CURRICULUM VITAE ET STUDIORUM

PAOLO DE NATALE

1. PERSONAL DATA AND SHORT BIOGRAPHY

Name	**PAOLO DE NATALE**
Address	**LARGO ENRICO FERMI, 6 – FIRENZE 50125**
E-mail	**PAOLO.DENATALE@INO.IT; DENATALE@LENS.UNIFI.IT**
Website	www.ino.it, **Google page** http://scholar.google.it/citations?sortby=pubdate&hl=it&user=kC_WPz0AAAAJ&view_op=list_works:)
ORCID	http://orcid.org/0000-0002-3308-8569
Nationality	**ITALIAN**

EDUCATION AND TRAINING

DECEMBER 2013	Habilitation *to Full Professor in Italian Universities for Experimental Physics-Structure of Matter*
April 1993	*Diploma Scuola di Specializzazione* in Optics *cum laude* from the University of Florence - Italy
December 1987	*Degree in Physics (Laurea)* cum laude *from the University Federico II, Naples - Italy*

PRESENT POSITION

DIRECTOR
NATIONAL INSTITUTE OF OPTICS (INO) OF THE ITALIAN NATIONAL RESEARCH COUNCIL (CNR)

February 2010 – Today	Director of the **National Institute of Optics-CNR** (INO – CNR, former INOA – CNR) (Provvedimento CNR n. 0015 del 29.01.2010 and subsequent extentions, AMMCNT - CNR n. 0045739 del 13/07/2012).
January 2007	Director of the **National Institute of Applied Optics-CNR** (Provvedimento CNR n. 004 del 31.01.2007 and subsequent extentions).
Since September 2003	Research director at the **National Institute of Applied Optics – INOA (former INO)** (Derogation DPR 31.07.2003 s.n. G.U. 198/2003)
SINCE MARCH 2003	**Head of INOA Section Innovative Photonic Devices in Pozzuoli (NA)** (Delibera INOA n. 117 del 18.03.2003)
Nov. 2001-Jan. 2007	Head of the **National Institute of Applied Optics-CNR Unit in Pozzuoli (NA) (former INO)** (Delibera INO n. 17 del 5/10/2001 Prot. n. 1050 del 29.11.2001 and INOA n. 117 del 18.03.2003)
1997	Senior Research Scientist at the **National Institute of Optics – INO** (Delibera INO n. 11 del CdA del 24.11.1997)
1996	Research Scientist at the **National Institute of Optics – INO** (Delibera INO n. 320 del 04/09/96 e n. 344 del 13/05/97)
1988	*Permanent staff position at the **European Laboratory for Nonlinear Spectroscopy** – **Lens** University of Florence Italy*

2. SUMMARY OF SCIENTIFIC ACTIVITY

AREAS OF EXPERTISE AND RESEARCH MAIN ACTIVITY

The main areas of expertise are: Nonlinear optics, laser physics, atomic and molecular high precision spectroscopy, frequency metrology, environmental monitoring with optical devices, optical sensors and diagnostics, physics of non-linear optical crystals, development of infrared

coherent sources. Paolo De Natale undertook some of the pioneering atomic structure measurements on hydrogen and helium atoms using precision laser spectroscopy and nonlinear optical techniques that have challenged our current understanding of quantum electrodynamics. Indeed, PDN was in the team that, in Paris, performed the first ever pure frequency measurement on a hydrogen atom transition (*First pure frequency measurement of an optical transition in atomic hydrogen: better determination of the Rydberg constant*, Nez et al., *Europhys. Lett*. 24, 635 (1993)) and, later on, at LENS, in Florence-Italy, on the second lighter atom, helium (*First pure frequency measurement of an optical transition in helium: Lamb shift of the 2^3S_1 metastable level*, *Phys. Rev. Lett*. 73, 42 (1994)). These pioneering works paved the way to a new approach to frequency measurements in fundamental physics that is nowadays routinely used to perform high precision measurements in atoms and molecules. In quite unexplored spectral regions, like infrared and far-infrared (THz), highly coherent and tunable sources were developed by PDN to carry on Atomic, Molecular and Optical-AMO physics research.

Basing on this long standing experience, PDN has published two key papers on new photonic technologies in the THz range, generating THz combs and combining them with quantum cascade lasers-QCLs (*Phase-locking to a free-space terahertz comb for metrological-grade terahertz lasers*, Consolino et al., *Nature Communications* 3, 1040 (2012)), then providing evidence of application to highly accurate frequency measurements for molecular spectroscopy (*Frequency-comb-assisted terahertz quantum cascade laser spectroscopy*, Bartalini et al., *Phys. Rev. X* 4, 021006 (2014) and the related Editors' suggestion, *Synopsis in Physics: High-Precision Terahertz Spectroscopy*).

PDN has studied and designed novel optoelectronic devices, especially based on ferroelectric crystals. For such research PDN, just after settling a new section of the Italian National Institute of Optics in Pozzuoli (Naples), summoned a multidisciplinary team, combining unusual skills in spectroscopy, interferometric diagnostics, mastering of nonlinear sources and techniques, that enabled a quick achievement of unique results. In particular, borrowing methods that are typical of high resolution spectroscopy, breakthrough results were obtained, e.g., in optical fiber physics (*Probing the Ultimate Limit of Fiber-optic Strain Sensing*, Gagliardi et al., *Science* 330, 1081 (2010), also selected for online publication in *Science Express* and Gagliardi et al. *Science*, 335, 286 (2012)) with promising applications in a number of fields. For these studies, femtosecond laser combs and phase/frequency locking techniques were the key technologies for getting the results. Not only has PDN contributed to fundamental science using spectroscopy, but he has also applied this to practical experimental problems. For instance, he spent several years developing laser spectrometers for geophysical applications. This work produced pioneering results in fiber optics laser-based precise measurements of gases emitted in volcanic areas (Remote sensing of volcanic gases with a DFB-laser based fiber spectrometer, L. Gianfrani et al., Appl. Phys. B - Rapid Comm. 70, 467 (2000) or highlight in Optics & Photonics News, 11, 44 (2000)) and, in the framework of national and international projects, several measurement campaigns in volcanic craters, led by PDN. In recognition of PDN commitment to these frontier spectroscopic applications, he was appointed member of the Scientific Board of the National Volcanological Group-GNV of Italy (2002-2005) and member of the Board of Directors of a Public Consortium in the field of Analysis and Monitoring of Environmental Risk-AMRA, developing innovative methodologies for managing environmental problems. In the last few years, PDN has led a group that, by developing new concepts of coherent sources and spectroscopic techniques, has recently achieved a record spectroscopic sensitivity (better than 1 part per trillion) paving the way to all-optical radiocarbon dating, with applications to many different fields (environment, homeland security, biomedicine, cultural heritage) (Physical Review Letters 107, 270802 (2011) or Science Shot: Sniffing Out the One in a Quadrillion in Science Express, December 9, 2011 and was selected as one out of the three best results in Optics in 2012. In 2016 a new breakthrough result (a sensitivity of a few parts per quadrillion, or 10^{-15}) has been published (Optica **4**, 385-388 (2016) doi: 10.1364/OPTICA.3.000385) and was **selected by OSA for a press release** that, according to OSA, had an **audience** reach close to **300 milllion people worldwide**, and was advertised by **Physics Today** by a short story and a longer *Search&Discovery*.

