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E-mail:zanolin@ligo.mit.edu, zanolinm@erau.edu  
Status: Naturalized US citizen.

**Education** UNIVERSITY OF PARMA Parma, Italy  
Ph.D. in Physics, 2001  
Thesis “Array technologies in acoustics” Advisor: Prof. P. Podini

UNIVERSITY OF PARMA Parma, Italy  
Laurea (equivalent to bachelors and masters) in Physics, July 1997  
Average grades: **29.7 out of 30**, Final grade: **110 out of 110** Cum Laude  
Thesis title: Wilson Renormalization group for non Abelian gauge field theories interacting with fermion fields. Advisors: Prof. M. Bonini, Prof. G. Marchesini

**Research Positions** MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA USA  
June 2008 - present  
**Research Associate** Laser Interferometer Gravitational Wave Observatory (LIGO), Physics Department.

EMBRY RIDDLE AERONAUTICAL UNIVERSITY Prescott, AZ USA  
August 2007 - present  
**Assistant Professor** Physics Department.

LIGO Cambridge, MA USA  
August 2005 - July 2007  
**co-chair** of the LIGO-Virgo research working group.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA USA  
January 2004 - July 2007  
**Post-Doctoral Associate** with the LIGO laboratory at the Kavli Center for Space Research.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA USA  
December 2000 - September 2003  
**Post-Doctoral Associate** with the Underwater Acoustic Group of Prof. N. Makris.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA USA  
September 1999 - November 2000  
**Invited Scholar** in the Underwater Acoustic Group of Prof. N. Makris.

UNIVERSITY OF PARMA Parma, Italy  
March 1999 - June 1999  
**Fellowship** with the Industrial Engineering Department, with Prof A. Farina, studying acoustic scattering properties of diffusive panels.

## External Grants

NATIONAL SCIENCE FOUNDATION Starting fall 2009  
**Principal Investigator:** standard renewable grant (\$80K, number 855567) to support the PI and two undergraduates in gravitational waves data analysis and acoustics measurements of the Young's modulus in the coatings of LIGO mirrors.

NASA Starting fall 2009  
**Principal Investigator** \$5K support for an undergraduate student doing research for two semesters .

SPINNER PROGRAM - EUROPEAN UNION 2001  
**Co-Principal Investigator** (25K euros - protocol number 369), in collaboration with CoPI Dr. Paolo Martignon and Prof. P. Podini of the Physics Department at the U. Parma (Italy).

**Rewiever** (1) Physical Review D, (2) Journal Acoustical society of America, (3) Icaurs.

- Papers**
- [1] Farina, Angelo, Zanolin, Michele, Crema, Elisa “ Measurement of Sound Scattering Properties of Diffusing Panels through the Wave Field Synthesis Approach”, Journal of the Audio Engineering society 108, 5091 (2000).
  - [2] Zanolin, Michele; Podini, Paolo; Farina, Angelo; De Stabile, Stefano; Vezzoni, Paolo “Active Control of Noise by Wave Field Synthesis”, Journal of the Audio Engineering Society 108, 5092 (2000)
  - [3] M. Zanolin, E. Naftali and N. Makris “Asymptotic expansions of performance indicators for a maximum likelihood estimation of non random parameters vectors, based on data randomized by a generally correlated Gaussian noise” Technical Report, MIT Press, Jan (2001).
  - [4] A. Thode, M. Zanolin, E. Naftali, I. Ingram, P. Ratilal, N. Makris “Necessary conditions for a MLE to become asymptotically unbiased and attain the Cramer Rao lower bound, II: range and depth localization of a sound source in a ocean wave guide” J. Acoust. Soc. Am. 112 1890 (2002)
  - [5] S. Lee, A. Thode, M. Zanolin, N. Makris R. Pappalardo “Estimating Europa’s internal structure with ambient noise” International Journal of Solar System Studies (ICARUS) 165, 144-167 (2003).
  - [6] M. Zanolin, I. Ingram, A. Thode, N. Makris “Necessary conditions for MLE Geo-Acoustic Parameter Inversions to Become Asymptotically Unbiased and Attain the Cramer Rao Lower Bound” J. Acoust. Soc. Am. 116, 2031 (2004).
  - [7] LIGO scientific collaboration, “A Search for Gravitational Waves Associated with the Gamma Ray Burst GRB030329 Using the LIGO Detectors”, Phys. Rev. D 72, 042002 (2005).
  - [8] LIGO scientific collaboration, “ Limits on Gravitational-Wave Emission from Selected Pulsars Using LIGO Data”, Phys. Rev. Lett. 94, 181103 (2005).

