Arnaud Tourin

Professor at ESPCI Paris – PSL

Personal information

Date of birth: June 9, 1972 in Boulogne Billancourt (France)
Nationality: French
Married, two children

Professional address

✉	Institut Langevin, 1 rue Jussieu, 75005 Paris, France
☎	+ 33 1 80 96 30 63
E-mail	arnaud.tourin@espci.psl.eu
Personal webpage	https://www.institut-langevin.espci.fr/arnaud_tourin

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Education

- 2005 **Habilitation à Diriger des Recherches, Université Paris Cité**
  Waves in complex media

- 1999 **PhD in Physical Acoustics, Université Paris Cité**
  Multiple scattering and time reversal of ultrasound

- 1995 **Engineering Degree in Materials Science from ENSI Caen**

  MSc degree in materials science - University of Caen Normandy

  Master of Business Administration (Certificat d'Aptitude à l'Administration des Entreprises - CAAE) - University of Caen Normandy

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Past responsibilities

- Vice-president for research at PSL University (2022-2024)
- Head of *Institut langevin* (2014-2022)
- Academic director of the PSL's Graduate Program in Physics (2019-2022)
- Head of LabEx (Laboratory of Excellence) WIFI (2020-2022)
  Waves and Imaging: from Fundamentals to Innovation
- Member of the management committee of ESPCI Paris – innovation advisor (2020-2022)
- Member of the governance committee of incubator *PC'Up* (2016-2022)
- Member of the scientific committee of the DIM (Domain of Main Interest) *Empowering Life sciences with Innovative Technologies*, key research sector backed by the Paris Region (2016-2021)
- Member of the Research Council of Université PSL / member of the bureau (2016-2019)
- Member of the National Scientific Research Committee (CoNRS, section 5, 2012-2016)
- Deputy director *of Institut Langevin* (2009-2013)
- Deputy director of *Laboratoire Ondes et Acoustique* (2005-2009)
- Member of the National Council of Universities (CNU, section 60, 2007-2010)
- Member of ESPCI board of directors - elected representative of associate professors (2005-2008)

Teaching activities

- Responsible for the teaching unit *Waves and Acoustics*, ESPCI Paris-PSL (2nd year of the engineering curriculum)
- *Time Reversal in geophysics* (Master *Sciences de la Terre et des planètes, environnement*, Université PSL)
- *Turn basic research into startups*, Centrale Supelec (2019-2021)
- *Time Reversal of waves,* PSL Week (2018-2022)
- *Voice and Image*, EFREI - Engineering School of Information and Digital Technologies (2004-2006)
- *Waves in Complex Media*, Master of Science in acoustics, Université Paris Cité (2004-2008)
- *Electronics*, Bachelor of Science, Université Paris Cité (1999-2000)
- *Image analysis*, Master of Science in optics, Université Paris Cité (1997-2003)

Research interests

My research mainly focuses on wave propagation in strongly scattering media. During my PhD work, I carried out pioneering experiments to test the reversibility of ultrasound in multiple scattering media and brought the explanation to an intriguing result: the more complex the propagation medium, the greater the possibility of making a wave revive its past. This rather counterintuitive result contributed to creating a new paradigm for the manipulation of waves in complex media: contrary to long-held beliefs, disorder is not only an impediment to focusing and imaging but can be turned into an ally for controlling waves.
Afterwards, I have been working on applying time reversal focusing to wireless communications and geophysics. Using ultrasound, I have also demonstrated spectacular effects that have their equivalent in condensed matter physics: weak localization, transverse localisation and resonant tunnelling. My most recent research has focused on two main topics: on the one hand, the design of acoustic metamaterials with exotic properties (super reflection, super absorption, negative refraction) and, on the other hand, the investigation of earthquakes and landslides triggering based on analogue scaled acoustic experiments.

PhD supervisions

F. Van der Biest (2002-2005), A. Bretagne (2007-2011), M. Vanderhaegen (2010-2013), J. Aulbach (2010-2013), M. Lanoy (2013-2016), M. Harazi (2014-2017), M. Thieury (2017-2020), R. Monsarrat (2018-2022), Y. Abraham Fernandes (2017-2023), Pedro Nieckele Azevedo (2019-2022), Guyu Zhou (2019-2024), Arhur Le Ber (2020-2024)

Publication record

- 62 publications in peer-reviewed international journals
- h index : 25 (Scopus); 30 (Google Scholar)
- 1 book : *les nouveaux entrepreneurs du public,* D. Raffini et A. Tourin (Presses des Mines, 2023)
- Co-editor of the book *Imaging of complex media with acoustic and seismic waves*, Topics in Applied Physics, vol. 84 (Springer, Heidelberg, Berlin 2002)
- 29 invited talks and lectures in conferences and summer schools