In his quest for developing frontier coherent sources and spectroscopic techniques in the infrared range, PDN started to apply quantum cascade lasers to high resolution spectroscopy as early as in 2002, in the framework of a collaboration with Federico Capasso group at Bell Labs, USA (*Sensitive detection of methane and nitrous oxide isotopomers using a continuous wave quantum cascade laser, Eur. Phys. J. D* 19, 327 (2002)). More recently, PDN team has experimentally unveiled the ultimate linewidth for QCLs in the IR and THz domain (*Observing the intrinsic linewidth of a quantum-cascade laser: beyond the Schawlow-Townes limit*, *Phys. Rev. Lett.* 107, 270802 (2011) and the related Editors' suggestion, Synopsis in Physics; *Quantum-limited frequency fluctuations in a terahertz laser, Nature Photonics* 6, 525 (2012)), paving the way to new, metrological-grade applications of such lasers to spectroscopy (see e.g.:

Comb-assisted subkilohertz linewidth quantum cascade laser for high-precision mid-infrared spectroscopy, Appl. Phys. Lett. 102, 121117 (2013) or a recent review on QCLs: *Quantum cascade lasers: 20 years of challenges,* M.S. Vitiello, G. Scalari, B. Williams and P. De Natale, *Opt. Expr.* 23 (4), 5167-5182 (2015)).
In conclusion, since the beginning of his career, PDN has uninterruptedly contributed novel ideas and experiments to the international community of Optics, Photonics and Atomic and Molecular Physics.

PUBLICATION METRICS

GOOGLE SCHOLAR

(http://scholar.google.it/citations?sortby=pubdate&hl=it&user=kC_WPz0AAAAJ&view_op=list_works)
Citations: 4788; h_{index}: 39; i10index: 134.

10 SELECTED PUBLICATIONS (WITH IMPACT FACTOR)

1. Microcavity-Stabilized Quantum Cascade Laser
Mario Siciliani de Cumis, Simone Borri, Giacomo Insero, Iacopo Galli, Anatoliy Savchenkov, Danny Eliyahu, Vladimir Ilchenko, Naota Akikusa, Andrey Matsko, Lute Maleki and Paolo De Natale, *Laser & Photonics Reviews* **10**, (1) 153–157 (2016) IF 8.008

2. Real-time terahertz digital holography with a quantum cascade laser
Massimiliano Locatelli, Marco Ravaro, Saverio Bartalini, Luigi Consolino, Miriam S. Vitiello, Riccardo Cicchi, Francesco Pavone & Paolo De Natale, *Scientific Reports* **5**, Article number: 13566 (2015) doi:10.1038/srep13566 IF 5.578

3. Frequency-comb-assisted terahertz quantum cascade laser spectroscopy, S Bartalini, L Consolino, P Cancio, P De Natale, P Bartolini, A Taschin, M De Pas, H Beere, D Ritchie, MS Vitiello, R Torre, *Phys. Rev. X* **4**, 021006 (2014) (Editors' suggestion, Synopsis in *Physics*) IF 9.043

4. Phase-locking to a free-space terahertz comb for metrological-grade terahertz lasers, L. Consolino, A. Taschin, P. Bartolini, S. Bartalini, P. Cancio, A. Tredicucci, H.E. Beere, D.A. Ritchie, R. Torre, M.S. Vitiello, P. De Natale, *Nature Communications* **3**, 1040 (2012) IF 11.47

5. Quantum-limited frequency fluctuations in a terahertz laser, M. S. Vitiello, L. Consolino, S. Bartalini, A. Taschin, A. Tredicucci, M. Inguscio, P. De Natale, *Nature Photonics* **6,** 525 (2012) IF 32.386

6. Frequency Metrology of Helium around 1083 nm and Determination of the Nuclear Charge Radius P. Cancio Pastor, L. Consolino, G. Giusfredi, P. De Natale, M. Inguscio, V.A. Yerokhin, K. Pachucki, *Physical Review Letters*, **108**, 143001 (2012) IF 7.512

7. Molecular gas sensing below part-per-trillion: Radiocarbon-dioxide optical detection, I. Galli, S. Bartalini, S. Borri, P. Cancio, D. Mazzotti, P. De Natale, and G. Giusfredi**,** *Physical Review Letters* **107**, 270802 (2011) December, 30th (Editors' suggestion, Focus in *Physics;* selected as one of the best three results of the year for Optics, in *Optics and Photonics News* 2012) IF 7.512

8. Saturated-absorption cavity ring-down spectroscopy, G Giusfredi, S Bartalini, S Borri, P Cancio, I Galli, D Mazzotti, P De Natale *Physical Review Letters* **104** (11), 110801 (2010) IF 7.512

9. Probing the Ultimate Limit of Fiber-optic Strain Sensing, G. Gagliardi, M. Salza, S. Avino, P. Ferraro, P. De Natale, *Science* **330**, 1081 (2010) (selected for online publication in *Science Express*) IF 33.61

10. Observing the intrinsic linewidth of a quantum-cascade laser: beyond the Schawlow-Townes limit, S. Bartalini, S. Borri, P. Cancio, A. Castrillo, I. Galli, G. Giusfredi, D. Mazzotti, L. Gianfrani, P. De Natale, Physical Review Letters 104, 083904 (2010) (Editors' suggestion, Synopsis in Physics) IF 7.512

Publications by PDN include papers that appeared in the following Journals:
Nature Publishing Group: 5 (of which 1 in press); **Science**: 2; **Laser Photonics Reviews**: 2 (of which 1 in press); **PRL and PRX**: 11

Books and special issues

1. **Ferroelectric Crystals for Photonic Applications- Including Nanoscale Fabrication and Characterization Techniques**, edited by P. Ferraro, S. Grilli, and P. De Natale, (Springer-Verlag, Berlin, Heidelberg, 2014- II edition). ISBN 978-3-642-41085-7.
2. **Laser-Based Measurements for Time and Frequency Domain Applications: a Handbook**, M. Bellini, P. Maddaloni, P. De Natale **authors** (**736 pages**), Taylor&Francis ed.,

April 2013. ISBN 978-1-4398-4151-8.
3. **Ferroelectric Crystals for Photonic Applications** P. Ferraro, S. Grilli, and P. De Natale eds., (Springer-Verlag, Berlin, Heidelberg, 2009).