- [9] LIGO scientific collaboration, “Upper Limits on Gravitational Wave Bursts in LIGO’s Second Science Run”, *Phys. Rev. D* 72, 062001 (2005).
- [10] LIGO scientific collaboration, “Upper limits from the LIGO and TAMA detectors on the rate of gravitational-wave bursts”, *Phys. Rev. D* 72 (2005) 122004
- [11] LIGO scientific collaboration, “Search for gravitational waves from galactic and extra-galactic binary neutron stars.”, *Phys. Rev. D* 72 (2005) 082001
- [12] LIGO scientific collaboration “Search for gravitational waves from primordial black hole binary coalescences in the galactic halo”. *Phys. Rev. D* 72 (2005)
- [13] (M Zanolin and G Guidi group chairs while this work was performed) F. Beauville, M.A. Bizouard, L. Blackburn, L. Bosi, P. Brady, L. Brocco, D. Brown, D. Buskulic, S. Chatterji, N. Christensen, A.C. Clapson, S. Fairhurst, D. Grosjean, G. Guidi, P. Hello, E. Katsavounidis, M. Knight, A. Lazzarini, F. Marion, B. Mours, F. Ricci, A. Vicere, and M. Zanolin. A comparison of methods for gravitational wave burst searches from LIGO and Virgo. (2008) *Class. Quantum Grav.* 25 045002 (32pp)
- [14] (M Zanolin and G Guidi group chairs while this work was performed) Beauville, MA. Bizouard, L. Blackburn, L. Bosi, P. Brady, L. Brocco, DA. Brown, D. Buskulic, S. Chatterji, N. Christensen, A.C. Clapson, S. Fairhurst, D. Grosjean, G. Guidi, P. Hello, E. Katsavounidis, M. Knight, A. Lazzarini, F. Marion, B. Mours, F. Ricci, A. Vicere, and M. Zanolin. “Detailed comparison of LIGO and Virgo Inspiral Pipelines in Preparation for a Joint Search. F.” (2008) *Class. Quantum Grav.* 25 045001 (22pp)
- [15] LIGO scientific collaboration, “Search for gravitational-wave bursts in LIGO’s third science run”. *Class. Quant. Grav.* 23 (2006) S29-S39
- [16] LIGO scientific collaboration, “Search for gravitational-wave bursts in LIGO data from the fourth science run” ,*Class. Quantum Grav.* 24 5343-5369
- [17] LIGO scientific collaboration, “A Joint Search for Gravitational Wave Bursts with AURIGA and LIGO.”*Class. Quantum Grav.* 25 (2008) 095004
- [18] LIGO scientific collaboration, “Search for gravitational wave radiation associated with the pulsating tail of the SGR 1806-20 hyperflare December 27, 2004 using LIGO” *Phys. Rev. D* 76 (2007) 062003
- [19] J. Markowitz, M. Zanolin, L.Cadonati, and E. Katsavounidis “Gravitational Wave Burst Source Direction Estimation using Time and Amplitude Information”, *Phys. Rev. D* 78, 122003 (2008)
- [20] LIGO scientific collaboration, “Search for gravitational waves from binary black-hole inspirals in LIGO data.”, *Phys. Rev. D* 73 (2006) 062001
- [21] LIGO scientific collaboration, “Joint LIGO and TAMA300 Search for Gravitational Waves from Inspiralling Neutron Star Binaries”. *Phys. Rev. D* 73 (2006) 102002

