

*Milano, September 28th, 2015*

## **Curriculum Vitae - Paolo BIAGIONI**

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## Education and training

March 2004 -  
February 2007

### **Ph.D. in Physics**

I spent three years as a Ph.D. candidate in the surface physics group at the Physics Department, Politecnico di Milano. My main activities were in the field of nano-optics, i.e. the study of light-matter interactions at the nanometer scale, and in the application of sub-diffraction optical techniques (in particular, scanning near-field optical microscopy). During the third year, I spent six months by the group of prof. Dieter Pohl, University of Basel (CH), working on gold nano-antennas for visible light.

Title of the thesis: “*Field enhancement and confinement at optical wavelengths: non-linear near-field microscopy and resonant metal nanoparticles*”.

Supervisor: prof. Lamberto Duò.

Thesis Defense: May 15th, 2007. Final evaluation: with honors.

September 1997  
- October 2003

### **Master's Degree in Electronic Engineering**

Obtained with honors from Politecnico di Milano on October 16<sup>th</sup>, 2003.

Title of the thesis: “*Caratterizzazione magnetica del trilayer Fe/NiO/Fe mediante tecniche spettroscopiche e ottiche*” (in Italian, “*Magnetic characterization of the Fe/NiO/Fe trilayer by means of spectroscopic and optical techniques*”).

Supervisor: prof. Lamberto Duò.

September 1992  
- June 1997

**Scientific high-school diploma** (Diploma di Maturità Scientifica), obtained on July 25th, 1997 from Liceo Scientifico Statale A. Einstein in Milano. Final evaluation 60/60.

## Work experience

October 2014  
to present

**Associate Professor**, Physics Department, Politecnico di Milano, Italy

March 2011  
to October  
2014

**Faculty researcher (Ricercatore Universitario)**, Physics Department, Politecnico di Milano, Italy

June 2010 to  
February 2011

**Researcher (Ricercatore a tempo determinato, dote Regione Lombardia)**

Research activity on “*Fabbricazione e caratterizzazione di campioni nanostrutturati per applicazioni in spintronica, nano-ottica, elettronica e fotovoltaico*” (Fabrication and characterization of nanostructured samples for spintronics, nano-optics, and photovoltaics applications), Physics Department (group prof. Franco Ciccacci), Politecnico di Milano, Italy

June 2009 to  
May 2010

**Post-doctoral fellowship by CNISM** (Consorzio Nazionale Interuniversitario per le Scienze Fisiche della Materia)

Research activity on “*Proprietà nano-ottiche di singoli emettitori e nanostrutture metalliche*” (Nano-optical properties of single emitters and metal nanostructures), Physics Department (group prof. Franco Ciccacci), Politecnico di Milano, Italy

June 2008 to  
May 2009

**Research Fellowship for Postdoctoral Researcher** awarded by the Von Humboldt Foundation (Germany) after personal submission of the project “*Nano-antennas for light*”. All activities have been based in the group of prof. Bert Hecht, Experimental Physics 5, Würzburg University, Germany.

March 2007 to  
May 2008

### **Post-doctoral fellowship**

Research activity on “*Nanostrutture magnetiche studiate mediante tecniche di microscopia e spettroscopia elettronica*” (Investigation of magnetic nanostructures by means of electron microscopy and spectroscopy), Physics Department (group prof. Franco Ciccacci), Politecnico di Milano, Italy.

## **Overview of the scientific activity**

My research activity is primarily located in the fields of nano-optics and plasmonics. The investigation of field confinement, field enhancement, and light-matter interactions on sub-wavelength scales is a fundamental branch of nanotechnology research nowadays. Near-field microscopy techniques allow imaging with sub-diffraction resolution and find applications in nanoparticle research, guided optics, and material science. Plasmonic systems exploit the resonant excitation of the conduction electrons in metal nanostructures for field enhancement and confinement, sub-diffraction waveguiding, nonlinear optics, and to boost the interaction of light with molecules and nanomatter. The main past and present research subjects of my activity are described in detail below.

- *Nano-antennas for visible light*

A nano-antenna is the optical counterpart of standard radio-frequency and micro-wave antennas. The possibility to engineer resonant nanostructures for visible light, by a suitable choice of geometry and material (often noble metals supporting plasmonic resonances), represents an almost unique opportunity for the creation of intense local fields below the diffraction limit and for the coupling between light and emitters (e.g. single molecules and nanocrystals), with applications ranging from single-photon sources to nonlinear optics, sensing, photovoltaics, high-resolution microscopy and lithography.

My experimental activity on gold nanoantennas for visible light starts in 2007 and is still a very relevant part of my research. It focuses mainly on the design, realization and characterization of gold nanostructures for (i) control of light polarization in the near field of the antennas (with special emphasis on circular polarization) and (ii) enhanced nonlinear optics (with special emphasis on second-harmonic generation and multi-photon photoluminescence). The extended activity on optical antennas also led to the publication of a topical review (Ref. 5 in the publication list below) and of a book chapter (Ref. 47).

In particular, we

- designed and demonstrated a novel cross antenna geometry for polarization engineering (Refs. 17, 21, 49);
- investigated second-harmonic generation in gold nanorods by means of scanning near-field optical microscopy (Refs. 23, 25, 29, 30, 51, 52);
- theoretically addressed the issue of selection rules for second harmonic generation in nanostructures (Ref. 34);
- investigated multiphoton emission processes in gold nanostructures (Refs. 7, 20, 48);
- demonstrated gold nanoresonators with atomic-scale gaps for extreme light concentration (Ref. 8);
- developed a novel procedure for the fabrication of single-crystal gold nanostructures (Refs. 11,13);
- applied a combination of near-field and far-field microscopy to quantitatively study the polarizability of gold nanoantennas (Refs. 14,18);
- developed a procedure for the laser-assisted flattening of atomic-force microscopy tips, aimed at the subsequent fabrication of antennas on tips (Ref. 28).