4. Special Volume "**Advanced monitoring techniques and coherent sources"** C, P. De Natale and P. Ferraro Guest Editors Optics and Lasers in Engineering 45, N.4 (2007).
5. Special Volume "**Optical characterization methods and techniques**", P. De Natale and P. Ferraro Guest Editors **Optics and Lasers in Engineering** 45, N.3 (2007).
6. Special Volume "**Advanced monitoring techniques and coherent sources"** A, P. De Natale and P. Ferraro Guest Editors Optics and Lasers in Engineering 44, N.7 (2006).
7. Special Volume "**Optical Methods in Earth Sciences**", G. De Natale, P. De Natale, P. Ferraro, L. Gianfrani, Guest editors. Optics and Lasers in Engineering 37, Nos. 2-3 (2002), Editor Elsevier Science Ltd.
8. "**International Conference of Atomic Physics**", E. Arimondo, P. De Natale, M. Inguscio Eds, Vol. 551 of AIP Conference Proceedings, (American Institute of Physics, Melville, New York, 2001).
9. "**IV European Conference of Quantum Electronics (EQEC'93) and VII Italian Conference on Quantum Electronics (EQUAP'93):** Technical Digest", P.De Natale, R.Meucci, S.Pelli Eds. (Firenze, 1993).

In addition, PDN has authored more than 20 chapters/invited papers in books/special volumes (last 10 years).

PUBLICATIONS FOR A GENERAL PUBLIC

- **Le Scienze**: "*Luce sul tempo*" di P. Maddaloni, M. Bellini, F. Levi e P. De Natale *Le Scienze*, febbraio 2014 http://www.lescienze.it/archivio/articoli/2014/02/04/news/luce_sul_tempo-1992506/ ;
- Le Scienze: *Luce dentro il vulcano*, di G. De Natale, C. Troise, P.De Natale, E. Boschi Vol. Gennaio 2008, pp. 78-85.
- *Fotonica* di De Natale P. in: ***Scienza e Tecnica*** Ed.: **Istituto della Enciclopedia Italiana** - ***Roma*** (*2007*).

PATENTS

8 patents related to Photonics and Optoelectronics, several extended to EU and USA

AWARDS AND FELLOWSHIPS

MARCH 2015 Appointed Italian representative of **ICO** – International Commission for Optics

NOVEMBER 2014 Awarded with **OSA** (the Optical Society of America) **Fellowship**

DECEMBER 2012 "All-Optical Radiocarbon Dating" by Davide Mazzotti, Saverio Bartalini, Simone Borri, Pablo Cancio, Iacopo Galli, Giovanni Giusfredi, and Paolo De Natale selected as one of the **best 3** contributions **in Optics in 2012** by OSA.

DECEMBER 2011 Awarded with **SPIE** (the International Society for Optical Engineering) **Fellowship**

DECEMBER 2010 Awarded as one of the best contributions in Optics in 2010 in **Optics&Photonics News, Optical Society of America**, *Quiet Cascade*

SINCE 2007 **Academy memberships:** *Optical Society of America-OSA; Society for Photo Instrumentation and measurement-SPIE; European Physical Society-EPS*

SELECTED TEACHING AND OUTREACH ACTIVITIES

INTERNATIONAL

PDN has given seminars in prestigious scientific institutions worldwide including: Helsinki University, Siegen University (Germany), Amsterdam - VU University, Zurich - ETH, Berlin - Max Planck (Fritz Haber), Pasadena – Caltech, Lund University (Sweden).
PDN has been lecturer in important international schools including: Varenna Summer Courses 2012 Metrology and Physical Constants directed by E. Bava (past INRIM President); Erice 1998 25th Course "Observational Database and Mechanisms of Climate"; ICTP Trieste "The Abdus Salam International Centre for Theoretical Physics" (2001 Winter School on Laser Spectroscopy and Applications, 2013 Trends in Laser Development and Multidisciplinary Applications to Science and Industry, 2016 Optical Frequency Combs - from multispecies gas sensing to high precision interrogation of atomic and molecular targets).
- Supervisor for students of the Ecole Superieure d'Optique-Institut d'Optique, Orsay Francia, at LENS-Università di Firenze

- Opponent at Lund (Sweden), in 2006, and Helsinki (Finland), in 2015, Universities for Ph.D. Theses
- Jury member Conservatoire national des arts et métiers-CNAM, Paris, July 2015, Habilitation à diriger les recherches-HDR

Since Academic Year 1999-2000 to 2001-2002 Professor of Physics of Materials for optoelectronics - University Diploma Course in Technical Optics - University of Florence.

NATIONAL

Supervisor of 1 Diploma Thesis in Technical Optics, University of Florence
Supervisor of 5 Theses (Laurea) in Physics at the Department of Physics, University of Florence
Supervisor of 2 PhD Theses at the Department of Physics, University of Florence
Supervisor of 3 international PhD Theses at LENS, European Laboratory for Nonlinear Spectroscopy, University of Florence

Tutor, under the measure training FSE 3.13, for the Centro di Competenza Regione Campania – AMRA: Dr.ssa Melania Paturzo, Dr.ssa Libera Nasti (till december 2006).
Teacher for the training program in the framework of the Project PON-SIMONA: Non Linear Optics (50 hours) Measurement Techniques of High Resolution Optical Spectroscopy and Fiber Optics Sensors (50 hours). (Prot. INOA n.49 del 12/01/2004).

