

Michele Armano

M.Sc., Ph.D.

Current status

- 2007-now **Scientist for the – currently operational – LISA Pathfinder (LPF) Space Mission, European Space Astronomy Centre (ESAC) at European Space Agency (ESA), Science Directorate, Mission Operations Division (SCI-OO).**
- 2015.12.03 - 2016.02.29** Low-Earth orbit manoeuvres and commissioning
- 2016.03.01 - 2016.06.25** ESA Payload operations and data analysis
- 2016.03.26 - 2016.11.30** NASA Payload operations and data analysis
- 2016.12.01 - 2017.06.30** Granted ESA & NASA Payload operations and data analysis extension
- Experiment and science operations specialist
 - Instrument calibration scientist, payload hardware expert and data analysis specialist
 - Member of the LPF Science and Technology Operations Centre (STOC) and liaison scientist to all the Principal Investigator (PI) teams.
 - Payload planner for science activities. Designer of payload science strategies.
 - Expert in gravity experiments on ground and in space. Specialist in field theory, fundamental physics, gravitation and cosmology.
 - STOC liaison to industry for science and dynamics simulators.
 - STOC liaison to Mission Operations Control (MOC) team at ESOC.
 - Technical manager and Configuration Control Board member of the LPF scientific operational software.
 - Technical manager of STOC Operational Exercises and Simulations.
 - Reviewer at Project, Ground Segment, STOC and Industry reviews.
 - Developer and reviewer for the LTP Data Analysis (LTPDA) toolbox.
 - Coordinator of data conversion, delivery and storage and Archive Scientist during and after operations.
 - Invited STOC scientist at the LPF Science Working Team.
 - Spokesman for the LPF collaboration at conferences and seminars.
- 2009-now **Associate Fellow at the Department of Physics, University of Como-Insubria, Faculty of Science.**
- 2008-now **ESA Faculty fellow, ESAC.**
Regularly performing public outreach activities on space science, mostly in the field of gravitational waves, including publication of papers in refereed journals, technical and public talks.
- 2007-now **Collaborator at the Department of Physics, University of Trento, Faculty of Science.**
- 2012-now **COSPAR Research Associate, Committee on Space Research.**
- 2015-now **IAU Associate, International Astronomical Union, Member of Divisions (D) High Energy Phenomena and Fundamental Physics, (D1) Gravitational Waves Astrophysics, (J) Galaxies and Cosmology.**

Academic titles

- 2006.09.26 **Ph.D. in Physics, University of Insubria, Como, Italy, top marks with honours.**
The LTP Experiment on LISA Pathfinder: Operational Definition of Transverse-Traceless Gauge in Space

2002.04.11 **M.Sc. in Physics**, *University of Milano Bicocca, Milan, Italy*, top marks with honours.

Non-Abelian Lattice Gauge Models in Relativistic Quantum Field Theories beyond the Standard Model

Experience

Work experience and education

2007-now **ESA Contractor**, *Aurora Technology BV, Swedish Space Corporation (SSC) Group*, Heereweg 345, 2161CA Lisse, The Netherlands.

Duty station since 2008: ESAC. Previously stationed 2007-2008 at European Space Technology Centre (ESTEC).

- Expert in the LPF mission structure and operations ground segment.
- Organizer and manager of 44 (so far) Operations Exercises to design payload activities, operational procedures and data analysis pipelines from LPF high-level science description.
- Organizer and manager of 5 (so far) Operational Simulations extending the Operations Exercises to realistic mission grounds with multiple teams (PI's and more) in co-location on ESA sites.
- Science specialist and scheduler for Spacecraft Closed Loop Tests / Real-Time Bench / Spacecraft Onboard Verification Tests and all preparatory exercises.
- Member of the task force *Alternative Theories of Gravity Testing with LPF* (AToG) in 2005 and in the renewed AToG action started in 2013.
- Proficient at application of ESA standards for quality assurance.
- More than 130 functional missions for ESA in 8 years.
- Expert of the industry-provided payload dynamics and control (drag-free, attitude, charge management) Offline System Emulator (OSE) and Software Verification Facility (SVF).
- Expert in usage and testing of uplink/downlink software between the STOC and the Mission Operations Control (MOC).
- Excellent knowledge of all STOC ground segment SW, including the Data Disposition System, MUST server and clients, MOIS software and related interfaces
- Regular participant to LTP PI DA meetings as developer and reviewer.
- Expert in the usage of the SCOS mission database.
- Co-designer and SW developer of the State-Space-Model library of the LTP Data Analysis Toolbox (LTPDA). SW developer of the science designer and calibration packages inside LTPDA. SW developer for SCOS mission browser tool inside LTPDA.
- Co-designer of the MUST-XML telemetry extraction SW.
- Co-responsible for the transfer of the technology and lessons learned from LPF to future gravitational waves observatories.

