

# Curriculum Vitae

Andrea Cintio

## Personal details

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Birth date and place

Marital status

Citizenship

## Education

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**12.2011** Ph.D. degree - by Physics Department, University of Pisa (XXI Cycle)

thesis title:

*Absorption of an ultrashort intense laser pulse as a few degrees of freedom Hamiltonian system;*

advisor: Prof. Fulvio Cornolti.

**10.2003 - 9.2004** Post-Graduate Specialization School for Secondary School Teaching (SSIS), University of Pisa.

**9.2002** Graduate degree (Diploma di laurea vecchio ordinamento (V.O.)) - Physics Department, University of Pisa

graduation: 110/110 cum laude

thesis title:

*Regole di somma per sistemi infiniti;*

advisor: Dr. G. Morchio

**7.1988** High school diploma

## Research experience.

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### Postdoctoral Research

**1.2021 - 9.2024** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino), one-year fellowship renewed three times

- Research fellow (assegnio di ricerca) working on 'Caratterizzazione dielettrica di materiali ad alta frequenza e temperatura'. Call for selection: IPCF-AR-002-2020-PI prot. AMMCEN n. 0074474, date November 20th, 2020.

Development of models of microwave chemical vapor infiltration processes of oxide and non-oxide ceramic composites in multimode reactors based on multiphysics programs. The objective is to increase the efficiency in the coupling between the microwave sources and the reactor and keep the control over the thermal dynamics. The serious analysis performed to this aim demands to take into account many factors relevant to the interaction of the microwave radiation with the sample and the cavity walls, the dielectric properties of the material, the thermal exchanges of the sample, the geometry of the apparatus, particularly whether the sample is static or rotating.

In addition, the activity focused on the design of a program in LabVIEW development software for the monitoring of microwave heating processes in a resonant cell through the control of a vector network analyzer and a thermal camera. The emission power of the vector network analyzer and the temperature of the sample are promptly regulated by means of a PID controller.

**9.2019 - 1.2021** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino), fellowship grant renewed after the first year

- Research fellow (assegno di ricerca) working on 'Caratterizzazione dielettrica ad alta frequenza e temperatura'. Call for selection: IPCF-AR-003-2019-PI prot. AMMCEN n. 0045981, date June 26th, 2019.

Development of a methodology for the design of overmoded resonant cavities in reactors for microwave-assisted processes. The aim is the development of a rigorous numerical analysis that is necessary for the determination of the dimensions of the reactor chamber to ensure that optimal coupling conditions are reached for different samples and operating conditions, on the basis of the knowledge of both the dielectric properties of the sample and the resistivity of the chamber walls.

Also, the research activity focused on the measurement of both the dielectric constant and the conductivity of crystalline silicon at microwave frequencies for temperatures from 25 up to 1200 °C.

**2.2018 - 2.2019** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino)

- Research fellow (assegno di ricerca) working on 'Caratterizzazione dielettrica di materiali ad alta frequenza e temperatura' under the supervision of dott. Giuseppe Annino. Call for selection: n IPCF-004-2017-PI - Protocollo IPCF - CNR n.6288, date October 26th, 2017.

The fellowship activity focused on dielectric characterizations *as functions of the temperature* of materials with very different properties (rubber samples and SIC-based ceramic composites). A method of resonant cavity measurement was adopted using an apparatus that allows to operate in a temperature range up to 1200 °C. The measurement procedure consists of an electromagnetic data acquisition and an extraction of the dielectric quantities from the data based on a *rigorous* modelling of the cavity field pattern. Different procedures were created in order to automate and speed up the data analysis, both for the electromagnetic curves and for the determination of the dielectric quantities.

**3.2017 - 3.2017** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino)

- Project and manufacturing of quartz sample-holders with low insertion losses, suited for operating in vacuum conditions in microwave resonant cavities for high-temperature dielectric measurements. IPCF - CNR Prot. no. 0000009, date January 3rd, 2017.

**1.2017 - 1.2017** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino)

- Manufacturing of quartz sample-holders with low insertion losses for high-temperature dielectric measurements in microwave resonant cavities. Microwave dielectric characterization of several samples at temperatures up to 1200 °C. IPCF - CNR Prot. no. 0000009, date January 3rd, 2017.

**6.2016 - 9.2016** Collaboration agreement with the group of Mario D'Acunto at the Institute of structure of matter (ISM) - CNR, Roma.

- Modeling and numerical simulation of the effects of nanoparticle dispersion on the mechanical properties of nanoparticle/polymer composites. Biological applications of metal nanoparticles.

**5.2016 - 5.2016** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino)

- Project and manufacturing of quartz sample-holders with low insertion losses for high-temperature dielectric measurements in microwave resonant cavities. IPCF - CNR Prot. no. 0001912, date May 2nd, 2016.