RESPONSIBILITY OF RELEVANT RESEARCH PROJECTS

2015 - TODAY **EU-FET (Future Emerging Technologies) Project *UltraQCL*,** Responsible for INO-CNR (Amount for INO: 133 k€)

2011 - TODAY **ELI Extreme Light Infrastructure Project.** Responsible for INO-CNR. Belonging to the EU ESFRI roadmap and MIUR (total amount till now: 3.6 M€).

2014-2015 **Progetto Premiale MIUR:** *Synchronization of distributed laboratories by time&frequency standards using an optical fiber.* Responsible for CNR (131 k€)

2011-2014 **Energia da FOnti Rinnovabili-EFOR**, Funded by MIUR/MEF, Responsible for INO-CNR (Amount for INO: 187 k€)

2010-2012 **CTOTUS Project** – *Progetto Integrato per lo sviluppo della Capacità Tecnologica e Operativa della Toscana per l'Utilizzo dello spazio*. Funded by **Regione Toscana**; for CNR-INO: 750 k€. (Prot. CNR-INO n.1064 4/03/2010)

2004-2006 Photonic circuits for optical communications and sensing for the study of innovative optical devices and sensors. Funded by (562.5 k€): Italian Ministry of University and Research-**MIUR**. (Decreto Direttoriale MIUR 1291/2003 e 1359/2004)

2002-2007 Coordinator **Project FIRB-negoziale** *Microdispositivi Fotonici in Niobato di Litio* for the delovpment of techniques and photonic devices in lithium niobate. Total amount: 3,000 kEuro. (Prot. INOA n. 923-18/10/2001 e n. 931-22/10/2001)

2003-2005 Coordinator of an **International research project:** *Sviluppo di un sistema spettroscopico integrato per la rivelazione remota e in continua di gas vulcanici.* Funded by **INGV and Gruppo Nazionale di Vulcanologia-GNV**. Partners: Cambridge Univ.(UK); Rice University Houston, TX, (USA); II Università di Napoli. Total amount: 465 k€. (prot. INOA n. 331-11/4/2000, n.1148-21/12/2001, n.139-18/2/2002)

2002-2006 **PON** *Integrated Environmental Monitoring System*-**SIMONA**. Funded by (1.033 k €+Training: 697 k€): EU and MIUR through the National Operative Programme-PON.Subject: Development of an integrated network of optical fiber sensors, geophysical and geochemical monitoring in areas exposed to earthquakes and volcanic risks. The Project SIMONA-PON has been selected in a list of Research of Excellence-The first catalog of excellent PON projects, in the framework of "*Scientific research, technological development, higher education*," 2002-2006.

2002-2006 **POR** project (Programma Operativo Regionale)-**Regione Campania**, for the Centro Regionale di Competenza on *Analysis and monitoring of environmental risk* for the realization of optical innovative sensors based on coherent sources and fiber optical technologies; Amount for INOA: 559 k€. (prot.INOA n.1322 del 10/09/2002)

1997-1998 *Continuous monitoring of volcanic gases with semiconductor lasers***.** Funded by Italian National Research Council-**CNR**

ORGANIZATION AND PARTICIPATION TO COMMITTEES OF INTERNATIONAL CONFERENCES (SELECTION)

28 SEPTEMBER-2 OCTOBER 2015 **FISMAT 2015** Italian National Conference on Condensed Matter Physics Palermo, Italy. Member of the scientific committee and Chair of the Non linear Optics Session.

24-28 AUGUST 2015 **HRMS 2015** The 24th Colloquium on High Resolution Molecular Spectroscopy Dijon, France. Member of the Steering Committee

21-25 JUNE 2015 **CLEO®/Europe 2015** CH - Optical Sensing and Metrology Munich, Germany. Programme Committe Member

10-15 MAY 2015 **OSA conference CLEO 2015** Laser Science to Photonic Applications, San Jose Convention Center, San Jose, California, USA. Subcommittee Member - Optical Metrology

6-8 MAY 2015 Fotonica 2015, 17th National Conference on Photonic Technologies, Torino, Italy, Executive Committee. http://www.fotonica2015.it

8-13 JUNE 2014 **OSA conference CLEO 2014** Laser Science to Photonic Applications, San Jose Convention Center, San Jose, California, USA. Subcommittee Member

12-14 MAY 2014 **Fotonica 2014**, 16th National Conference on Photonic Technologies, Napoli, Italy, Executive Committee. http://www.fotonica2014.it

26-30 AUGUST 2013 **23rd Colloquium on High-Resolution Molecular Spectroscopy International Conference**, Budapest (Hungary), Executive Committee

9-14 JUNE 2013 **OSA conference CLEO 2013** Laser Science to Photonic Applications, San Jose Convention Center, San Jose, California, USA. Subcommittee Member

21-23 MAY 2013 **Fotonica 2013**, 15th National Conference on Photonic Technologies, Milano, Italy, Executive Committee. http://www.fotonica2013.it/documenti/Fotonica2013_Call_for_Papers.pdf

15-17 MAY 2012 **Fotonica 2012**, 14th National Conference on Photonic Technologies, Pisa, Italy, Executive Committee. http://www.fotonica2012.it/comitatoesecutivo.htm

AUGUST 2011 **22nd Colloquium on High-Resolution Molecular Spectroscopy International Conference**, Dijon, France, Executive Committee.

MAY 2011 **Fotonica 2011**, 13th National Conference on Photonic Technologies, Pisa, Italy, Executive Committee. http://www.fotonica2011.it/comitatoesecutivo.htm

25-27 MAY 2010 **Fotonica 2010**, 12th National Conference on Photonic Technologies, Pisa, Italy, Chairman. http://www.fotonica2010.it/comesecutivo.htm

31 AUGUST-4 SEPTEMBER 2009 **21st Colloquium on High-Resolution Molecular Spectroscopy International Conference**, Castellammare di Stabia (NA) Italy, Chairman. http://www.inoa.it/HRMS09/

27-29 MAY 2009 **Fotonica 2009**, 11° Convegno Nazionale delle Tecnologie Fotoniche, Pisa, Italy, co-chairman. http://www.fotonica2009.it/comesecutivo.htm

10-12 JUNE 2008 **Elettroottica 2008**, 10° Convegno Nazionale Strumentazione e Metodi di Misura Elettroottici Milan Executive Committee. http://www.associazioneaict.it/elettroottica2008/