References: Mr. Damien Texier (damien.texier@esa.int, ESA/ESAC LPF STOC Development Manager), Dr. Paul McNamara (paul.mcnamara@esa.int, ESA/ESTEC LPF Project Scientist), Mr. Alex Jeanes (alexjeanes@aurora.nl Aurora Director).

2011-now **Scientific Consultant (part-time)**, *Geodynamics WorldWide*, Corso Bettini 58, 38068 Rovereto (TN), Italy.

- Physics and technology expert for passive seismic characterisation of hydrocarbon reservoirs.
- Expert in passive seismic sensors design and testing.
- Data analysis specialist and expert on sensor calibration, performance and distribution.
- Quality assurance specialist.

References: Mr. Andrew Shrager (andrewshrager@btconnect.com, GWW CEO).

2010-2011 **Scientific Consultant (part-time)**, *GeoDynamics Research S.R.L.*

- Data analysis specialist.
- Mission co-designer for land surveys with passive seismic detection devices.
- Expert in magnetic-coil devices for passive seismic grid survey.
- Spokesman at conferences.

2006-2007 **Post-doc Fellow**, *University of Trento and Consortium for Space Research on Low-Temperatures*, The LISA and LTP projects.

- Specialist in electrostatic sensing and control for the LTP electrode housings.
- Expert in magnetometers and particle detectors.
- Expert in heating and thermometry onboard LPF.
- Co-writer of core scientific requirements documentation for the LPF mission.
- Acting theorist and model specialist for the experimental team.
- Reviewer with industry as expert on the LPF dynamics and controls. Co-writer of Test Verification Plans and Test Procedures.
- Member of the LTPDA toolbox development team.
- Data analysis specialist for the applications of frequency-domain techniques to geophysical phenomena.

References: Prof. Stefano Vitale (stefano.vitale@unitn.it, microgravity and low-temperatures group leader, University of Trento), Dr.Eng. Daniele Bortoluzzi (daniele.bortoluzzi@unitn.it, mechatronics and industrial engineering department, University of Trento)

2006-2008 **Collaborator and Research Fellow**, *GeoDynamics Research S.R.L.*

- Developer of a frequency domain coherence method for the location and characterisation of oil reservoirs.
- Scientific validator of the Infrasonic Passive Differential Spectroscopy (IPDS) and related software.
- Liaison scientist to several outer institutions, including: Abu-Dhabi Company for Onshore Oil Operations, Tufts University in Boston, University of Trieste, Technical University Delft.

A.Y. 2003-2006 **Philosophy Doctorate**, *Universities of Como and Trento*.

- Data analyst and theorist for the low-temperatures and experimental gravity group at the University of Trento.
- Measurements and calibration specialist of the LTP electrostatic sensing.
- Gravity modelling specialist of the LPF spacecraft and analyst for the gravitational compensation of the science payload.
- Experience on the 1 d.o.f. torsion pendulum facility for electrostatic detection and noise reduction.
- Specialist in system-identification and cross-talk analysis for the LTP dynamics.
- Developer of real-time applications for the LPF front end electronics software and related high-speed performance data analysis.
- Fully funded position, admission exam and test passed as 2nd over 60 candidates.

Major subjects:

- General relativity, relativistic magnetohydrodynamics and fluid mechanics.
- Laser interferometer detectors for gravitational waves.
- Signal theory, data analysis and spectral processing. Control theory.
- Stochastic processes in mathematics, economics and geology, microseismic analysis, mathematical statistics.

Thesis Tutors: Prof. S. Vitale (Trento), Prof. F. Haardt (Como).

Thesis Examining Commission: Prof. V. Gorini (Como), Prof. M. Cerdonio (University of Padova), Prof. A. Lobo (IEEC Barcelona)

Defence and award: honours, 2006.09.26 University of Insubria, Como, Italy.

2003.04.21-11.31 **Collaboration Contract**, *Carlo Gavazzi Space Italia S.P.A. (currently CGS), Scientific Payloads Division*, Software development and scientific liaison for the LISA project.

2002.10.20-2003.04.20 **Work Stage in Physics and Engineering**, *Carlo Gavazzi Space Italia S.P.A., Systems and Software Division*, LISA space project.

2002.05-2002.10 **University Research Collaborator**, *University of Milano Bicocca*, Project: *Non-Abelian many flavours scalar field theory* - investigation on low energy behavior of non-Abelian gauge theories on the lattice.