Innovation

- 7 patents
- Co-founder of a start-up: *Time Reversal Communications* (now a Bull-ATOS company)

Award Diderot Innovation prize (2007)

List of publications in peer-reviewed international journals

1. S. Hidalgo-Caballero, S. Kottigegollahalli Sreenivas, V. Bacot, S. Wildeman, M. Harazi, X. Jia, A. Tourin, M. Fink, A. Cassinelli, M. Labousse, E. Fort
Damping-Driven Time Reversal for Waves
Phys. Rev. Lett. 130, 087201 (2023)

2. R. Monsarrat, R. Pierrat, A. Tourin, A. Goetschy
Pseudogap and Anderson localization of light in correlated disordered media
Physical Review Research 4, 033246 (2022)

3. Soysal, U., P. N. Azevedo, F. Bureau, A. Aubry, M. S. Carvalho, A. C. S. N. Pessoa, L. G. D. L. Torre, O. Couture, A. Tourin, M. Fink, and P. Tabeling
Freeze-Dried Microfluidic Monodisperse Microbubbles as a New Generation of Ultrasound Contrast Agents
Ultrasound in Medicine and Biology, 48, 1484 (2022)

4. Van Den Wildenberg, S., X. Jia, J. L. Gennisson, and A. Tourin
Acoustic Localization of an Intruder in a Strongly Scattering Medium
Physical Review Applied 18, 064097 (2022)

5. Mokh, A., R. Khayatzadeh, A. Ourir, M. Kamoun, A. Tourin, M. Fink, J. De Rosny
Time-reversal of Sub-THz Pulses in Complex Media
Progress In Electromagnetics Research B 95, 141-162 (2022)

6. Q. Ma, X. Guo, X. Jia, A. Tourin, D. Zhang
Ultrasonic multiple scattering parameters of densely packed cylinders immersed in water
Acta Acustica (Chinese version) 46, 1178 (2021)

7. H. Zhou, X. Jia, Li-Yun Fu, A. Tourin
Monte Carlo Simulations of Ultrasound Scattering and Absorption in Finite-Size Heterogeneous Materials
Phys. Rev. App. **16**, 034009 (2021)

8. M. Lanoy, F. Lemoult, G. Lerosey, A. Tourin, V. Leroy, J. Page,
Three-dimensional acoustic lensing with a bubbly diamond metamaterial
J. App. Phys, **129**, 245107 (2021)

9. J. Léopoldès, X. Jia, A. Tourin, and A. Mangeney
Triggering granular avalanches with ultrasound
Phys. Rev. E 102, 042901(2020)

10. Phenomenological law for the acoustic reflection by an array of cylindrical cavities in a soft elastic medium
M. Thieury, V. Leroy, J. Dassé, A. Tourin
J. App. Phys. 128, 135106 (2020)

11. J. Brum, J. L. Gennisson, M. Fink, A. Tourin, X. Jia
Drastic slowdown of the Rayleigh-like wave in unjammed granular suspensions
Phys. Rev. E 99, 042902 (2019)

12. S. van den Wildenberg, X. Jia, J. Léopoldès, A. Tourin
Ultrasonic tracking of a sinking ball in a vibrated dense granular suspension
Scientific Report 9 :5460 (2019)

13. V. Leroy, N. Chastrette, M. Thieury, O. Lombard, A. Tourin
Acoustics of bubble arrays: role played by the dipole response of bubbles
Fluids 3, 95 (2018)

14. M. Lanoy, A. Bretagne, V. Leroy, A. Tourin
A Phononic Crystal-Based High Frequency Rheometer
Crystals 8, 195 (2018)

15. M. Lanoy, J. H. Page, G. Lerosey, F. Lemoult, A. Tourin, and V. Leroy
Acoustic double negativity induced by position correlations within a disordered set of monopolar resonators
Phys. Rev. B 96, 220201 (2017)

16. Harazi, Y. Yang, M. Fink, A. Tourin, X. Jia
Time reversal of ultrasound in granular media
Eur. Phys. J. Special Topics 226, 1487 (2017)

17. V. Leroy, A. Bretagne, M. Lanoy, A. Tourin
Band gaps in bubble phononic crystals
AIP Advance, 6, 121604 (2016)

18. S. van den Wildenberg, A. Tourin, X. Jia
Sound velocity fluctuations in confined granular materials: Coarse-graining lengths and elastic heterogeneities
EPL, 115, 34005 (2016)

19. M. Lanoy, C. Derec, A. Tourin, V. Leroy
Manipulating bubbles with secondary Bjerknes forces
Appl. Phys. Lett. 107, 214101 (2015)