- [22] LIGO scientific collaboration, “First all-sky upper limits from LIGO on the strength of periodic gravitational waves using the Hough transform”. *Phys. Rev. D* 72 (2005)
- [23] LIGO scientific collaboration, “Limits on gravitational wave emission from selected pulsars using LIGO data”. *Phys. Rev. Lett.* 94 (2005) 181103.
- [24] LIGO scientific collaboration, “Coherent searches for periodic gravitational waves from unknown isolated sources and Scorpius X-1: results from the second LIGO science run”. *Phys. Rev. D* 76 (2007) 082001
- [25] LIGO scientific collaboration, “A Joint Search for Gravitational Wave Bursts with AURIGA and LIGO” *Class. Quantum Grav.* 25 (2008) 095004
- [26] LIGO scientific collaboration, “Search of S3 LIGO data for gravitational wave signals from spinning black hole and neutron star binary inspirals”. *Phys. Rev. D* 78 (2008) 042002
- [27] LIGO scientific collaboration, “Upper limits on a stochastic background of gravitational waves”. *Phys. Rev. Lett.* 95 (2005) 221101
- [28] LIGO scientific collaboration, “Search for gravitational wave radiation associated with the pulsating tail of the SGR 1806-20 hyperflare of December 27, 2004 using LIGO” *Phys. Rev. D* 76 (2007) 062003
- [29] LIGO scientific collaboration, “Search for Gravitational Waves Associated with 39 Gamma-Ray Bursts Using data from the Second, Third, and Fourth LIGO Runs” *Phys. Rev. D* 77 (2008) 062004
- [30] LIGO scientific collaboration, “First joint search for gravitational-wave bursts in LIGO and GEO600 data” *Class. Quantum Grav.* 25 (2008) 245008
- [31] LIGO scientific collaboration, “Search for gravitational waves from binary inspirals in S3 and S4 LIGO data” *Phys. Rev. D* 77 (2008) 062002
- [32] LIGO scientific collaboration, “Upper Limits on Gravitational Wave Emission from 78 Radio Pulsars.” *Phys. Rev. D* 76 (2007) 042001
- [33] LIGO scientific collaboration, “All-sky search for periodic gravitational waves in LIGO S4 data” *Phys. Rev. D* 77 (2008) 022001
- [34] LIGO scientific collaboration, “The Einstein@Home search for periodic gravitational waves in LIGO S4 data” to appear in *Phys Rev D* arXiv:0804.1747 200804
- [35] LIGO scientific collaboration, “Searching for Stochastic Background of Gravitational Waves with LIGO.” *Astrophys. J.* 659 (2007) 918
- [36] LIGO scientific collaboration, “Upper limit map of a background of gravitational waves.” *Phys. Rev. D* 76 (2007) 082003
- [37] LIGO scientific collaboration, “First Cross-Correlation Analysis of Interferometric and Resonant-Bar Gravitational-Wave Data for Stochastic Backgrounds.” *Phys. Rev. D* 76 (2007) 022001

- [38] LIGO scientific collaboration, “Implications for the Origin of GRB 070201 from LIGO Observations” *Astrophys. J.* 681 (2008) 1419
- [39] LIGO scientific collaboration, “Beating the spin-down limit on gravitational wave emission from the Crab pulsar” *ApJ Lett* 683 (2008)
- [40] LIGO scientific collaboration, “Search for Gravitational Wave Bursts from Soft Gamma Repeaters” *Phys. Rev. Lett.* 101 (2008)
- [41] LIGO scientific collaboration, “All-sky LIGO Search for Periodic Gravitational Waves in the Early S5 Data” arXiv:0810.0283 200810
- [42] LIGO scientific collaboration (M Zanolin and N.Cornish paper coordinators), “Search for gravitational-wave bursts in LIGO’s 5th science run”. accepted in *Phys Rev D*. Preprint available at: gr-qc/0905.0020.
- [43] LIGO scientific collaboration (B. Hughey, M Zanolin and E. Katsavounidis search leaders) , “High frequency search for gravitational-wave bursts in the first year of LIGO’s 5th science run”. accepted in *Phys Rev D*. Preprint available at: arXiv:0904.4910v2.

### **Papers in submission**

- [1] Yeming Shi (undergraduate student), Michele Zanolin, Erik Katsavounidis “Non-Parametric Distributional Tests for Gravitational Wave Transient Event Detection” , to PRD
- [2] M.Zanolin, M. Lebourde (undergraduate student), J.Smith (undergraduate student) , “Detectability of shallowly buried dense artifacts by an evanescent wave sonar array”. to *Journal Acoustical Society of America*.
- [3] I. Bertsatos, T. Chen, N. C. Makris, M. Zanolin, P. Ratilal “Theoretical Limits of Passive Source Localization in a Fluctuating Ocean Waveguide” to *Journal Acoustical Society of America*.
- [4] LSC Virgo “Directional reconstruction of gravitational burst sources “ to PRD

### **Proceedings and technical documents**

- [1] P. Martignon, M. Zanolin, P. Podini, S. Destabile “Virtual acoustic application of Kirkhoff Helmholtz integrals”, 19th International Conference of Acoustics, Sept 2-7 Rome, Italy, (2001).
- [2] P. Martignon, M. Zanolin, S. De Stabile, P. Podini “Sound focalization by wave field synthesis for audio reproduction”, 19th International Conference of Acoustics, Italy, Sept 2-7 Rome, (2001).
- [3] E. Crema, P. Martignon, S. De Stabile, M. Zanolin “In situ determination of the acoustic absorption of a barrier: which kind of source?”, 19th International Conference of Acoustics, Rome, Sept 2-7, Italy, (2001).