SELECTED RESEARCH HIGHLIGHTS

JUNE 2016 **Physics Today**, *Search&Discovery: Smaller, faster, cheaper detection of radiocarbon (http://scitation.aip.org/content/aip/magazine/physicstoday/article/69/6/10.1063/PT.3.3186)*

APRIL 2014 **Physics**, *Synopsis: High-Precision Terahertz Spectroscopy (http://physics.aps.org/synopsis-for/10.1103/PhysRevX.4.021006) April 2014*

JANUARY 2014 Review of the "**Laser-Based Measurements for Time and Frequency Domain Applications – A Handbook**" by Mircea Dragoman, National Research and Development Institute on Microtechnology, Bucharest, Romania for **OPN-OSA**: "*This is a beautiful and monumental work about time and frequency laser measurements. Despite being more than 700 pages long, this book is easy to read thanks to its clear and concise style… This book is a must-read for anybody working in laser research and industry, and will be particularly helpful for Ph.D. students.*"(http://www.osa-opn.org/home/book_reviews/2014/0114/laser-based_measurements_for_time_and_frequency_do/#.UzFkIxZbWXp)

DECEMBER 2012 **Selection of PRL** paper**:** *Molecular Gas Sensing Below Parts Per Trillion: Radiocarbon-Dioxide C Detection* as one of the **best 3** contributions **in Optics in 2012** by OSA

FEBRUARY 2012 **Nature 'News & Views',** *Analytical chemistry: Ultrasensitive radiocarbon detection* Nature 482, pp. 312–313, February 2012

DECEMBER 2011 **Physics,** *Focus: Carbon Dating with Lasers in Physics 4, 111, December 2011*

DECEMBER 2011 **Science,** *ScienceShot: Sniffing Out the One in Science NOW,* December 2011

DECEMBER 2011 **Physicsworld,** *Cavity spectroscopy does carbon dating,* December 2011

FEBRUARY 2011 **Optics&Photonics News**, Optical Society of America, *Frequency Comb Pushes Limit of Fiber-Optic Strain Sensing*, p.6, February 2011

JANUARY 2011 **Nature Photonics – Research Highlights**, Combs boost sensitivity, p.2, January 2011

DECEMBER 2010 **Optics&Photonics News,** Optical Society of America, *Quiet Cascade*, invited paper among the best contributions in Optics in December 2010.

15 MARCH 2010 **American Physical Society,**: *Quiet cascade* in "Physics: spotlighting exceptional research", Synopsis Published March 15, 2010 *http://physics.aps.org/synopsis-for/10.1103/PhysRevLett.104.083904*

MAY 2010 **Physics Today** *The intrinsic limits of Quantum Cascade Lasers* in "Physics update" p.21

MAY 2006 **Photonics Spectra, Spectroscopy Focus** *Mid-IR Spectrometer Incorporates Difference-Frequency Generator*, *p. 111,* May 2006, by Daniel Burgess, about the news in the new spectrophotometer in the medium IR developped in INOA CNR Naples Unit its description is published in: *Optics Express, Feb. 6, 2006, pp. 1304-1313.*

JUNE 2001 **Opto & Laser Europe,** *Sensors working overtime,* pp. 37-38, Giugno 2001 Issue 85, describing the scientific highlights of the Conference OMES (Chairman Paolo De Natale).

DECEMBER 2000 **Optics & Photonics News**, Optical Society of America, Dicembre 2000: invited article, included among the most significant contributions in the field of Optics published in 2000.

10-15 SEPTEMBER 2000 **CLEO(Conf. on Lasers and Electro-Optics)/Europe-IQEC(Int. Quantum Electronics Conf.) 2000**, 10-15/9/2000, Nizza, France: (title: *High resolution spectroscopy with novel non-linear devices*) among the *Highlights* (volume CLEO EXTRA, p.8-9) of the Conference.

SELECTED INVITED/PLENARY TALKS

28-30 SEPTEMBER 2015 **AMAV International Workshop on Advanced Monitoring of Active Volcanoes** Naples, Italy.
Frontiers of laser monitoring of gases
http://www.ov.ingv.it/ov/doc/AMAV/brochure_ultima22settembre.pdf

21-25 SEPTEMBER 2015 **Società Italiana di Fisica-SIF 101° Congresso Nazionale**
Plenary speaker
http://www.sif.it/attivita/congresso/101

12-18 JULY 2015 **Fourteenth Marcel Grossmann Meeting - MG14**
University of Rome "La Sapienza", Rome.
http://www.icra.it/mg/mg14/

MARCH 30-APRIL 2, 2015 **Solvay Workshop on Atomic and molecular collision mechanisms - ACME Collisions: astrophysics, atmospheric, dynamics, reactivity, spectroscopy, theory**
Bruxelles, Novel sources and spectroscopic techniques for precision spectroscopy of cold molecules
http://www.solvayinstitutes.be/event/workshop/acme_2015/acme_2015.html

7-11 DECEMBER 2014 **Pushing the limits of precise spectroscopic sensing**
Australian Institute of Physics Congress
Canberra, Australia (7-11 Dec. 2014)
http://aip2014.org.au/index.asp?IntCatId=14

2-5 DECEMBER 2014 Optics and photonics for Energy and the Environment – Light, Energy and Environment **OSA Conference** (**LEE 2014**), Canberra Australia (2 – 5 December 2014)
Novel Infrared Sources and Spectroscopic Techniques for Cutting Edge Environmental Metrology
http://www.aie.org.au/AIE/Eflash/AIE_Canberra_OSA_Light_Energy_Congress_2014.pdf

3-8 NOVEMBER 2013 **Shenzhen International Conference on Advanced Science and Technology - Terahertz Science & Technology and Application,**
Shenzhen, China (3-8 November 2013).