**1.2016 - 4.2016** Institute for Chemical-Physical Processes (IPCF) - CNR, Pisa (research adviser: Giuseppe Annino), under the research project HELM, High-frequency ELeCTro-Magnetic technologies for advanced processing of ceramic matrix composites and graphite expansion, June 2012 - May 2016.

- Numerical modelling of the performance of a resonant microwave cavity for the heating of a planar sample of silicon carbide.

**5.2014 - 1.2015** (8 months) Institute of Biophysics - CNR, Pisa (research adviser: Dr. Angelo Di Garbo) – contratto di prestazione d’opera artt. 2222 e seguenti del c.c.

- Numerical analysis of cerebral cortex signals in tetanus toxin models.

**10.2013 - 3.2014** (6 months) Institute of Biophysics - CNR, Pisa (research adviser: Dr. Angelo Di Garbo) – contratto di prestazione d’opera artt. 2222 e seguenti del c.c.

- Numerical analysis of the effects of environment on the signal scaling of cortex signals from mice in different environmental conditions.
- Numerical simulations of seizure-like dynamics of the cortex-thalamus coupling in a realistic model of the cortico–thalamo–cortical network.

## Doctoral Research

**2.2006 - 12.2011** Physics Department, University of Pisa (research adviser: Prof. Fulvio Cornolti).

- One-degree of freedom models of the interaction of an intense, short, laser pulse with both solid and clustered matter.

## Publications

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### Peer-reviewed journal papers

7. R. D’Ambrosio, A. Mohammad Gholipour Aghdam, A. Cintio, A. Korschak, J. Schmidt, J. Maier, L. Toma, L. Del Campo, O. Rozenbaum, M. Mallah, S. Probst, G.L. Vignoles, R. Bechara, A. Lazzeri, G. Annino  
*Improved densification of SiC<sub>f</sub>/SiC composites by microwave-assisted chemical vapor infiltration process based on multifrequency solid-state sources excitation*, JECS **45** 116950 (2025).  
Available online <https://www.sciencedirect.com/science/article/pii/S0955221924008239>
6. A. Cintio, A. Michelangeli  
*Self-adjointness in quantum mechanics: a pedagogical path*. Quantum Stud.: Math. Found. **8**, 271 (2021).
5. R. D’Ambrosio, A. Cintio, A. Lazzeri, G. Annino  
*Design of an overmoded resonant cavity-based reactor for ceramic matrix composites production* Chem. Eng. J. **405** 126609 (2021). Accepted 9 August 2020. Available online 12 August 2020.

4. F. Vallone, E. Vannini, A. Cintio, M. Caleo and A. Di Garbo  
*Time evolution of interhemispheric coupling in a model of focal neocortical epilepsy in mice*  
Phys. Rev. E **94**, 032409 (2016).
3. F. Vallone, A. Cintio, M. Mainardi, M. Caleo and A. Di Garbo  
*Existence of anticorrelations for LFPs recorded from mice reared in standard conditions and environmental enrichment* Phys. Rev. E **91** , 012702 (2015).
2. F. Vallone, A. Cintio, S.Chillemi, and A. Di Garbo  
*Thalamic inputs modulate cortical activity: Possibility to control the generation and the termination of seizure-like behaviour* Neurocomputing **151**, 34 (2015)
1. A. Cintio, G. Morchio  
*Sum rules and density waves spectrum for nonrelativistic fermions*  
Journal of Mathematical Physics **50**, 042102 (2009)

### Outline of contributions.

7. An effective control of the thermal profile of a Ceramic Matrix Composite preform in a Chemical Vapor Infiltration threatment can be achieved in a three-port reactor through a multifrequency excitation.

My contribution to the paper was mostly in preparing a multiphysics model of microwave heating in a three-port reactor where, in general, the emission frequencies of the three solid sources are distinct from each other. The model is used for the self-consistent solution to the electromagnetic and thermal problems in the reactor for the computation of the most suited frequencies of excitation.

5. In the research activity whose results are described in the paper, I contributed to the development of the numerical model applied to the coupled electromagnetic and thermal problems. The numerical study is aimed at a rigorous evaluation of the electromagnetic fields in the cavity and a self-consistent computation of the heating dynamics of the sample. The comparison of the results with the measurements, in particular the fraction of power dissipated in the sample, allows to check the computation of the cavity volume, which is performed on the basis of general basic arguments and using simplifying hypotheses. A contribution to the design of the reactor is the determination of the cavity volume for which a given mode density is obtained.  
In addition, I collaborated on the microwave dielectric characterization of the SiC-based materials chosen in the densifying infiltration process and the material for the electrical and thermal isolations of the infiltrated preform.