- *Guided optics in dielectric and plasmonic systems*

The field of guided optics is a natural application for both scanning near-field microscopy, since the technique allows one to map evanescent fields in dielectric waveguides with high resolution (scanning

tunneling optical microscopy), and plasmonics, where sub-diffraction waveguiding is obtained by avoiding cut-off conditions thanks to metal-insulator waveguides.

My experimental and computational activity on the subject focuses both on the investigation of optical analogues of quantum effects by exploiting dielectric waveguide arrays and on the development of a novel approach for the impedance description of the coupling between plasmonic waveguides and optical antennas.

In particular, we

- demonstrated quantitative analysis of discrete diffraction in waveguide arrays, a classical simulator for the ballistic motion of electrons in a tight-binding lattice (Ref. 35);
- demonstrated the classical analogue of the quantum Zeno effect in tunneling-coupled waveguides (Ref. 27);
- developed the analysis for impedance matching between a two-wire plasmonic waveguide and a dipolar nanoantenna and validated it by means of finite-difference time-domain simulations (Refs. 22, 50).

- Scanning near-field and far-field microscopy with polarization analysis

Polarization-modulation techniques are a fundamental tool in material science and nanotechnology. By exploiting a system based on hollow-pyramid near-field probes, we were able to achieve full control over the light polarization in the near field of the aperture.

In particular, we

- experimentally characterized the degree of linear polarization achieved at the aperture (Refs. 41, 42);
- applied the control over linear polarization to the implementation of multi-level bit encoding in azo-polymeric thin films (Refs. 15, 24);
- experimentally characterized the degree of circular polarization achieved at the aperture (Ref. 16);
- applied far-field polarization-modulation microscopy to investigate the spontaneous formation of left- and right-handed domains in an enantiopure polyfluorene film (Refs. 6, 9).

- Germanium-based nanoresonators and antennas for near-infrared and mid-infrared applications

I started a new activity over the last two years that employs epitaxial germanium grown on silicon for near-infrared and mid-infrared applications. The research follows two different lines:

- material and photonics engineering to build nanoresonators for efficient light emission at telecommunication wavelengths (Ref. 2);
- Heavily-doped germanium for mid-infrared plasmonics and sensing. This activity has been funded by the FP7 program under the FET-Open X-Track call with the “GEMINI” project, of which I am the coordinator.

Besides the main research in the field of nano-optics and plasmonics, I also personally started a very active collaboration with the Department of Food Science and Technology at Università degli Studi di Milano and since the beginning of my Ph.D. I have been contributing to the broader activities of the surface-physics group at the Department of Physics at Politecnico. A brief overview is given below.

- Scanning-probe microscopy on functionalized and nanostructured materials for food packaging applications

The collaboration exploits atomic-force microscopy to study the morphology of novel packaging thin films, with special emphasis on the effects of flame treatments and on the applications of cellulose nano-crystals (Refs. 1,3,4,10,12).

- Microscopic and spectroscopic characterization of magnetic thin films

The activity mainly focuses on ferromagnet/antiferromagnet multilayers, studied by means of electron-based and synchrotron-based spectroscopies and microscopies, optical spectroscopy based on the magneto-optical Kerr effect, spin-polarized scanning tunneling microscopy, and by means of advanced numerical simulations (Refs. 19, 31, 32, 38, 39, 40, 43, 44, 46, 53, 54)

## Funded research projects

- FP7-ICT-2013-X FET X-Track: “**Germanium mid-infrared plasmonics for sensing (GEMINI)**”  
The project aims at investigating the application of heavily-doped Ge as a plasmonic material for mid-infrared plasmon-enhanced sensing. The consortium comprises the University of Glasgow, the University of Konstanz, and the University of Roma “La Sapienza”.  
Years: 2014 to 2017  
Personal role: **Coordinator of the consortium**
- CARIPLO Foundation: “**Solar cells based on quantum nanostructures grown by droplet epitaxy (SOQQUADRO)**”  
The project, coordinated by prof. S. Sanguinetti from Università di Milano Bicocca, aims at integrating III-V intermediate band solar cells on silicon and coupling them to plasmonic interfaces.  
Years: 2011 to 2014  
Personal role: **Coordinator of the Politecnico unit**
- Von Humboldt Foundation: “**Nano-antennas for light**”  
The project aimed at developing antennas on atomic-force microscopy tips for efficient coupling with single molecules and nanocrystals.  
Years: 2008 to 2009  
Personal role: **Principal investigator**
- CARIPLO Foundation: “**Polarized near-fields for data encoding and retrieving**”  
The project, coordinated by prof. M. Finazzi at Politecnico, aimed at exploiting azo-polymeric films and near-field techniques for polarization-based multi-level bit encoding.  
Years: 2010 to 2012  
Personal role: Participant
- NanoSci-E+ Consortium, Transnational Call for Collaborative Proposals in Nanoscience: “**Femtosecond nano-optical magnetic recording and retrieval (FENOMENA)**”  
The project, coordinated by prof. A. V. Kimel at the University of Nijmegen, aimed at developing sub-diffraction techniques based on optical antennas and near-field probes for all-optical magnetic recording and readout.  
Years: 2009 to 2012  
Personal role: Participant
- Vigoni program, Ateneo Italo-Tedesco: “**Nano-antennas for light**”  
The project, coordinated by prof. M. Finazzi at Politecnico, aimed at fostering the collaboration in the field of optical nanoantennas with the group of prof. B. Hecht at the University of Wuerzburg.  
Years: 2010 to 2011  
Personal role: Participant
- Italian Ministry of University and Research, PRIN: “**Plasmonica in nanoparticelle metalliche auto-organizzate**” (Plasmonics in self-organized metal nanoparticles)  
The project, coordinated by prof. M. Finazzi at Politecnico, aimed at exploiting spontaneous organization of metal surfaces under ion beam bombardment as efficient plasmonic surfaces.  
Years: 2009 to 2011  
Personal role: Participant