21-26 JULY 2013 Frequency-Comb-Assisted Laser Sources from the Mid-IR to the THz Range
Non-Linear Optics **OSA Topical Meeting**
The Fairmont Orchid, Kohala Coast, Hawaii, USA (21 - 26 July 2013)
http://www.osa.org/en-us/meetings/topical_meetings/nonlinear_optics_(nlo)/

10-13 JUNE 2013 *Frequency-comb-assisted mid-IR cavity-enhanced spectroscopy*
International Meeting and Summer School on Cavity-Enhanced Spectroscopy-CES2013, Naples (2013)
http://www.ino.it/ces2013/

4-15 FEBRUARY 2013 Lecture: *Comb-based coherent sources in the Infrared: basics and applications*
ICTP 2013 Winter College, Trieste, Italy (2/2013)
http://cdsagenda5.ictp.trieste.it/full_display.php?ida=a12164

SEPTEMBER 2012 *Frequency-comb-based laser sources from the near IR to the THz range*, SPRC 2012 **Annual Symposium, Stanford University**, USA (9/2012)

23-27 JULY 2012	**ICAP 2012** The 23rd International Conference on Atomic Physics Intitute Politecnique Palaiseau FRANCE http://www-lpl.univ-paris13.fr/icap2012/invited.htm
17-27 JULY 2012	**SIF Italian School of Physics**, Course CLXXXV "Metrology and Physical Constants" Varenna ITALY http://www.sif.it/attivita/scuola_fermi/mmxii
1-6 MAY 2011	2011 Conference on Lasers and Electro-Optics **OSA Conference** (**CLEO 2011**), Baltimore, (USA). P. De Natale, I. Galli, D. Mazzotti, G. Giusfredi, P. Cancio, G. Gagliardi, and P. Maddaloni *"Probing sensitivity limits by comb-based spectroscopic techniques",*
23-27 JANUARY 2011	**Photonics West-Quantum Sensing and Nanophotonic Devices VIII,** San Francisco, (USA). S. Bartalini, S. Borri, P. Cancio, I. Galli, G. Giusfredi, D. Mazzotti, and P. De Natale, *"Narrow linewidth quantum cascade lasers as ultra-sensitive probes of molecules",*
5–9 SEPTEMBER 2010	**10th International Conference on Mid-Infrared Optoelectronics-MIOMD X**: **Materials and Devices**, Shanghai (CHINA). P. De Natale: "*Observing the intrinsic frequency fluctuations of mid-IR QCLs: towards frontier applications"* http://www.miomd-10.cn/index.asp
30 SEPTEMBER 2009	**3rd EOS Topical Meeting on Optical Microsystems (OMS09)**, Palazzo dei Congressi, Capri (NA) (ITALY). P. De Natale et al.: "*Quantum cascade lasers linked to optical frequency comb synthesizers: a new IR metrological tool"* http://www.myeos.org/capri_oms09#InvitedSpeakers
6-11 SEPTEMBER 2009	Field Laser Applications in Industry and Research **FLAIR 2009** Grainau, (GERMANY). P. De Natale: *Towards metrological-level optical sensors for environmental monitoring* http://www.gap.fzk.de/flair/FLAIR_Invited.htm
14-19 SEPTEMBER 2008	**International Quantum Cascade Lasers School&Workshop** Monte Verita, Ascona, (SWITZERLAND) P. De Natale: *Frequency Metrology with Quantum Cascade Lasers* http://www.iqclsw.phys.ethz.ch/program.php
20 AUGUST 2008	**Caltech - California Institute of Technologies APh-OSA Optics Seminar** P. De Natale "*Combining Frequency-Comb-Synthesizers with Novel Coherent Sources in the Mid-IR: A Window for a New Generation of Photonic Tools"* Pasadena, California http://www.its.caltech.edu/~osa/seminars.html
28-30 APRIL 2008	**2nd ESA International Workshop on Optical Clocks ESA/ESRIN** Frascati, Rome (ITALY) P. De Natale, P. Cancio, M. Inguscio: Accurate Frequency Standards for the Infrared Region http://www.congrex.nl/07c23/
10-12 OCTOBER 2007	**18th International Conference on Laser Spectroscopy**, Telluride, Colorado, (USA). P. De Natale: Frequency-comb-assisted mid-IR spectroscopyhttp://www.laserspectroscopy.org/speakers.htm
JUNE 2007	**Campi Flegrei Caldera Deep Drilling Project, International Workshop**, Napoli (ITALY). P. De Natale: Advanced Monitoring Techniques for Ground Deformations and Gas Emissions http://www.essac.ecord.org/index.php?mod=workshop&page=past-workshop
20-22 DECEMBER 2004	**SIRIS 2004 – International Workshop on Stable Isotope Ratio Infrared Spectrometry, IAEA**, Vienna (AUSTRIA). P. De Natale: Non-linear optics for high resolution molecular spectroscopy http://www.rug.nl/ees/onderzoek/CIO/SIRIS2004/programma
6-8 SEPTEMBER 2004	**16th International Conference on Laser Spectroscopy**, Palm Cove, North Queensland, (AUSTRALIA). P. De Natale: Extending the optical comb synthesizer to the infrared: absolute frequency measurements of molecular transitions around 4.3 m http://eproceedings.worldscinet.com/9789812703002/toc.shtml
13-18 JULY 2003	P. De Natale: Novel laser-based techniques for monitoring of volcanoes **European Science Foundation (ESF) Workshop**: Gases in magmatic evolution: from depth to atmosphere, from micro-scale to macro-scale, from calculation to observation Roma, http://www.ov.ingv.it/ew0235/volatiles2fp6.htm
10-14 MAY 2003	P. De Natale: Novel laser-based techniques for monitoring of volcanoes **European Science Foundation (ESF) Workshop**: Gases in magmatic evolution: from depth to atmosphere, from micro-scale to macro-scale, from calculation to observation Roma, http://www.ov.ingv.it/ew0235/volatiles2fp6.htm
22-28 JUNE 2002	Conference on Laser, Application and Technologies **OSA Conference**, **LAT-2002**. Mosca (RUSSIA). P. De Natale: Frequency Metrology and Precision Spectroscopy in the Infrared. Technical Digest p. 104. http//osa.org/meetings/archives/2002/IQEC/IQEC%202002%20Archive.pdf
SEPTEMBER, 2001	**Seventeenth Colloquium on High Resolution Molecular Spectroscopy**, Papendal (NETHERLANDS). P. De Natale: Recent advances in infrared sources for high resolution spectroscopy. http://spectroscopy.mps.ohio- state.edu/symposium_56/symposium/Archive.html
25-29 APRIL 2000	P. De Natale: Novel Optical techniques for monitoring of volcanoes. **European Geophysical society-XXV General Assembly**. Newsletter Number 74 March 2000, p. 89, Nizza, (FRANCIA). http://www.egu.eu/meetings/general-assemblies.html
20-24 SETTEMBRE 1998	P. De Natale: **Progresses and Perspectives in Optical Sensing of Trace Gases Workshop "Around Virgo"** Tirrenia, Pisa. http://www.spectro.jussieu.fr/GREX/Pisa98.html

3. MANAGEMENT ACTIVITY

MAIN SCIENTIFIC MANAGEMENT

July 2012 – today
PDN is director of INO-CNR. Under the direction of PDN, employees have increased up to 160 with more than 300 overall people working in the whole Institute (spread over the headquarters and 7 sections throughout Italy), 45 of which are technical and administrative staff. At present more than 70 national and international projects are active (June 2016), in the area of Optics and Photonics, in the Institute (see www.ino.it).