[4] Non-Parametric Distributional Tests for Gravitational Wave Transient Event Detection Yeming Shi, Erik Katsavounidis, Michele Zanolin Poster at GWDAW12, Dec 2007 Link: <http://www.ligo.caltech.edu/docs/G/G070884-00/G070884-00.ppt>

[5] Localization of burst sources with GW detectors, LIGO DCC M Zanolin, G0900683v6, July 2009

[6] G080246-00-Z 04/10/2008Activities of the LSC glitch group during S5 Authors:Shantanu Desai; Lindy Blackburn; Laura Cadonati; Sarah Caudill; S. Chatterji; Josh Dalrymple; A. Di Credico; Justin Garofoli; Lisa Goggin; Gabriela Gonzalez; Romain Gouaty; Corey Gray; Andri Gretarsson; D. Hoak; Erik Katsavounidis; J. Kissel; S. Klimenko; A. Mercer; S. Mohapatra; Soma Mukherjee; Fred Raab; Keith Riles; Peter Saulson; Robert Schofield; Peter Shawhan; Jacob Slutsky; Joshua Smith; R. Stone; Cheryl Vorvick; Michele Zanolin; Natalia Zotov; John Zweizig

[7] P080016-01-Z 06/16/2008The LSC Glitch Group: Monitoring Noise Transients During the Fifth LIGO Science Run Authors:Lindy Blackburn; Laura Cadonati; Santiago Caride; Sarah Caudill; S. Chatterji; Nelson Christensen; Josh Dalrymple; Shantanu Desai; A. D. Credico; Greg Ely; Justin Garofoli; Lisa Goggin; Gabriela Gonzalez; Romain Gouaty; Corey Gray; Andri Gretarsson; D. Hoak; T. Isogai; Erik Katsavounidis; J. Kissel; S. Klimenko; R.a. Mercer; S. Mohapatra; Soma Mukherjee; Fred Raab; Keith Riles; Peter Saulson; Robert Schofield; Peter Shawhan; Jacob Slutsky; J.r. Smith; R. Stone; Cheryl Vorvick; Michele Zanolin; Natalia Zotov; John Zweizig

[8] P080016-00-Z 02/26/2008The LSC Glitch Group: Monitoring Noise Transients During the Fifth LIGO Science Run Authors:Lindy Blackburn; Laura Cadonati; Santiago Caride; Sarah Caudill; S. Chatterji; Nelson Christensen; Josh Dalrymple; Shantanu Desai; A. Di Credico; Greg Ely; Justin Garofoli; Lisa Goggin; Gabriela Gonzalez; Romain Gouaty; Corey Gray; Andri Gretarsson; D. Hoak; T. Isogai; Erik Katsavounidis; J. Kissel; S. Klimenko; A. Mercer; S. Mohapatra; Soma Mukherjee; Fred Raab; Keith Riles; Peter Saulson; Robert Schofield; Peter Shawhan; Jacob Slutsky; J.r. Smith; R. Stone; Cheryl Vorvick; Michele Zanolin; Natalia Zotov; John Zweizig

### **Selected Presentations**

[1] M. Zanolin, A. Thode, N. Makris “Probing Europa’s interior with natural ambient noise sources”, Europa Focus Group Workshop, Nasa-Ames Research Center San Francisco, CA February 1-2, 2001

[2] E. Crema, P. Martignon, S. DeStabile, M. Zanolin “Wave field synthesis approach to define an absorption coefficient for barriers”, 19th International conference of Acoustics, Rome, Sept 2-7 (2001)

[3] A. Thode, M. Zanolin, S. Lee, N. Makris “ The other ocean: probing Europa’s interior with natural ambient noise sources ”, 141st Meeting of the acoustical Society of America, Chicago, June 4-8 (2001)

[4] M. Zanolin, E. Naftali, N. Makris “Second order bias for multivariate gaussian

data and a chain-rule for the higher moments ” ENAR/IMS Eastern Regional, March 15-21, 2002, Washington.