- CNISM (Consorzio Interuniversitario per le scienze fisiche della materia), Progetti d'Innesco della Ricerca Esplorativa: **“Spin-polarised scanning tunneling microscopy with antiferromagnetic bulk Cr tips”**  
The project, coordinated by prof. L. Duò at Politecnico, aimed at developing novel antiferromagnetic tips for spin-polarized scanning tunneling microscopy.  
Years: 2006 to 2007  
Personal role: Participant
- Italian Ministry of University and Research, PRIN: **“Microscopia ottica a scansione a campo prossimo con analisi della polarizzazione della luce per microscopia magnetica e nano-magnetometria”** (Scanning near-field optical microscopy with polarization analysis for magnetic microscopy and nano-magnetometry)  
The project, coordinated by Dr. P. Vavassori at the University of Ferrara, aimed at developing magneto-optical near-field techniques.  
Years: 2004 to 2006  
Personal role: Participant

## Publications on international peer-reviewed journals

- 1) *“Emission engineering in germanium nanoresonators”*  
M. Celebrano, M. Baselli, M. Bollani, J. Frigerio, A. B. Shehata, A. Della Frera, A. Tosi, A. Farina, F. Pezzoli, J. Osmond, X. Wu, B. Hecht, R. Sordan, D. Chrastina, G. Isella, L. Duò, M. Finazzi, and P. Biagioni  
ACS Photonics **2**, 53 (2015)
- 2) *“Group-IV midinfrared plasmonics”*  
P. Biagioni, J. Frigerio, A. Samarelli, K. Gallacher, L. Baldassarre, E. Sakat, E. Calandrini, R. W. Millar, V. Giliberti, G. Isella, D. J. Paul, and M. Ortolani  
Journal of Nanophotonics **9**, 093789 (2015)
- 3) *“Mode matching in multiresonant plasmonic nanoantennas for enhanced second harmonic generation”*  
M. Celebrano, X. Wu, M. Baselli, S. Grossmann, P. Biagioni, A. Locatelli, C. De Angelis, G. Cerullo, R. Osellame, B. Hecht, L. Duò, F. Ciccacci, and M. Finazzi  
Nature Nanotechnology **10**, 412 (2015)
- 4) *“Quasistatic limit for plasmon-enhanced optical chirality”*  
M. Finazzi, P. Biagioni, M. Celebrano, and L. Duò  
Phys. Rev. B **91**, 195427 (2015)
- 5) *“Self-organized plasmonic metasurfaces for all-optical modulation”*  
G. Della Valle, D. Polli, P. Biagioni, C. Martella, M.C. Giordano, M. Finazzi, S. Longhi, L. Duò, G. Cerullo, and F. Buatier de Mongeot  
Phys. Rev. B **91**, 235440 (2015)
- 6) *“Three-dimensional fabrication of free-standing epitaxial semiconductor nanostructures obtained by focused ion beam”*  
V. Giliberti, E. Sakat, L. Baldassarre, A. Di Gaspare, A. Notargiacomo, E. Giovine, J. Frigerio, G. Isella, M. Melli, A. Weber-Bargioni, S. Aloni, S. Sassolini, S. Cabrini, P. Biagioni, M. Ortolani, and M. Bollani  
Microelectron Engineering **141**, 168 (2015)

- 7) “*Spin voltage generation through optical excitation of complementary spin populations*”  
F. Bottegoni, M. Celebrano, M. Bollani, P. Biagioni, G. Isella, F. Ciccacci, and M. Finazzi  
Nature Materials **13**, 790-795 (2014)
- 8) “*Mapping physicochemical surface modifications of flame-treated polypropylene*”  
S. Farris, S. Pozzoli, S. La Vecchia, P. Biagioni, C. L. Bianchi, L. Piergiovanni  
Express Polymer Letters **8**, 256 (2014).
- 9) “*Hydrostatic strain enhancement in laterally confined SiGe nanostripes*”  
G. M. Vanacore, M. Chaigneau, N. Barret, M. Bollani, F. Boioli, M. Salvalaglio, F. Montalenti, N. Manini,  
L. Caramella, P. Biagioni, D. Chrastina, G. Isella, O. Renault, M. Zani, R. Sordan, G. Onida, R. Ossikovski,  
H.-J. Drouhin, A. Tagliaferri  
Phys. Rev. B **88**, 115309 (2013).
- 10) “*Multi-functional coating of cellulose nanocrystals for flexible packaging applications*”  
F. Li, P. Biagioni, M. Bollani, A. Maccagnan, L. Piergiovanni  
Cellulose **20**, 2491 (2013).
- 11) “*Tunable green oxygen barrier through layer-by-layer self-assembly of chitosan and cellulose nanocrystals*”  
F. Li, P. Biagioni, M. Finazzi, S. Tavazzi, L. Piergiovanni  
Carbohydrate Polymers **92**, 2128 (2013).
- 12) “*Nanoantennas for visible and infrared radiation*”  
P. Biagioni, J.-S. Huang, B. Hecht  
Rep. Prog. Phys. **75**, 024402 (2012).  
(selected for the cover of the issue)
- 13) “*Circular dichroism probed by two-photon fluorescence microscopy in enantiopure chiral polyfluorene thin films*”  
M. Savoini, X. Wu, M. Celebrano, J. Ziegler, P. Biagioni, S. C. J. Meskers, L. Duò, B. Hecht, M. Finazzi  
J. Am. Chem. Soc. **134**, 5832 (2012).  
(selected for JACS Spotlight)
- 14) “*Dynamics of four-photon photoluminescence in gold nanoantennas*”  
P. Biagioni, D. Brida, J.-S. Huang, J. Kern, L. Duò, B. Hecht, M. Finazzi, G. Cerullo  
Nano Lett. **12**, 2941 (2012).
- 15) “*Atomic-scale confinement of resonant optical fields*”  
J. Kern, S. Großmann, N. V. Tarakina, T. Häckel, M. Emmerling, M. Kamp, J.-S. Huang, P. Biagioni, J. C.  
Prangma, B. Hecht  
Nano Lett. **12**, 5504 (2012).
- 16) “*Spontaneous formation of left- and right-handed cholesterically ordered domains in an enantiopure chiral polyfluorene film*”  
M. Savoini, P. Biagioni, S. C. J. Meskers, L. Duò, B. Hecht, M. Finazzi  
J. Phys. Chem. Lett. **2**, 1359 (2011).
- 17) “*Wetting of biopolymer coatings: contact angle kinetics and image analysis investigation*”  
S. Farris, L. Introzzi, P. Biagioni, T. Holz, A. Schiraldi, L. Piergiovanni  
Langmuir **27**, 7563 (2011).