September 2002 – March 2012
Member of the Scientific Board (for optical sensors) and of the Board of Directors of the consortium for Environmental Risk Analysis and Monitoring - AMRA S.c.ar.l.

2005 –2012
Member of the Board of Directors of a consortium for Environmental Risk Analysis and Monitoring - AMRA S.c.ar.l.,

October 2010
PDN is appointed Director f.f. of the National Institute of Optics of the National Research Council (INO-CNR) following the transformation of INOA in an Institute of the Italian National Research Council (CNR). In the meantime staff employees have become 118, spread over five Units, with the headquarters in Florence.

January 2007
PDN leaves the direction of INOA Unit in Pozzuoli: staff employees have increased to 10 (6 staff scientists) with 35 ISI Web papers published in 2006. PDN is appointed INOA Director, an Institute with 67 employees with the headquarters in Florence and two Units (Pozzuoli and Lecce).

2002-2005
Member of the Scientific Board, of the Technical Administrative Board and Head of the section on Sensors of AMRA-Center of Competence - Campania Region.

2002 – 2005
Member of the Scientific Board of the National Group of Volcanology (GNV)-INGV.

November 2001
On behalf of INOA Board of Directors and President, PDN settles a new Unit of the Italian National Institute of Applied Optics (INOA) in Pozzuoli Naples. In March 2003 a Section of INOA is formally started. Only 2 personnel units (1 technician, 1 clerk) are present at that time.

SHORT SUMMARY OF MANAGEMENT ACTIVITY AS DIRECTOR OF ISTITUTO NAZIONALE DI OTTICA-CNR (JULY 2012-TODAY)

In the following, a few sentences extracted from the Report of the Evaluation Panel (performed in 2015 by a truly international Committee for the Institutes of our Department (Department of Physical Sciences and Technology of Matter) that evaluated the 2011-2014 period):

"*The Institute is a strong performer in many aspects of Optics, with a particular strength in Cold Atoms and pockets of strength in more applied areas such as Sensors & Imaging. The Institute has been able to attract some strong junior researchers, so there is potential for further improvement and growth, especially as INO is also able to attract a large number of PhD students. The publication output is high, and the external research income is very good*".

"The Director appears to exercise strong and constructive leadership within the constraints imposed upon him by the central administration".

"I cannot comment on internal resources, but I recognise that the external income is impressive… This is a truly impressive figure for an Italian institute of this size".

"Overall, I am happy to use the word "excellent" in the final assessment, although the performance across the breadth of activity could be more consistent".

SHORT SUMMARY OF MANAGEMENT ACTIVITY AS DIRECTOR OF ISTITUTO NAZIONALE DI OTTICA APPLICATA-CNR (FEBRUARY 2007-JANUARY 2010)

In the following, a few sentences extracted from the Report from three Evaluation Panels that evaluated INOA, in the framework of the CNR Evaluation (period of evaluation: 2003-2007).
In the ***Final Summary of the Panel for Physical Sciences*** it is reported for INOA:

"*..The overall impression of the Institute is very positive: very good the management, the research activities and the coordination among the Units.*"

In the final assessment, comparing all the Institutes for Physical Sciences:

"..From the overall assessments the Panel concludes that eight Institutes (out of 18 evaluated) *can be rated "very good" (IMM,IGI, IFN, ISMN, IMEM, IFP, INFM,* ***INOA****)*."

4. MANAGEMENT OF HUMAN RESOURCES, RESEARCH PLANNING, RELATION WITH INDUSTRIES

MANAGEMENT OF HUMAN RESOURCES

Starting from 2001, when PDN received the first appointment to direct the INOA Unit in Pozzuoli (Naples), the number of scientific, administrative and technical personnel has increased almost constantly in time. At present PDN directs INO CNR with an overall number of about 300 people including employees, temporary grants and associated scientists. In the last 15 years PDN has managed personnel distributed, within INOA/INO CNR units, throughout Italy.

As emerges from PDN personal track record, his professional activity developed in different Institutions: University of Florence, European Laboratory for Non Linear Spectroscopy – Lens, Istituto Nazionale di Ottica (INO and INOA) and the National Research Council - CNR. During PDN career, he has managed personnel from different Institutions and geographical locations. Indeed, the first Unit directed by PDN was belonging to the National Institute of Optics - INO in interaction with scientists from CNR and Universities in Campania; after PDN appointment as director of INOA, in 2007, INOA was already part of CNR, with the headquarters and the units spread over Tuscany, Puglia and Campania regions having scientists, technical and administrative staff also located within the Department of Physics of the University of Florence and Lens; in 2010, when INO-CNR was founded, PDN had to manage people coming from different scientific communities and Institutions, namely INOA, INFM, CNR and Universities.

In the period June - December 2015 PDN has attended a course for management of scientific structures organized by Politecnico di Milano in collaboration with the SUM - Scuola di Management per Università, Enti di ricerca e Istituzioni scolastiche, held at CNR in Rome.

RESEARCH PLANNING

Key aspects for research planning are collaborations with other Institutions and fostering projects.
Towards this end, PDN has always promoted the structures directed, as hubs to aggregate scientists from different Universities and Research Institutions at regional, national and international level. Indeed, several INO Units are co-located within University Departments, Consortia or laboratories.

In order to efficiently organize and plan research activities, PDN has promoted, at INO – CNR, a distribution of research activities and personnel within 6 macro-areas that offer a clearer view of the internal scientific organization, thus simplifying the interaction with external partners.

RELATIONS WITH INDUSTRIES AND

The relationship with industries is strategic from the point of view of technological transfer, for contracts as well as for joint Projects. Therefore, it has been significantly fostered by PDN, as

director of INO.

In the period 2010-2015, the overall revenues from contracts with companies amounted to about 2.2 MEuros, that is an average of more than 370 kEuros/year.