[5] N. Makris, S. Lee, A. Thode, J.D. Wilson M. Zanolin, R. Pappalardo “Probing Europa’s interior structure with natural ambient noise”, AGU 2001 Fall Meeting, Dec 10-14 San Francisco, California.

[6] P. Martignon, M. Zanolin, S. DeStabile “Characterization of the acoustic response of an auditorium for its recreation in a rehearsal room” . 3-7 June 2002 in Pittsburgh

[7] S.Lee, M. Zanolin, A.M. Thode, N. C. Makris R. Pappalardo ‘Estimating Europa’s internal structure with ambient noise’ ASA 3-7 June 2002, Pittsburgh and J. Acoust. Soc. Am. 111, 2372 (2002)

[8] M. Zanolin, N.C. Makris “Optimal source localization in a partially saturated fluctuating waveguide” ASA Pittsburgh, June 3-7 (2002), and, J. Acoust. Soc. Am. 111, 2438 (2002).

[9] T. Chen, P. Ratilal, M. Zanolin, N. C. Makris “Propagation through a stratified ocean waveguide with random volume inhomogeneities, Part II. application: Internal waves, bubbles, sub-bottom and seafloor anomalies” J. Acoust. Soc. Am. 112 2403 (2002)

[10] N. Makris, S. Lee, M. Zanolin, A. Thode, R. Pappalardo,”Probing Europa’s interior Structure with Natural Ambient Noise” Denver Annual Meeting of the Geological Society of America (GSA) Denver, CO (October 27-30, 2002)

[11] N. Makris, S. Lee, M. Zanolin, R. Pappalardo,”Probing Europa’s Interior with Natural Sound Sources” 34th Lunar and Planetary Science Conference, March 17-21, 2003 NASA Johnson Space Center, Houston, TX.

[12] M. Zanolin for the Ligo scientific Collaboration “Comparison of methods for gravitational-wave burst search using simulated LIGO and VIRGO data” GW-DAW9 Annecy France dec 15-18 (2004)

[13] M. zanolin for the Ligo scientific Collaboration LSC “Search for high frequency burst triggers in the first year of S5“ plenary talk, LSC-Virgo conference July 14-18th 2008 Paris, France.

[14] M. zanolin for the Ligo scientific Collaboration “S5y1 low frequency burst search” plenary talk, LSC-Virgo conference Dec 14-18th 2008 Washington D.C.

[15] Localization of burst sources with GW detectors, LIGO DCC M Zanolin, G0900683v6, July 2009 Marcel Grossmann Meeting Paris, France

[16] G080350-00-Z 06/09/2008 Review Report on the S4 LIGO-GEO Bursts Paper - LSC/Virgo Collaboration Meeting, June 9-12, 2008, Orsay France Authors:Patrick Sutton; Keith Riles; Michele Zanolin

**Teaching  
Experience**

EMBRY RIDDLE AERONAUTICAL UNIVERSITY

Prescott, AZ

During the fall 2007, spring 2008 and fall 2008 I taught 6 sections of Electricity

and Magnetism for undergraduate physicists and engineers (3 hours/week), three sections of mechanics for undergraduate physicists and engineers (3 hours/week), and one section of Electromagnetism Laboratory for undergraduate physicists and engineers (3 hours/week).

MASSACHUSETTS INSTITUTE OF TECHNOLOGY Cambridge, MA  
Assisted in advising graduate students in the Ocean Acoustic Group and at the LIGO laboratory.

UNIVERSITY OF PARMA Parma, Italy  
Spring 1999, Fall 1999

Co-advisor to a master's student in the Physics Department at the University of Parma (Title of the thesis "Virtual reality applications of acoustic holography by means of loudspeakers arrays")

ENAIPI INSTITUTE OF PISA Parma, Italy  
Spring 1999

Lecturer in the Room Acoustics class for the master course for Acoustical Engineers.

## Research Interests

My main line of research is in gravitational waves detection and astronomy. In particular I focus on data analysis, and hardware development with a focus to acoustic related issues. Acoustics remote sensing is the topic of my Ph.D. thesis and I still maintain a certain degree of involvement in it.

Gravitational waves and acoustics share a good deal of data analysis techniques because the frequencies and the ratios of source (receiver) sizes to the gravitational wave wavelengths are similar among the two fields.

**Referencies** Available upon request