- 18) “*Atomically flat single-crystalline gold nanostructures for plasmonic nanocircuitry*”  
J.-S. Huang, V. Callegari, P. Geisler, C. Brünig, J. Kern, J. C. Prangma, X. Wu, T. Feichtner, J. Ziegler, P. Weinmann, M. Kamp, A. Forchel, P. Biagioni, U. Sennhauser, B. Hecht.  
Nature Comm. **1**, 150 (2010).  
(selected for the March 2011 issue of *Photonics Spectra*)
- 19) “*The fundamentals of flame treatment for the surface activation of polyolefin polymers – A review*”  
S. Farris, S. Pozzoli, P. Biagioni, L. Duò, S. Mancinelli, L. Piergiovanni  
Polymer **51G**, 3591 (2010).
- 20) “*Mode imaging and selection in strongly coupled nanoantennas*”  
J.-S. Huang, J. Kern, P. Geisler, P. Weinmann, M. Kamp, A. Forchel, P. Biagioni, B. Hecht  
Nano Lett. **10**, 2105 (2010).
- 21) “*Recent developments in linear and nonlinear near-field microscopy on single plasmonic nanoparticles*”  
L. Duò, P. Biagioni, and M. Finazzi  
Phys. Status Solidi B **247**, 2040 (2010).
- 22) M. Savoini, P. Biagioni, M. Finazzi, L. Duò  
“*Macroscopic movement of azo-polymer chains by near-field probes: dependence on the illumination conditions*”  
Phys. Status Solidi B **247**, 2067 (2010).
- 23) “*Near-field circular polarization probed by chiral polyfluorene*”  
M. Savoini, P. Biagioni, G. Lakhwani, S. C. J. Meskers, L. Duò, M. Finazzi  
Opt. Lett. **34**, 3571 (2009).  
(selected for the Dec. 2<sup>nd</sup> 2009 issue of the *Virtual Journal for Biomedical Optics*)
- 24) “*Near-field polarization shaping by a near-resonant plasmonic cross antenna*”  
P. Biagioni, M. Savoini, J. S. Huang, L. Duò, M. Finazzi, B. Hecht  
Phys. Rev. B **80**, 153409 (2009).  
(selected for the Nov. 2<sup>nd</sup> 2009 issue of the *Virtual Journal of Nanoscale Science & Technology*)
- 25) “*Retrieving the complex polarizability of single plasmonic nanoresonators*”  
M. Celebrano, M. Savoini, P. Biagioni, M. Zavelani-Rossi, P.-M. Adam, L. Duò, G. Cerullo, M. Finazzi  
Phys. Rev. B **80**, 153407 (2009).  
(selected for the Oct. 18<sup>th</sup> 2009 issue of the *Virtual Journal of Nanoscale Science & Technology*)
- 26) “*Influence of three-dimensional dynamics on the training effect in ferromagnet-antiferromagnet bilayers*”  
P. Biagioni, A. Montano, M. Finazzi  
Phys. Rev. B **80**, 134401 (2009).
- 27) “*Dependence of the two-photon photoluminescence yield of gold nanostructures on the laser pulse duration*”  
P. Biagioni, M. Celebrano, M. Savoini, G. Grancini, D. Brida, S. Mátéfi-Tempfli, M. Mátéfi-Tempfli,  
L. Duò, B. Hecht, G. Cerullo, M. Finazzi  
Phys. Rev. B **80**, 045411 (2009).  
(selected for the August 2009 issue of the *Virtual Journal of Ultrafast Science*)
- 28) “*Cross resonant optical antenna*”  
P. Biagioni, J. S. Huang, L. Duò, M. Finazzi, B. Hecht  
Phys. Rev. Lett. **102**, 256801 (2009).  
(selected for the July 6<sup>th</sup> 2009 issue of the *Virtual Journal of Nanoscale Science & Technology*)