In order to properly address the theme of Technological Transfer, in 2015 PDN has created, at INO, a Tech Transfer team, including 6 scientists, each working in a different INO Unit and already experienced in the field. The tasks of this team include: reinvestment of royalties from patents in other tech transfer-related activities, dissemination of tech transfer best practices and information towards INO scientists, promotion and commercialization of INO Patents, consultancy for spin off activities, interaction with the central CNR Tech Transfer Office (UVR) in Rome. PDN promoted also a Tech-transfer event in Arcetri (FI) in 2012 and co-organized with the Department of Physical Sciences (DSFTM-CNR) another one in Rome in 2015 to stimulate INO scientists on this subject and to create useful links with other partners in the transfer chain. In the period 2011-2014, 19 patents were filed by INO. INO has hosted a spin-off company from 2012 to 2015. Following this Tech-Transfer activity pursued by PDN, another spin off company, involving INO scientists, was approved by CNR in February 2016 and MIUR, and was founded on April, 29th 2016.
The International Committee appointed for the CNR internal Evaluation (performed in 2015 and evaluating the 2011-2014 period, when PDN was the director) has written for INO what follows:

"….In terms of patents, the Institute did very well in 2013 and less well in 2014, but I am less concerned about the number of patents as such rather than how they were used. In this respect, the translation of research appears to be improving, which is good to see; there are some very nice examples of technology transfer. …"

5. EXPERIENCES IN THE EVALUATION OF RESEARCH

NATIONAL AND INTERNATIONAL RESEARCH EVALUATION EXPERIENCES (SELECTION)

PDN has been member of many Scientific Committees of national and international Conferences (e.g. CLEO - Conference on Lasers and Electro Optics, USA and CLEO/Europe), for the evaluation of scientific contributions to Conferences.

Since June 2011, PDN is in the Editorial Board of Optics Express, a Journal of the Optical Society of America publishing high quality papers in the field of fundamental and applied Optics and Photonics.

PDN regularly serves as referee for the main journals in the field of atomic, molecular and optical physics (Nature group journals, American Physical Society journals, e.g. Physical Review Letters, Optical Society of America journals and many others).

PDN acts as reviewer of Projects for Agencies funding Research of several countries (including EU, Belgium, the Netherlands, France, Austria, Switzerland) for AMO Physics related projects.

PDN served as Jury member in several national and international Committees for evaluation of PhD/Habilitation candidates (including: Lund University, Nov.2006, PhD; Helsinki University, Dec.2015, PhD; Conservatoire national des arts et métiers-CNAM, Paris, July 2015, Habilitation à diriger les recherches-HDR). PDN was also member of several national Committees for the selection of research scientists, also as President.

In 2014 PDN was member of the Jury for awarding the prestigious *Enrico Fermi Prize* of the Italian Physical Society - SIF.

6. ADDITIONAL HIGHLIGHTS RELATED TO THE TOPICS OF INO MISSION

PDN was awarded the OSA (Optical Society of America) fellowship in 2015 with the following motivation:

"For pioneering contributions to the study and development of laser-based devices and techniques for frequency metrology, particularly for atomic and molecular measurements across the infrared and THz spectral regions."

In the Press release (http://www.cnr.it/news/file/documento/id/467) following the SPIE fellowship awarded, in 2012, to PDN, is reported:

"…De Natale has conducted breakthrough research across many fields of photonics, including nonlinear optics, laser physics, atomic and molecular high precision spectroscopy, frequency metrology, optical sensors and diagnostics, physics of non-linear optical crystals, and infrared coherent sources. He is responsible for many firsts in these areas, such as developing the first fiber-based frequency comb for the mid-infrared spectral range, demonstrating its suitability for frequency metrology. …."

For dissemination of frontier research in the field of Atomic, Molecular and Optical Physics, PDN co-authored a book, published in 2013:

Laser-Based Measurements for Time and Frequency Domain Applications, M. Bellini, P. Maddaloni, P. De Natale authors, Taylor&Francis ed., April 2013. ISBN 13:978-1-4398-415 1-8.

This book, as synthesized in the hard back cover:

"Discusses laser-based time-frequency measurements not only in the context of frequency metrology and the science of timekeeping but also in light of contemporary and future trends of fundamental and applied research in physics….."

And, as written by Professor T.W. Hänsch, co-recipient of the 2005 Nobel Prize in Physics, in his Foreword to this book:

"..The authors … provide a detailed treatment of the basic concepts of time and frequency measurements, carefully describe different kinds of lasers and some of the most advanced laser-based measurement techniques, and finally present the latest developments in the field, with a hint to the possible future trends in applications and fundamental science. Being among the many important actors in this long story, the authors of this book are privileged witnesses of the evolution of time and frequency measurements and can provide an informed and wide vision of this developing field from many different viewpoints.."

INO CNR OUTREACH ACTIVITIES (2010-2016)

Ino Cnr outreach activities significantly increased in the period 2010-2016

Events

More than 45 events dedicated to the general public. Some examples:

- *Ino Annual Symposium*. Starting from 2013 it is CNR INO annual symposium organized every year in a different geographical Unit and it has a typical attendance of more than 100 participants. It is a special occasion for the scientific community to discuss of frontier research in optics and to meet companies and political representatives. During the 2016 edition there was a celebration for the restoration of the CNR INO's headquarters in Arcetri;
- *Ludoteca scientifica* in Pisa, the interactive and didactic exhibition with more than 110.000 visitors per year;
- *Science events* CNR INO presence in several scientific events like: *Enrico Fermi a Firenze*, *Notte dei ricercatori, Festival dei bambini, ScienzEstate* and CNR INO special events as *Il futuro è quantum, Sotto una nuova ottica, Dentro il microscopio* and others, achieved an attendance of several thousand visitors.
- *School* The CNR INO activities in the "Chiavi della Città", the publication of the Town of Florence dedicated to the schools in the Florentine area, obtained a great success and many requests. In 2016/2017 more than 24 school asked for didactic laboratories

about light.

*Press office**

Starting from 2010, the CNR INO presence in media is increased every year:
2010 N- 52 output on media
2011 N.145 output on media +178% compared to 2010
2012 N. 210 output on media +44% compared to 2011
2013 N. 256 output on media +21% compared to 2012
2014 N. 374 output on media +46% compared to 2013
2015 and 2016 about the same output but with more quantity and quality of public thanks to an increasing presence on general media and TV.
*Eco della Stampa