A.Y. 2000-2002 **Master of Science**, *University of Milan Bicocca*.

Thesis Tutors: Prof. G. Marchesini, Dr. R. Frezzotti.

Defence and award: 110 cum laude (honours) / 110, 2002.04.11 University of Milano Bicocca, Milan, Italy.

A.Y. 1999-2000 **Erasmus fellow**, *The Niels Bohr Institute (NBI) and Copenhagen University, Copenhagen, Denmark.*

Major subjects:

- Statistical mechanics, critical phenomena, phase transitions, nuclear theory.
- Lattice quantum field theory, computational physics, Monte-Carlo methods, renormalization group techniques.
- Advanced theoretical astrophysics: black holes, compact objects, stellar evolution.
- Advanced astronomy, solar system physics.
- Particle physics, Standard Model, advanced field theory, QED, QCD, super-symmetry, string theory.

References: Prof. Thomas Døssing (associate professor at NBI).

A.Y. 1996-2000 **Undergraduate and graduate University Education in Physics**, *University of Milan.*

A.Y. 1998-1999 Laboratory experience and experiments on Carbon-60 and Fullerene Physics, tutor: prof. P.Milani.

A.Y. 1994-1996 **Undergraduate University education in Philosophy**, *Milan.*

1994.07.14 **A-level GCSE High School Degree (Diploma di Maturità Scientifica)**, *Final mark 60/60 (honours).*

1989-1994 **High School education**, *Major subjects: Physics, Mathematics, Informatics, Natural Sciences, Philosophy, Literature, Latin, History. Foreign language and literature: English. Institute A. Antonelli in Novara, Italy.*

1981-1994 **Compulsory standard Elementary and Junior-high School education.**

Funds management

2011.01-now **Validation Exercises for the Science and Technology Operations Centre**, *Managing the fund line on account of the LPF STOC Manager.*

Supporting visiting scientists as active members of the LPF STOC, mostly on data analysis and operations activities.

2011.06-now **LISA Pathfinder and Non-Newtonian theories of Gravity**, *Managing the fund line on account of the SRE-OD division at ESAC for the LPF Project.*

Supporting scientists and engineers active in collaborating with ESA on the front of investigating a possible mission extension to send LPF at the Sun-Earth saddle point in search of non-Newtonian MOND-like violation of the gravity gradient law.

Other experiences

2008-2009 **ESA European Astronauts Selection**, *Selected for the first call of tests at the German Aerospace Center (DLR) Hamburg, Germany.*

2008-now **Private Pilot License (PPL)**, *Training for the European License, 20 active hours of flight on single piston airplane Grob Aerospace G109. Training and flight hours accredited by Aeroclub Valkenburg (ACV), Valkenburg Airport (EHVB), Holland.*

2001-2002 **Red Cross Trained Rescuer**, *Emergency rescue specialist, Army Social Service 2001.11.11-2002.09.12. Radio operator. Permanent status.*

Awards and grants

2006 **HPC-Europa Transnational Access Programme grant**, *EPCC, University of Edinburgh, United Kingdom.*

2003-2006 **SUPRA Chancellor's award and grant at Swinburne University, Melbourne, Australia.**

2003-2004 **Della Riccia grant for graduate students, Florence, Italy.**

Training

2016.10.25-28 **Astro-Statistics Workshop, ESAC, Madrid.**

2016.09.21-25 **Gestalt Group Therapy Principles and Workshop, Gestalt Institute Trieste, held in Ponte di Piave, Italy.**

2016.09.06-2016.12.10 **Principles and Training in Negotiation and Coaching, Remote training by Negovia, Bussy Saint Georges, France.**

2016.06.28-07.01 **Advanced Python Training, ESAC, Madrid, Spain.**

2015.10.19-21 **Data Analysis and Statistics 2015 workshop, ESAC, Madrid, Spain.**

2014.10.27-31 **Advanced Data Analysis and Statistics 2014 workshop, ESAC, Madrid, Spain.**

2014.09.22-25 **Spacecraft System Engineering Course, ESAC, Madrid, Spain.**

2014.02.24-27 **Software Carpentry Bootcamp on Python, ESAC, Madrid, Spain.**

2012.05.30-06.02 **Astronomical Programming in Python, ESAC, Madrid, Spain.**

2005.08.01-15 **Advanced School on Chaotic Phenomena, Centre for Applied Mathematics and Theoretical Physics, University of Maribor, Slovenia.**

Teaching

A.Y. 2005-2006, 2nd Term Assistant lecturer for the Master course in *Dynamics and Control* at the Faculty of Engineering, University of Trento

A.Y. 2005-2006, 1st Term Assistant lecturer for the Ph.D. course of *Mathematical Statistics* at the Faculty of Economics, University of Trento

A.Y. 2005-2006 Assistant lecturer for the Ph.D. course of *Foundations in Mathematics and Statistics* at the Faculty of Economics, University of Trento

A.Y. 2004-2005, 2nd Term Assistant lecturer for the course in *Statistics and Inference* at the Faculty of Science, University of Trento, Ph.D. level course at Department of Informatics and Information Technology.