- 29) “*Impedance matching and emission properties of nanoantennas in an optical nanocircuit*”  
J. S. Huang, T. Feichtner, P. Biagioni, B. Hecht  
Nano Lett. **9**, 1897 (2009).
- 30) “*Hollow-pyramid based scanning near-field optical microscope coupled to femtosecond pulses: a tool for nonlinear optics at the nanoscale*”  
M. Celebrano, P. Biagioni, M. Zavelani-Rossi, D. Polli, M. Labardi, M. Allegrini, M. Finazzi, L. Duò, G. Cerullo  
Rev. Sci. Instrum. **80**, 033704 (2009).  
(selected for the April 6th 2009 issue of the Virtual Journal of Nanoscale Science & Technology and for the April 2009 issue of the Virtual Journal of Ultrafast Science)
- 31) “*All-optical subdiffraction multilevel data encoding onto azo-polymeric thin films*”  
M. Savoini, P. Biagioni, L. Duò, M. Finazzi  
Opt. Lett. **34**, 761 (2009).
- 32) “*Near-field second-harmonic generation from gold nanoellipsoids*”  
M. Celebrano, P. Biagioni, M. Finazzi, L. Duò, M. Zavelani-Rossi, D. Polli, M. Labardi, M. Allegrini, J. Grand, P.-M. Adam, P. Royer, G. Cerullo  
Physica Status Solidi (c) **5**, 2657 (2008).  
(selected for the cover of the issue)
- 33) “*A novel diagnostics for polymer degradation based on near-field two-photon photoluminescence*”  
P. Biagioni, M. Celebrano, M. Labardi, D. Polli, M. Zavelani-Rossi, G. Cerullo, G. Lanzani, M. Finazzi, L. Duò  
Physica Status Solidi (c) **5**, 2587 (2008).
- 34) “*Experimental demonstration of the optical Zeno effect by scanning tunneling optical microscopy*”  
P. Biagioni, G. Della Valle, M. Ornigotti, M. Finazzi, L. Duò, P. Laporta, S. Longhi  
Opt. Exp. **16**, 3762 (2008).
- 35) “*A simple method for producing flattened atomic force microscopy tips*”  
P. Biagioni, J. N. Farahani, P. Mühlischlegel, H.-J. Eisler, D. W. Pohl, B. Hecht  
Rev. Sci. Instrum. **79**, 016103 (2008).  
(selected for the week 5 – 2008 issue of the Nanotechweb.org Newswire and for the February 2008 issue of the Virtual Journal of Ultrafast Science)
- 36) “*Mapping local field enhancements at nanostructured metal surfaces by second-harmonic generation induced in the near field*”  
M. Celebrano, M. Zavelani-Rossi, D. Polli, G. Cerullo, P. Biagioni, M. Finazzi, L. Duò, M. Labardi, M. Allegrini, J. Grand, P.-M. Adam  
Journal of Microscopy **229**, 233 (2008).
- 37) “*Near-field second-harmonic generation in single gold nanoparticles*”  
M. Zavelani-Rossi, M. Celebrano, P. Biagioni, D. Polli, M. Finazzi, L. Duò, G. Cerullo, M. Labardi, M. Allegrini, J. Grand, P.-M. Adam  
Appl. Phys. Lett. **92**, 093119 (2008).  
(selected for the March 17<sup>th</sup> 2008 issue of the Virtual Journal of Nanoscale Science & Technology)
- 38) “*Bulk Cr tips for scanning tunneling microscopy and spin-polarized scanning tunneling microscopy*”  
A. Li Bassi, C. S. Casari, D. Cattaneo, F. Donati, S. Foglio, M. Passoni, C. E. Bottani, P. Biagioni, A. Brambilla, M. Finazzi, F. Ciccacci, L. Duò  
Appl. Phys. Lett. **91**, 173120 (2007).

- 39) “*Exchange-induced frustration in Fe/NiO multilayers*”  
N. Rougemaille, M. Portalupi, A. Brambilla, P. Biagioni, A. Lanzara, M. Finazzi, A. K. Schmid, L. Duò  
Phys. Rev. B **76**, 214425 (2007).
- 40) “*High-resolution imaging of local oxidation in polyfluorene thin films by nonlinear near-field microscopy*”  
P. Biagioni, M. Celebrano, M. Zavelani-Rossi, D. Polli, M. Labardi, G. Lanzani, G. Cerullo, M. Finazzi,  
L. Duò  
Appl. Phys. Lett. **91**, 191118 (2007).  
(selected for the December 2007 issue of the Virtual Journal of Ultrafast Science)
- 41) “*Selection rules for second-harmonic generation in nanoparticles*”  
M. Finazzi, P. Biagioni, M. Celebrano, L. Duò  
Phys. Rev. B **76**, 125414 (2007).
- 42) “*Discrete diffraction in waveguide arrays: a quantitative analysis by tunneling optical microscopy*”  
G. Della Valle, S. Longhi, P. Laporta, P. Biagioni, L. Duò, M. Finazzi  
Appl. Phys. Lett. **90**, 261118 (2007).  
(selected for the July 16<sup>th</sup> 2007 issue of the Virtual Journal of Nanoscale Science & Technology)
- 43) “*Space charge effects on the active region of a planar organic photodetector*”  
T. Agostinelli, M. Caironi, D. Natali, M. Sampietro, P. Biagioni, M. Finazzi, L. Duò  
J. Appl. Phys. **101**, 114504 (2007).
- 44) “*Prospects of resonant optical antennas for nano-analysis*”  
B. Hecht, P. Mühlischlegel, J. N. Farahani, H.-J. Eisler, D. W. Pohl, O. J. F. Martin, P. Biagioni  
CHIMIA **60**, 765 (2006).
- 45) “*Interface coupling transition in a thin epitaxial antiferromagnetic film interacting with a ferromagnetic substrate*”  
M. Finazzi, A. Brambilla, P. Biagioni, J. Graf, G.-H. Gweon, A. Scholl, A. Lanzara, L. Duò  
Phys. Rev. Lett. **97**, 097202 (2006).
- 46) “*Direct observation of magnetic instabilities in NiO thin films epitaxially grown on Fe(001)*”  
L. Duò, A. Brambilla, P. Biagioni, M. Finazzi, A. Scholl, G.-H. Gweon, J. Graf, A. Lanzara  
Surface Science **600**, 4160 (2006).
- 47) “*Nano-sized magnetic instabilities in Fe/NiO/Fe(001) epitaxial thin films*”  
A. Brambilla, P. Biagioni, N. Rougemaille, A. K. Schmid, A. Lanzara, L. Duò, F. Ciccacci, M. Finazzi  
Thin Solid Films **515**, 712 (2006).
- 48) “*Unexpected polarization behavior at the aperture of hollow-pyramid near-field probes*”  
P. Biagioni, D. Polli, M. Labardi, A. Pucci, G. Ruggeri, G. Cerullo, M. Finazzi, L. Duò  
Appl. Phys. Lett. **87**, 223112 (2005).  
(selected for the Dec. 5<sup>th</sup> 2005 issue of the Virtual Journal of Nanoscale Science & Technology)
- 49) “*Near-field vs. far-field polarization properties of hollow pyramid SNOM tips*”  
P. Biagioni, M. Coduri, D. Polli, T. Virgili, M. Labardi, G. Cerullo, M. Finazzi, L. Duò  
Phys. Stat. Sol. (c) **2**, 4078 (2005).
- 50) “*Magnetization reversal properties of Fe/NiO/Fe(001) trilayers*”  
A. Brambilla, P. Biagioni, M. Portalupi, M. Zani, M. Finazzi, L. Duò, P. Vavassori, R. Bertacco, F. Ciccacci  
Phys. Rev. B **72**, 174402 (2005).