4. My work was in the application of various tools of linear and nonlinear dynamics to the analysis of LFP signals detected from both hemispheres of mouse models of induced unilateral epilepsy so as to determine the evolution of the level of interhemispheric coupling.
3. I collaborated on the long range correlation analysis of LFP signals recorded from the motor and visual cortices of mice reared in environmental enrichment and standard conditions. The long range correlation is ascertained through the consistent values of three parameters (the fractal dimension, the Hurst exponent and the scaling properties of the power spectrum) obtained using the Higuchi method, the detrended fluctuation analysis and the spectral analysis.
2. I collaborated to investigate a model of the cortico-thalamo-cortical network. In particular, manipulating some model parameters one try to understand how thalamic inputs can modulate seizure-like behaviours involved in the epilepsy.

1. I dealt with the computation of some frequency sum rules, in the limit of large wavelength, in extended quantum systems of nonrelativistic fermions. Energy spectra are expressed in terms of time derivatives of appropriate commutators with local Hamiltonians. More specifically, the limit of zero momentum follows from relations between frequency moments of the energy spectral measures associated with density waves excitations.

## Books

*Trails in Modern Theoretical and Mathematical Physics - A Volume in Tribute to Giovanni Morchio*, ed. by A. Cintio, A. Michelangeli (Springer, 2023)

A. Cintio (2020) *Il problema della previsione in un sistema deterministico classico*

In A. Marinucci, S. Salvia, L. Bellotti (eds) **Scienza e filosofia della complessità** (chapter 2), Roma IT, Carocci ed.

A. Marinucci, S. Salvia, A. Cintio (2015) *La meccanica classica. Storia, filosofia e fondamenti.*

In P. Pecere (ed.) **Il libro della natura** (chapter 6), Roma IT, Carocci ed.

M. D'Acunto, A. Cintio et al. (2016) *Near-Field identification of gold nanoshells inside cells.*

In A. Bianconi, A. Marcelli (eds.) **Atomically Controlled Surfaces Interfaces and Nanostructures** (pp 273-274), Roma IT, Superstripes Press

## Submitted for publication

A. Cintio, F. Cornolti

*Non-perturbative features of driven scattering systems* (submitted to Chaos)

<http://arxiv.org/abs/1206.1922>

## Conference presentations

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### Conference abstracts accepted as talks

7. A. Cintio, R. D'Ambrosio, G. Annino

*High-temperature dielectric characterization for microwave-assisted processes* - Giornate di Dipartimento DSCTM 2023, Sestri Levante, Italy, Oct 18-20, 2023.

6. A. Cintio, R. D'Ambrosio, G. Annino

*Microwave dielectric characterization of high-loss samples* - in Procs. 19th Int. Conf. on Microwave High Frequency Applications AMPERE 2023, Cardiff, United Kingdom, Sept 11-14, 2023, p. 325

5. R. D'Ambrosio, A. Cintio, M. Mallah, S. Probst, A. Lazzeri, G. Annino

*Microwave-Assisted Chemical Vapor Infiltration Processing of SiC<sub>f</sub>/SiC Composites Aided by Multiport-Multifrequency Solid-State Sources Excitation* - in Procs. 19th Int. Conf. on Microwave High Frequency Applications AMPERE 2023, Cardiff, United Kingdom, Sept 11-14, 2023, p. 65.

4. A. Cintio, R. D'Ambrosio, C. Prentice, M. Farnham, A. Lazzeri, G. Annino

*High temperature dielectric properties of different SiC<sub>f</sub>/SiC samples at various infiltration levels* - Ceramics in Europe 2022, Krakow, Poland, July 10-14, 2022.

3. R. D'Ambrosio, G. Annino, A. Cintio, A. Lazzeri  
*Design of a pilot-scale Microwave Heated Chemical Vapor Infiltration plant: An innovative approach* - 10th International Conference on High Temperature Ceramic Matrix Composites, Bordeaux, France, Sept 22-26, 2019.
2. R. D'Ambrosio, G. Annino, A. Cintio, A. Lazzeri  
*Design of an Overmoded Resonant Cavity-Based Reactor for SiC-Based Ceramic Matrix Composites Production* - 17th International Conference on Microwave and High Frequency Applications AMPERE 2019, Valencia, Spain, Sept 9-12, 2019.
1. G. Annino, A. Cintio, R. D'Ambrosio, A. Lazzeri  
*Dielectric Characterization of Si, SiC, SiC/SiC, and C/SiC Samples* - 17th International Conference on Microwave and High Frequency Applications AMPERE 2019, Valencia, Spain, Sept 9-12, 2019.

### **Outline of contributions.**

- 2.-3. I contributed to the building of the 3-D model of the reactor cavity adopted for solving the electromagnetic and thermal problems in the reactor design.
1. In the microwave dielectric characterization my contribution was in two ways: I collaborated on the measurement of the electromagnetic quantities of the cavity mode and on the data analysis, designed for materials with large variability of the dielectric properties when the temperature is changed.