A.Y. 2004-2005, 1st-2nd Terms Assistant lecturer for the course in *Mathematical Statistics* at the Faculty of Economics, University of Trento, Ph.D. level course at CIFREM Ph.D. school for Economics and Management.

Visits to research institutes

2008.07 **Computer Science Department, Tufts University, Boston, Massachusetts, USA,** by appointment of Prof. C. Brodley and Prof. J. Noonan.

2006.12 **Theoretical Atomic-scale Physics (CAMD), DTU Physics, Lyngby, Denmark,** by appointment of Prof. Jens Nørskov.

2006.12 **Nonequilibrium quantum and statistical physics, Department of Physics, FMF, University of Ljubljana and Stefan Institute, Slovenia,** by appointment of Prof. Tomaš Prosen.

Skills

Assets and expertise in team management and outreach

o Excellent group leader Excellent relationship with co-workers and service personnel

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- Ability to fluently communicate in many languages.
- Very positive attitude towards teamwork, proficient at independent work.
- High devotion to work and extreme integrity. Fast learner and very sharp at delivering outputs.
- Respectful of hierarchy and work structure, careful with handling of sensible information.
- Great flexibility in different environments: physics (theory and experiment), space operations, engineering, management.
- Strong interest in working in international environments, no geographical limitations to undertake new work positions.
- Excellent communicator, actively present at conferences and symposia.
- Strong scientific background. Vivid interest in science and technology. Proven teaching abilities.

Computing

	<i>Excellent</i>	<i>Very good</i>	<i>Good</i>
Operational SW	SCOS2k/MIB, MOIS, DDS, MUST, LPFSim/SimSat(Vega), LSS(ESA), DFACS/OSE(Airbus)	SVF(Airbus)	
Scientific packages	Mathematica, MATLAB, Simulink, StateFlow, MatPlotLib, MLab, SciPy, NumPy		R
Programming languages	C, C++, Python, Perl, Java, VisualBasic	PHP, Pascal, Prolog	Fortran
Databases	MySQL, PostGreSQL	Derby, Oracle	
Office packages	Microsoft Office (ECDL certificate), OpenOffice, LibreOffice		
Management packages	Microsoft Project, Merlin and similar, Lotus Notes		
Typesetting and graphics	L ^A T _E X, yEd, GIMP	PhotoShop	

- Administration Expert (super-user) in Linux/Unix systems and networks. Linux kernel expert.

Languages

	<i>Understanding</i>		<i>Speaking</i>		<i>Writing</i>
	<i>Listening</i>	<i>Reading</i>	<i>Interaction</i>	<i>Production</i>	
Italian	Mother tongue				
English	C2	C2	C2	C2	C2

Spanish	C2	C2	C1	C1	C1
French	B2	C1	B1	B1	A2
German	A2	B1	A2	A2	A2
Danish	A2	B1	A2	A2	A2
Slovene	A2	B1	A2	A2	A2
Serbo-Croatian	A2	B1	A2	A2	A2
Russian	A1	A1	-	-	-

see: European Language Levels Self Assessment Grid

Public Outreach

Author and co-author of more than 45 refereed scientific papers. See: the SAO/NASA Astrophysics Data System bibliography record. The 5 most relevant publications follow.

Refereed Articles

- [1] M. Armano, H. Audley, G. Auger, et al. Charge-induced force noise on free-falling test masses: Results from LISA Pathfinder. *Phys. Rev. Lett.*, 118:171101, Apr 2017. URL <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.118.171101>.
- [2] M. Armano, H. Audley, G. Auger, et al. Sub-femto- g free fall for space-based gravitational wave observatories: LISA Pathfinder results. *Phys. Rev. Lett.*, 116:231101, Jun 2016. URL <http://link.aps.org/doi/10.1103/PhysRevLett.116.231101>.
- [3] M. Armano, H. Audley, G. Auger, et al. Bayesian statistics for the calibration of the LISA Pathfinder experiment. *J. Phys. Conf. Ser.*, 610(1):012027, 2015. URL <http://stacks.iop.org/1742-6596/610/i=1/a=012027>.
- [4] F. Gibert, M. Nofrarias, M. Armano, et al. In-flight thermal experiments for lisa pathfinder: Simulating temperature noise at the inertial sensors. *J. Phys. Conf. Ser.*, 610(1):012023, 2015. URL <http://stacks.iop.org/1742-6596/610/i=1/a=012023>.
- [5] N. Korsakova, C. Messenger, F. Pannarale, et al. Data analysis methods for testing alternative theories of gravity with lisa pathfinder. *Phys. Rev. D*, 89:123511, Jun 2014. URL <dx.doi.org/10.1103/PhysRevD.89.123511>.