20. M. Lanoy, R. Pierrat, F. Lemoult, M. Fink, V. Leroy, A. Tourin
Subwavelength focusing in bubbly media using broadband time reversal **Phys. Rev. B 91,** 224202 (2015)

21. V. Leroy, A. Strybulevych, M. Lanoy, F. Lemoult, A. Tourin, J. H. Page
Super-Absorption of Acoustic Waves with Bubble Meta-Screens
Phys. Rev. B 91, 020301 (2015) – selected as a suggestion by the editor

22. A. Bretagne, M. Fink, and A. Tourin
Transverse localization of sound,
Phys. Rev. B 88, 100302 (2013) – selected as a suggestion by the editor

23. J. Aulbach, A. Bretagne, M. Fink, M. Tanter, A. Tourin
Optimal spatiotemporal focusing through complex scattering media
Phys. Rev. E 85, 016605 (2012)

24. L. Bonneau, C. Prada, M. Fink and A. Tourin
Imaging changes in scattering media from Time Reversal of the Coda Wave Difference (TRECOD)
Waves in Random and Complex Media 22, 109 (2012)

25. F. Lemoult, A. Ourir, J. de Rosny, A. Tourin, M. Fink, and G. Lerosey
Time Reversal in Subwavelength-Scaled Resonant Media: Beating the Diffraction Limit
International Journal of Microwave Science and Technology, article ID 25710 (2011)

26. A. Bretagne, A. Tourin and V. Leroy
Enhanced and reduced transmission of acoustic waves with bubble meta-screens
App. Phys. Lett. 99, 221906 (2011)

27. Naqvi, I.H. ; El Zein, G.; Lerosey, G.; de Rosny, J.; Besnier, P.; Tourin, A.; Fink, M.,
Experimental validation of time reversal ultra-wide band communication system for high data rates
Iet Microwaves Antennas & Propagation 4, 643 (2010)

28. V. Leroy, A. Bretagne, M. Fink, H. Willaime, P. Tabeling, A. Tourin
Design and characterization of bubble phononic crystals
Appl. Phys. Lett., 95, 171904 (2009)

29. M. Fink, J. de Rosny, G. Lerosey, A. Tourin,
Time Reversed waves and super resolution
Comptes Rendus de l'Académie des Sciences 10, 447 (2009)

30. R. Sprik, A. Tourin, J. de Rosny, M. Fink
Eigenvalue distributions of correlated multichannel transfer matrices in strongly scattering systems
Phys. Rev. B 78, 012202 (2008)

31. G. Lerosey, J. de Rosny, A. Tourin, M. Fink
Focusing Beyond the Diffraction Limit with Far-Field Time Reversal
Science 315, 1120 (2007)

32. A. Aubry, A. Derode, P. Roux, A. Tourin,
Coherent backscattering and far-field beamforming in acoustics
J. Acoust. Soc. Am., 121, 70 (2007)

33. C. Larmat, J. Montagner, M. Fink, Y. Capdeville, A. Tourin, and E. Clévédé
Time-reversal imaging of seismic sources and application to the great Sumatra earthquake
Geophys. Res. Lett. 33, L19312 (2006).

34. A. Tourin, G. Lerosey, J. de Rosny, A. Derode and M. Fink
Time reversal telecommunications in complex environments
Comptes Rendus de l'Académie des Sciences 7, 816 (2006)

35. A. Derode, V. Mamou and A. Tourin
Influence of correlations between scatterers on the attenuation of the coherent wave in a random medium
Phys. Rev. E 74, 036606 (2006)

36. G. Lerosey, J. de Rosny, A. Tourin, A. Derode, M. Fink
Time Reversal of Wideband Microwaves
App. Phys. Lett. 15, 154101 (2006)

37. A. Tourin, F. Van der Biest and M. Fink
Time Reversal of ultrasound through a phononic crystal
Phys. Rev.Lett. 96, 104301 (2006)

38. F. Van der Biest, A. Sukhovich, A. Tourin, J.-H Page, B. A. Van Tiggelen, Z. Liu, M. Fink
Resonant tunneling, of acoustic waves through a double barrier consisting of two phononic crystals
Europhys. Lett. 71, 63-69 (2005)

39. G. Lerosey, J. de Rosny, A. Tourin, A. Derode, G. Montaldo, M. Fink
Time reversal of electromagnetic waves and telecommunication
Radio Sci. 40, No. 6, RS6S12 (2005)

40. J. de Rosny, A. Tourin, A. Derode, P. Roux, and M. Fink
Weak Localization and Time Reversal of Ultrasound in a Rotational Flow
Phys. Rev. Lett. 95, 074301-1-074301-4 (2005)