51) “*Disclinations in thin antiferromagnetic films on a ferromagnetic substrate*”

M. Finazzi, P. Biagioni, A. Brambilla, L. Duò, F. Ciccacci

Phys. Rev. B **72**, 024410 (2005).

52) “*Rb-intercalated  $C_{60}$  compounds studied by photoemission spectroscopies*”

A. Brambilla, L. Giovanelli, P. Vilmercati, A. Cattoni, P. Biagioni, A. Goldoni, M. Finazzi, L. Duò

J. Elect. Spec. Rel. Phen. **144-147**, 803 (2005).

53) “*Magnetic properties of Fe/NiO/Fe(001) trilayers*”

P. Biagioni, A. Brambilla, M. Portalupi, N. Rougemaille, A. K. Schmid, A. Lanzara, P. Vavassori, M. Zani, M. Finazzi, L. Duò, F. Ciccacci

Journal of Magnetism and Magnetic Materials, **290-291**, 153 (2005).

## Book chapters

54) “*Fabrication and optical characterization of nanoantennas*”

J. Prangma, P. Biagioni, B. Hecht

In “Optical Antennas”, edited by M. Agio and A. Alù, Cambridge University Press (2013).

## Publications on conference proceedings

55) “*Dynamics of two-photon photoluminescence in gold nanostructures*”

P. Biagioni, D. Brida, J.-S. Huang, J. Kern, L. Duò, B. Hecht, M. Finazzi, G. Cerullo

Proc. of SPIE **8245**, 824504 (2012).

56) “*Tailoring the interaction between matter and polarized light with plasmonic optical antennas*”

P. Biagioni, X. Wu, M. Savoini, J. Ziegler, J.-S. Huang, L. Duò, M. Finazzi, B. Hecht

Proc. of SPIE **7922**, pp. 79220C-1 – 79220C-5 (2011) .

57) “*Antennas, transmission lines, and resonators at optical frequencies*”

B. Hecht, J. Kern, T. Feichtner, P. Geisler, S. Grossmann, P. Biagioni, J.-S. Huang

Proceedings of the Fourth European Conference on Antennas and Propagation (2010).

58) “*Mapping local field distributions at metal nanostructures by near-field second-harmonic generation*”

M. Celebrano, M. Zavelani-Rossi, P. Biagioni, D. Polli, M. Finazzi, L. Duò, G. Cerullo, M. Labardi, M. Allegrini, J. Grand, P. Royer, P.-M. Adam

Proc. of SPIE **6641**, 66411E-1 (2007).

59) “*Nonlinear optics and spectroscopy at the nanoscale with a hollow-pyramid aperture SNOM*”

P. Biagioni, M. Celebrano, D. Polli, M. Labardi, M. Zavelani-Rossi, G. Cerullo, M. Finazzi, L. Duò

J. Phys.: Conf. Series **61**, 125 (2007).

60) “*Magnetization reversal processes in Fe/NiO/Fe(001) trilayers studied by means of magneto-optical Kerr effect*”

P. Biagioni

EPIOPTICS-8, Proceedings of the 33rd Course of the International School of Solid State Physics, ed. Antonio Crisciti, World Scientific, p. 81 (2006).

61) *“Magnetic properties of Fe/NiO/Fe(001) trilayers studied by means of magneto-optical Kerr effect”*

A. Brambilla, P. Biagioni, M. Portalupi, P. Vavassori, M. Zani, M. Finazzi, R. Bertacco, L. Duò, F. Ciccacci  
Atti del XVII Congresso, Associazione Italiana del Vuoto (Ed. Compositori, 2004), p. 99.

## **Invited talks, contributions and organization activity at national and international conferences**

I co-authored more than 110 contributions to national and international conferences. Among them, I personally gave 8 invited talks and lectures and 17 contributed oral presentations, as detailed below.