Technical Notes

- [1] M. Armano. Report of the STOC-LTP simulation 4. Technical Report S2-ESAC-RP-5020, ESA, Mar 2014.
- [2] M. Armano. Plan for the STOC-LTP simulation 4. Technical Report S2-ESAC-PL-5029, ESA, Nov 2013.
- [3] P. W. McNamara, M. Armano, K. Danzmann, et al. LPF experiment master plan. Technical Report S2-EST-PL-5007, ESA, Jun 2011.
- [4] M. Armano and J. Fauste. LISA pathfinder data analysis toolbox acceptance test guidelines. Technical Report S2-ESAC-PL-5006 1.3, ESA, Jul 2009.
- [5] M. Armano, D. Bortoluzzi, and S. Vitale. LTP gravitation control protocol. Technical

Chaired sessions

- 2016.10.16-21 Chairman for the session on "Mission highlights, transients, TDEs" at Black Hole Accretion and Jets, Kathmandu, Nepal.
- 2016.07.31-08.06 Convenor and chairman for the "experimental physics in space" sub-theme of fundamental physics for COSPAR/2016, Istanbul, Turkey.
- 2015.07.12-18 Chairman for the session on LISA Pathfinder at 14th Marcel Grossmann Conference, Rome, Italy.
- 2014.08.02-09 Chairman for the session on high-energy fundamental physics at 40th COSPAR Assembly, Moscow, Russian Federation.
- 2012.04.29-05.05 Chairman for the session on CMB, Supernovae, Weak Lensing, Large Scale Structure at the 5th Petrov International Symposium on High Energy Physics, Cosmology and Gravity, Kyiv, Ukraine.
- 2012.06.25-27 Chairman for the session on new science with flares, gravitational waves, binary black holes at the Tidal Disruption events and AGN outbursts workshop, European Space Astronomy Centre, Madrid, Spain.

Given talks

- Dozens of talks on Data Analysis, System and Control Engineering, Operations Planning at several data analysis meetings for LPF.
- Dozens of talks on Physics, mostly on General Relativity, Gravity and related phenomena, at ESA sites, private institutions, public schools.
- More than 20 conferences attended in 8 years of work for ESA, mostly with invited talks.

Most recent or relevant talks:

- 2016.08.04 *LISA Pathfinder First Results*, invited highlight talk at COSPAR, Istanbul, Turkey.
- 2016.07.06 *LISA Pathfinder: the Gravity of Success*, invited talk at EWASS Conference, Athens, Greece.
- 2016.07.01 *LISA Pathfinder First Results*, talk at ESAC, Spain.
- 2015.07.25 *Operations with LISA Pathfinder*, invited plenary talk at 11th Amaldi Conference, Gwangju, South Korea.
- 2015.04.01 *From LPF to NOMAD: Newtonian or Modified Acceleration Dynamics*, talk at Jet Propulsion Laboratory, Pasadena, California, USA.
- 2014.08.06 *Alternative Theories of Gravity with LISA Pathfinder*, invited talk at 40th COSPAR Assembly, Moscow, Russian Federation.
- 2014.06.30 *Calibrating and using a Gravitational Observatory in space. The science of LISA and LISA Pathfinder*, invited plenary talk at Icranet Conference, Yerevan, Armenia.

Interviews with Media

- 2015.12.01 RTVE (Spanish Radio Television) Informe Semanal *La Mision LISA Pathfinder y la Nueva Astronomia con las Ondas Gravitatorias*
- 2015.12.01 RTVE (Spanish Radio Television) appeared on telediario (news) 2015.12.03 *Despega con exito LISA Pathfinder*
- 2015.12.04 RNE (National Spanish Radio) Europa Abierta: *Ondas Gravitatorias y Ciencia en el Espacio*

Personal information

Hobbies and sports Travelling, reading, carpentry, science in general. Kung-fu, ski, ski-de-randonnée, volleyball, jogging, swimming, body-building, biking, hiking, climbing, tango-dancing.