doi:10.3390/e18080304. PP.
36. Materassi M., G. Innocenti, D. Berzi, S. Focardi, “Kleptoparasitism and complexity in a multi-trophic web”, *Ecological Complexity* 29 (2017) 49–60. ME.
37. Focardi S., Materassi M., Innocenti G., Berzi D., “Kleptoparasitism and Scavenging Stabilize Ecosystem Dynamics”, *The American Naturalist*, vol. 190, n. 3, September 2017, doi = 10.1086/692798, <https://doi.org/10.1086/692798>. ME.
38. Alfonsi L.; Wernik A.W.; Materassi M.; Spogli L., “Modelling ionospheric scintillation under the crest of the equatorial anomaly”, *Advances in Space Research*, Volume 60, Issue 8, 15 October 2017, Pages 1698-1707. SW.

7.2 Books

1. Vespe F., Perona G., De Cosmo V., Petitta M., Materassi M., Tartaglione N., Zin A., Notarpietro R., Benedetto C., Casotto S., Speranza A., Sutera A., “ROSA - The Italian Radio Occultation Mission Onboard the Indian OCEANSAT-2 Satellite” in “New Horizons in Occultation Research: Studies in Atmosphere and Climate”, editors: Steiner A., Pirscher B., Foelsche U., pp. 263-274, Springer, Berlin (2009), ISBN: 9783642003202. SW.
2. Massimo Materassi, Giuseppe Consolini and Emanuele Tassi (2012). “Sub-Fluid Models in Dissipative Magneto-Hydrodynamics”, “Topics in Magnetohydrodynamics”, Dr. Linjin Zheng (Ed.), ISBN: 978-953-51-0211-3, InTech, DOI: 10.5772/36022.
Available at:
<http://www.intechopen.com/books/topics-in-magnetohydrodynamics/sub-fluid-models-in-dissipative-magneto-hydrodynamics>,
PP.
3. Materassi, M., “Lagrangian Hydrodynamics, Entropy and Dissipation”, accepted for publication in “Hydrodynamics”, editor Harry Edmar Schulz, ISBN: 978-953-51-4126-6, InTech Publications, Reijka (2014). PP.

4. Materassi, M., Forte, B., Coster, A., Skone, S. (editors), “The Dynamical Ionosphere”, Elsevier (in preparation). SW, PP.

7.3 International school and university lectures

1. Materassi, M., “Stochastic approaches to space plasmas”, Complexity and Turbulence in Space Plasmas, 18-22 September 2017, L’Aquila (Italy), webpage: <http://www.cifs-iss.org/programme.asp>. PP.
2. Materassi, M., “Origin, Structure and Morphology of the Ionosphere”, invited lecture at the Summer School “Underlying causes of ionospheric effects on radio wave propagation”, 19th - 22nd September 2011, Warsaw (Poland). SW.
3. Materassi, M., “Information Theory and Space Weather”, invited lecture given on June 9, 2012, at the “First European School on: fundamental processes in space weather: a challenge in numerical modeling”, 4-9 June 2012 Spineto, Tuscany, Italy, organized by SWIFF Co-organizer: CINECA, COST Action ES0803 Supported by: Spineto Studi, INAF, Dip. Fisica Pisa, webpage: http://www.df.unipi.it/~califano/SWIFF_School/EU_School_on_Space_Weather.html. SW, PP.

8 Students⁵

8.1 Bachelor students

1. Giulio Mariani (2013, Università di Firenze), “Fluidodinamica dei sistemi frattali” (Fluid Dynamics of Fractal Systems). PP.
2. Lorenzo Maffi (2014, Università di Firenze), “Sistemi trofici e biforcazioni” (Trophic Systems and Bifurcations). ME.

8.2 PhD students

1. Maria Letizia Di Bartolo (2014, Università di Firenze), “Modelling leaf dynamics and assessing the carbon storage capacity of a meadow of *Posidonia oceanica* ”. ME.

9 Work experience

From September 2007

Lecturer of General Physics at the University of Florence, in the Faculty of Engineering.

From June 2004

⁵PP Pure Physics, SW Space physics and Space weather, ME Mathematical Ecology.

Affiliated to the “Istituto dei Sistemi Complessi” of the National Council of Researches (ISC-CNR).

From June 2004 to December 2004

Post-doc scholarship in the European Research Training Network “Turbulent Boundary Layers in Geospace Plasmas” at the Space Research Center of the Polish Academy of Sciences (CBK-PAN), Bartycka 18A, Warsaw (Poland).

From December 28, 2001

Researcher at the Istituto di Fisica Ricerca Onde Elettromagnetiche “Nello Carrara” in Florence (<http://www.ifac.cnr.it>), C.N.R. (National Research Council).

2001

Teacher of Physics at the Italian State High School (permanent position winner).

2000

Office worker at the Town Administration of Sesto Fiorentino, at the Town-planning Office (Ufficio Assetto del Territorio).

Post-doc scholarship in “Variability of Ionosphere” at the former Istituto Ricerca Onde Elettromagnetiche “Nello Carrara” in Florence (now Istituto di Fisica Applicata “Carrara”).

1998

Co-author of the project: CDCS “Centro per la Divulgazione della Cultura Scientifica” (Center for the Scientific Culture Divulcation) in Sesto Fiorentino.

Member of the XX State Examining Board at the High School “Enriques”, Castelfiorentino (Firenze).

1997

Teacher of Physics at the Florence private school C.E.P.U., via San Gallo 103, 50100 Firenze (Italy), tel. 39-055-474960.

Organization assistant at the “VII Settimana della Cultura Scientifica” (Seventh Scientific Culture Week) of the University of Florence.