41. J. de Rosny, A. Tourin, A. Derode, B. A. Van Tiggelen, M. Fink
Relation between Time Reversal focusing and Coherent Backscattering in multiple scatering media: a diagrammatic approach
Phys. Rev. E. 70, 046601-1-046601-12 (2004)

42. G. Lerosey, J. de Rosny, A. Tourin, A. Derode, M. Fink
Time Reversal of electromagnetic waves
Phys. Rev. Lett. **92**, 193904-1-193904-4 (2004)

43. G. Montaldo, G. Lerosey, A. Derode, A. Tourin, J. de Rosny, M. Fink *Telecommunication in a disordered environment with iterative time reversal*
Waves in Random Media 14, 287-302 (2004)

44. J. H. Page, A. Sukhovic, S. Yang, M. L. Cowan, F. Van Der Biest, A. Tourin, M. Fink, Z. Liu, C. T. Chan, Ping Sheng
Phononic crystals
Phys. Sta. Sol. b 241, 3454-3462 (2004)

45. R. Sprik, A. Tourin
Time Reversed wave propagation experiments in chaotic micro-structured cavities
Ultrasonics 42, 775-779 (2004)

46. A. Derode, E. Larose, M. Tanter, J. de Rosny, A. Tourin, M. Campillo, M. Fink,
Recovering the Green's function from field-field correlations in an open scattering medium
J. Acoust. Soc. Am. 113 (6), 2973-2976 (2003)

47. A. Derode, A. Tourin, J. de Rosny, M. Tanter, S. Yon, M. Fink
Taking advantage of multiple scattering to communicate with time reversal antennas
Phys. Rev. Lett. **90** (1), 014301-1-014301-4 (2003)

48. A. Derode, A. Tourin, M. Fink
Time reversal versus phase conjugation in a multiple scattering environment
Ultrasonics 40 275 (2002)

49. A. Tourin, A. Derode and M. Fink
Sensitivity to Perturbations of a Time-Reversed Acoustic Wave in a Multiple Scattering Medium
Phys. Rev. Lett. **87** (27), 274301-1-274301-4 (2001)

50. M. Tanter, A. Derode, L Sandrin, A. Tourin and M. Fink
Numerical and experimental time reversal of acoustic waves in random media
J. Comp. Acoust., **9**, 991-998 (2001)

51. A. Derode, A. Tourin and M. Fink
Random Multiple Scattering of Sound, I. Coherent and Ballistic Wave
Phys. Rev. E 64, 036605-1-036605-7 (2001)

52. A. Derode, A. Tourin and M. Fink
Random Multiple Scattering of Sound, II. Is Time Reversal a self-averaging process?
Phys. Rev. E 64, 036606-1-036606-13 (2001)

53. J. de Rosny, A. Tourin, M. Fink
Observation of a coherent backscattering effect with a dipolar source for elastic waves: Highlight of the role played by the source
Phys. Rev. E 64, 066604-1-066604-4 (2001)

54. A. Tourin, A. Derode and M. Fink
Multiple scattering of sound
Waves in Random Media, **10** R31-R60 (2000)

55. A. Tourin, A. Derode, A. Peyre and M. Fink
Transport parameters for an ultrasonic pulsed wave propagating in a multiple scattering medium
J. Acoust. Soc. Am. 108 (2), 503-512 (2000)

56. A. Derode, A. Tourin and M. Fink
Limits of time-reversal focusing through multiple scattering: Long-range correlation
J. Acoust. Soc. Am. **107** (6), 2987-2998 (2000).

57. J. de Rosny, A. Tourin and M. Fink
Coherent backscattering in a 2 D chaotic cavity
Phys. Rev. Lett. 84, 1693-1695 (2000).

58. A. Tourin, A. Derode and M. Fink
Dynamic time-reversal of randomly backscattered acoustic waves
Europhys. Lett. **47**, 175-181 (1999)

59. A. Derode, A. Tourin, and M. Fink
Ultrasonic pulse compression with one-bit time reversal through multiple scattering
J. App. Phys. 85, 6343-6352 (1999).

60. P. Roux, A. Derode, A. Peyre, A. Tourin, and M. Fink
Acoustical imaging through a multiple scattering medium using a time-reversal mirror
J. Acoust. Soc. Am. **107** (2), L7-L12, (1999)

61. A. Derode, A. Tourin and M. Fink
Time reversal in multiply scattering media
Ultrasonics 36, 443-447 (1998)

62. A. Tourin, A. Derode, P. Roux, B. A. van Tiggelen and M. Fink
Time Dependent Coherent Backscattering of Acoustic Waves
Phys. Rev. Lett. 79, 3637-3639 (1997)