### Invited talks and lectures

- *“Tailoring the interaction between matter and polarized light with plasmonic optical antennas”*  
SPIE Photonics West 2011 – LASE Conference, San Francisco CA (USA), 22-27 January 2011
- *“Fabrication and applications of single-crystalline plasmonic nanostructures”*  
MRS Spring Meeting 2012, San Francisco CA (USA), 9-13 April 2012
- *“Germanium antennas for near-infrared light emission and mid-infrared plasmonics”*  
Workshop Extreme Light Concentration, Institut d’Optique, Palaiseau (Paris, France), June 6th 2014
- *“Polarization-modulation scanning near-field microscopy”*  
COST Action MP1302 Nanospectroscopy, Training School, Roma (Italy), September 26th 2014
- *“Mid-infrared plasmonic resonances exploiting heavily-doped Ge on Si”*  
SPIE Photonics West, San Francisco (USA), 7-12 February 2015
- *“Nanoantennas for visible and IR radiation”*  
Workshop Novel Materials and Devices for NEMS, INRIM, Torino (IT), 26th February 2015
- *“Mid-infrared plasmonics with heavily-doped germanium”*  
Workshop Surface plasmon and plasmonics (SPP2015), Genova (IT), June 7th – 10th, 2015
- *“The smaller the better: light confinement beyond diffraction”*  
Light Fantastic (Cumberland Lodge Weekend, The Maxwell Society, King’s College London),  
Cumberland Lodge (London, UK), 27 February, 1 March 2015

### Contributed talks

- *“Dynamics of multi-photon photoluminescence in gold nanoantennas”*  
P. Biagioni, D. Brida, J.-S. Huang, J. Kern, L. Duò, B. Hecht, M. Finazzi, G. Cerullo  
PLASMONICA2013, Milano (Italy), 1-3 July 2013.
- *“Unraveling four-photon photoluminescence in gold nanoantennas”*  
P. Biagioni, D. Brida, J.-S. Huang, J. Kern, L. Duò, B. Hecht, M. Finazzi, G. Cerullo  
12th International Conference on Near-field Optics, Nanophotonics and Related Techniques (NFO 12), Donostia – San Sebastian (Spain), 3-7 September 2012.
- *“Multi-photon autocorrelation in Au dipole antennas”*  
P. Biagioni, D. Brida, J.-S. Huang, J. Kern, L. Duò, B. Hecht, M. Finazzi, G. Cerullo  
SPIE Photonics West 2012 – LASE Conference, San Francisco (USA), 21-26 January 2012.

- “*Multiphoton autocorrelation in Au dipole antennas*”  
P. Biagioni, L. Duò, M. Finazzi, D. Brida, G. Cerullo, J. S. Huang, J. Kern, B. Hecht  
5th International Conference on Surface Plasmon Photonics (SPP5), Busan (Korea), 15-20 May 2011.
- “*Cross-antenna structures for polarization control and analysis*”  
P. Biagioni, J. S. Huang, M. Savoini, G. C. Gazzadi, L. Duò, M. Finazzi, B. Hecht  
Fourth International Conference on Surface Plasmon Photonics (SPP4), Amsterdam (The Netherlands), 21-26 June 2009.
- “*Visualizing quantum dynamics through quantum-optical analogies in tunneling-coupled optical waveguides*”  
P. Biagioni, G. Della Valle, M. Ornigotti, M. Savoini, M. Finazzi, L. Duò, P. Laporta, S. Longhi  
Tenth International Conference on Near-Field Optics, Nanophotonics and Related Techniques (NFO10), Buenos Aires (Argentina), 1-5 September 2008.
- “*A novel diagnostics for polymer degradation based on near-field two-photon photoluminescence*”  
P. Biagioni, M. Finazzi, L. Duò, M. Labardi, M. Celebrano, D. Polli, M. Zavelani-Rossi,  
G. Cerullo, G. Lanzani  
Optics at Surfaces and Interfaces VII (OSI-VII), Alta (USA, WY), 15-20 July 2007.
- “*Near-field second harmonic generation from resonant gold nanoparticles*”  
P. Biagioni, M. Finazzi, L. Duò, M. Labardi, M. Allegrini, J. Grand, P. –M. Adam, P. Royer,  
M. Celebrano, D. Polli, M. Zavelani-Rossi, G. Cerullo  
Optics at Surfaces and Interfaces VII (OSI-VII), Alta (USA, WY), 15-20 July 2007.
- “*A novel diagnostics for polymer degradation based on near-field two-photon photoluminescence*”  
P. Biagioni, M. Finazzi, L. Duò, M. Labardi, M. Celebrano, D. Polli, M. Zavelani-Rossi,  
G. Cerullo, G. Lanzani  
Italian Workshop on Optics and Photonics (IWOP2007), Ancona, May 30 – June 1 2007.
- “*Two-photon fluorescence from polymer blends with hollow-pyramid SNOM tips*”  
P. Biagioni, M. Finazzi, L. Duò, M. Labardi, M. Celebrano, D. Polli, M. Zavelani-Rossi,  
G. Cerullo, G. Lanzani  
Ninth International Conference on Near-Field Optics, Nanophotonics and Related Techniques (NFO-9), Lausanne (CH), 10-15 September 2006.
- “*Nonlinear optics and spectroscopy at the nanoscale with a hollow-pyramid aperture SNOM*”  
P. Biagioni, M. Celebrano, D. Polli, M. Labardi, M. Zavelani-Rossi, G. Cerullo, M. Finazzi,  
L. Duò  
Sixth International Conference on Nanoscale Science and Technology (ICN+T 2006), Basel (CH),  
July 30<sup>th</sup> – August 4<sup>th</sup> 2006.
- “*Near-field vs far-field polarization properties of hollow pyramid SNOM tips*”  
P. Biagioni, M. Coduri, D. Polli, T. Virgili, M. Labardi, G. Cerullo, M. Finazzi, L. Duò  
Optics at Surfaces and Interfaces (OSI VI), Aalborg (Denmark), 6-10 June 2005.
- “*Magnetization reversal processes in Fe/NiO/Fe(001) trilayers studied by means of magneto-optical Kerr effect*”  
P. Biagioni  
Epioptics-8, Erice (Italy), 20-26 July 2004.