### **Conference abstracts accepted as posters**

G. Annino, A. Cintio, R. D'Ambrosio, C. Prentice, M. Farnham, A. Lazzeri  
*Dielectric characterization of ceramic matrix composites at high temperatures* - Poster contribution at 11th International Conference on High Temperature Ceramic Matrix Composites, Jeju, South Korea, Aug 27-31, 2023.

A. Cintio, R. D'Ambrosio, A. Lazzeri, G. Annino  
*High temperature dielectric characterization of SiC-based Ceramic Matrix Composites* - Poster contribution at 10th International Conference on High Temperature Ceramic Matrix Composites, Bordeaux, France, Sept 22-26, 2019.

G. Annino, A. Cintio and A. Lazzeri  
*Microwave dielectric characterization up to 1200°C* - Poster contributions P-17 - Programme & Book of Abstracts - 9th International Conference on Broadband Dielectric Spectroscopy and its Applications, Pisa IT, Sept. 11-16 2016.

### **Seminar talks**

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12.12.2013 *Protein aggregation: mechanism, dynamics and models* - Institute of Biophysics CNR, Pisa.

### **Unpublished internal reports.**

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G. Annino, A. Cintio. *Electromagnetic and thermal profiles in the lab-scale hybrid radiant/MW CVI reactor* - Internal report of the HELM project, May 2016.

## **Conferences, Summer Schools attended.**

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Giornate di Dipartimento CNR - DSCTM 2023, Oct 18-20 2023 - Sestri Levante, Italy.

Ceramics in Europe 2022, July 10-14 2022, Krakow, Poland.

INdAM meeting *Contemporary Trends in the Mathematics of Quantum Mechanics*, July 4-8 2016 - Rome, Italy.

*Conference on Stability and Instability in Mechanical Systems: Recent Progress and Mathematical Theory*, September 22 - 26 2008, CRM - Barcelona, Spain.

*Advanced Course on Stability and Instability in Mechanical Systems*. September 15 - 19 2008 , CRM - Barcelona, Spain. Courses taken on averaging, variational and topological methods in Hamiltonian systems, KAM theory and Normal Hyperbolic theory.

*International School on Quantum Electronics, 43rd Course, "Matter in Super-Intense Laser Fields"* June 27 - July 5 2006 , Erice, Italy. Courses taken on the interaction of atoms, molecules and clusters with super-intense laser pulses and few cycle laser pulses.

## **Teaching experience.**

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**9.2017 - 2.2018** teaching mathematics at *Istituto agrario C. Cattaneo* in Cecina.

**7.2017 - 7.2017** teaching mathematics and physics at *Liceo F. Enriques* (scientific High School) in Livorno.

**5.2017 - 6.2017** teaching mathematics at *Liceo F. Cecioni* (scientific High School) in Livorno.

**2.2017 - 3.2017** teaching mathematics and physics at *Liceo F. Cecioni* (scientific High School) in Livorno.

## **Abilities**

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### **Languages**

*Italian* mother tongue

*English* upper intermediate

*French* basic

### **Informatics**

*Operating Systems*: Linux/Unix, Windows

*Typesetting packages*: Latex, MSOffice, OpenOffice.

*Mathematical and numerical packages*: **Matlab, Matematica, IDL.**

*Platform for Physics-Based Modeling and Simulation*: **Comsol Multiphysics.**

*Software to develop measurement, test, and control systems* : **LabVIEW.**

*Numerical skills*: **Fortran, C programming languages; basics of Particle in Cell coding.**

**Research background: applied mathematics - numerical modeling -experimental physics.**

- Applications of Hamiltonian perturbation methods to models of laser - plasma interaction, with few degrees of freedom.
- *Hamiltonian perturbation theory*: KAM theory and Nekhoroshev's perturbation methods.
- *Chaotic scattering*: non-hyperbolic scenario.
- *Deterministic chaos*.
- *Algebraic approach to the quantum mechanics of infinite systems*. Dispersion relations in the limit for long wavelength in the fundamental and thermal representations of observable algebras generated by localized canonical variables.
- Numerical techniques and statistical methods for the analysis of temporal series data. Mathematical modelling of biological systems.
- Electromagnetic field theory in cavities and numerical analysis of microwave circuits and dielectric resonators:
  - modelling and simulation of electromagnetic field distributions and resonance effects in resonant cavities for addressing microwave heating phenomena and dielectric response of materials with conductivity properties depending on the temperature.
- Fundamentals of the theory and the numerical modeling of polymer/nanoclay composites.
- Characterization of both devices and materials in the microwave range through perturbation techniques.
  - Characterization of the dielectric properties of materials in a resonant cavity from room temperature to 1200°C.
  - Experimental investigation of both nonradiative field patterns and far-field ones of dielectric disk resonators.