- *“Universal quasi-static limit for plasmon-enhanced optical chirality”*  
P. Biagioni, M. Celebrano, L. Duò, and M. Finazzi  
Workshop Optical Polarisation Conversion in the Near Field (OPCNF), Exeter (UK), June 25th-26th, 2015.
- *“Mid-infrared sensing with germanium antennas on silicon”*  
P. Biagioni, L. Baldassarre, E. Sakat, J. Frigerio, A. Samarelli, K. Gallacher, E. Calandrini, G. Isella, D. J. Paul, and M. Ortolani  
The 7th international conference on surface plasmon photonics (SPP7), Jerusalem (Israel), May 31st – June 5th, 2015.
- *“Universal quasi-static limit for plasmon-enhanced optical chirality”*  
M. Finazzi, P. Biagioni, M. Celebrano, and L. Duò  
The 7th international conference on surface plasmon photonics (SPP7), Jerusalem (Israel), May 31st – June 5th, 2015.
- *“Group-IV mid-infrared plasmonics for sensing”*  
E. Sakat, L. Baldassarre, J. Frigerio, A. Samarelli, K. Gallacher, E. Calandrini, G. Isella, D. J. Paul, M. Ortolani, and P. Biagioni  
FOTONICA2015, Torino (IT), May 6th-8th 2015 (oral P. Biagioni).

## Teaching experience

My teaching activity was all based at Politecnico di Milano, starting from 2004. In particular, I have been involved in:

- general physics classes for first-year and second-year Engineering students;
- classes on electron microscopy for Master's students in Physics Engineering;
- classes on plasmonics for Ph.D. students in Physics.

I have also been responsible for the experimental laboratory in "Scanning probe microscopy" for third-year Bachelor students in Physics Engineering over the last 10 years and tutored 3 Bachelor thesis over the last 3 years.

The whole teaching activity is detailed below:

Spring 2015	Teaching of "Fondamenti di Fisica Sperimentale I" (mechanics and thermal physics) to Mechanical, Energy and Aerospace Engineering students
Fall 2014	Teaching of "Plasmonics" to Ph.D. students in Physics
Fall 2014	Teaching assistant for "Fisica Sperimentale II" (electromagnetic theory) to Mathematical Engineering students – prof. P. Taroni
Fall 2014	Teaching assistant for "Electron microscopy" to Physics Engineering students – prof. A. Tagliaferri
Spring 2014	Teaching of "Fondamenti di Fisica Sperimentale I" (mechanics and thermal physics) to Mechanical, Energy and Aerospace Engineering students
Fall 2013	Teaching assistant for "Electron microscopy" to Physics Engineering students – prof. A. Tagliaferri
Fall 2013	Teaching assistant for "Fisica Sperimentale II" (electromagnetic theory) to Mathematical Engineering students – prof. P. Taroni
Spring 2013	Teaching assistant for "Plasmonics" to Ph.D. students in Physics – prof. G. Della Valle
Spring 2013	Teaching assistant for "Electron microscopy" to Physics Engineering students – prof. A. Tagliaferri
Spring 2013	Teaching of "Fondamenti di Fisica Sperimentale I" (mechanics and thermal physics) to Mechanical, Energy and Aerospace Engineering students
Fall 2012	Teaching assistant for "Fisica Sperimentale II" (electromagnetic theory) to Mathematical Engineering students – prof. P. Taroni
Spring 2012	Teaching assistant for "Electron microscopy" to Physics Engineering students – prof. A. Tagliaferri
Spring 2012	Teaching of "Fondamenti di Fisica Sperimentale I" (mechanics and thermal physics) to Mechanical, Energy and Aerospace Engineering students
Fall 2011	Teaching assistant for "Fisica Sperimentale II" (electromagnetic theory) to Mathematical Engineering students – prof. P. Taroni
Spring 2011	Teaching assistant for "Electron microscopy" to Physics Engineering students – prof. A. Tagliaferri
Spring 2011	Teaching of "Plasmonics" to Ph.D. students in Physics
Spring 2011	Teaching of "Fondamenti di Fisica Sperimentale I" (mechanics and thermal physics) to Mechanical, Energy and Aerospace Engineering students

- Fall 2009 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Management, Economics and Industrial Engineering students – prof. D. Polli
- Spring 2008 Teaching assistant for “Fondamenti di fisica sperimentale” (fundamental physics) to Mechanical and Energy Engineering students – prof. L. Duò
- Fall 2007 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Management, Economics and Industrial Engineering students – prof. D. Polli
- Spring 2007 Teaching assistant for “Fisica Sperimentale II” (electromagnetic theory) to Electronics Engineering students – prof. G. Ghiringhelli
- Fall 2006 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Management, Economics and Industrial Engineering students – prof. D. Polli
- Fall 2005 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Management, Economics and Industrial Engineering students – prof. D. Polli
- Spring 2005 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Energy Engineering students – prof. L. Duò
- Fall 2004 Teaching assistant for “Fisica Sperimentale A+B” (fundamental physics) to Management, Economics and Industrial Engineering students – prof. M. Zani