

CURRICULUM VITAE

NAME: **Kirill Cherednichenko**

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BORN: 18 June 1975, Sevastopol, USSR

NATIONALITY: United Kingdom, Russia

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Academic Employment

Currently: Reader in Mathematics, University of Bath; **Oct 2006 – Sept 2014:** Lecturer, then Senior Lecturer in Mathematics, Cardiff University; **Oct 2005 – Sep 2006:** Postdoctoral Research Associate, Department of Applied Mathematics and Theoretical Physics, University of Cambridge; **Oct 2001 – Sep 2005:** Junior Research Fellow in Mathematics, St. John’s College, University of Oxford.

Education and Qualifications

May 2009: Postgraduate Certificate in University Teaching and Learning, Cardiff University; **Nov 1998 – Nov 2001:** PhD Course in Mathematics under the supervision of V. P. Smyshlyaev, University of Bath. PhD awarded in December 2001. Viva date: August 2001. Thesis title: “Higher-order and non-local effects in homogenisation of periodic media”; **July 1998:** First-class diploma degree (equivalent of MSc) with distinction in Mathematics from St. Petersburg State University, Russia. Research project (MSc Dissertation) under the supervision of V. M. Babich. Dissertation title: “Asymptotic expansion of Fock’s type for solutions of linear ordinary differential equations of second order with a singular point and a large parameter”; **Sep 1993 – Jul 1998:** Undergraduate studies at the Department of Mathematics and Mechanics, St. Petersburg State University, Russia. Division of Mathematics, specialisation in Partial Differential Equations and Applications.

Research Funding

Current grants:

Engineering and Physical Sciences Research Council (EPSRC), Fellowship: July 2014 – June 2019 (Project title: “Mathematical foundations of metamaterials: homogenisation, dissipation and operator theory”. Value: £899K)

Royal Society – Newton Mobility Grant, March 2017 – February 2019 (Project title: “Homogenisation of degenerate equations and scattering for new materials”. Value: £12K)

London Mathematical Society (LMS), Conference Grant: Jun 2018 – Jan 2019 (Conference “Operators, Operator Families and Asymptotics II”. Value: 5.8K)

Previous grants:

London Mathematical Society (LMS), Conference Grant: Nov 2015 (Conference “Operators, Operator Families and Asymptotics”. Value: 6.8K)

University of Bath, Global Mobility Scheme: Mar 2015 – June 2016 (Project title: “Functional models for applied analysis: from Jacobi matrices to invisibility”. Value: 4.9K)

LMS, Joint Research Groups in the UK: Jan – Sep 2015 (Workshop Series “LMS-WIMCS Analysis Day”. Value: £1.5K)

Leverhulme Trust Grant RPG-167 (Co-Investigator): Apr 2012 – Mar 2013 (Project title: “Dissipative and non-self-adjoint problems”. Value: £161K)

EPSRC, Responsive Mode Grants: Nov 2011 – Oct 2012 (Project title: “The mathematical analysis and applications of a new class of high-contrast photonic band-gap composite media”. Value: £23.4K); Nov 2008 – Oct 2010 (Project title: “Variational convergence for nonlinear high-contrast homogenisation problems”. Value: £183.6K)

Cardiff University, International Collaboration Fund Award — Early Stage Researcher: May 2008 (For a visit by Prof. V. V. Zhikov. Value: £3.2K)

LMS, Conference Grants: Jul 2008 (Conference organised: “South-West UK Analysis Meeting”. Value: £2.5K); Feb 2008 (Conference organised: “Non-classical, boundary and localisation phenomena in mathematical homogenisation” Value: £3.1K); Feb 2007 (Conference organised: “Perturbed periodic PDE, problems with singular boundaries and their numerical aspects”. Value: £2.5K)

Wales Institute of Computational and Mathematical Sciences (WIMCS), Conference Grant, Apr 2008 (Conference organised: “Non-classical, boundary and localisation phenomena in mathematical homogenisation” Value: £0.9K)

LMS, Collaborative Grants: Oct 2007 (Collaborator: P. Padilla. Value: £0.6K); Mar 2006 (Collaborators: V. M. Babich, V. V. Zhikov. Value: £0.5K)

Research Supervision

Postdocs:

Dr R. Castaneira (Oct 2018 – Mar 2019), Dr Y. Ershova (Feb 2016 – Jul 2018), Dr J. Roberts (Nov 2016 – Mar 2017), Dr M. Waurick (Oct 2015 – Sep 2017), Dr M. Cherdantsev (Oct 2008 – Sep 2010), Dr S. Cooper (Apr 2012 – Mar 2013), Dr K. Kuliev (Sep 2012 – Aug 2013)

PhD students:

W. Graham (Oct 2018 – Sep 2022), Project title: “Wave problems on thin and singular structures”;

A. Pim (Sep 2017 – Mar 2021), Project title: “Homogenisation techniques for liquid crystals and existence theorems for associated energy functionals”;

S. D’Onofrio (Sep 2016 – Mar 2020), Project title: “Operator-theoretic methods in homogenisation of singular periodic structures”;

M. Lewis (Sep 2014 – Mar 2018), Project title: “Eigenvalue problems for nonlinear p -Laplace equations”;

J. Evans (Sep 2012 – Mar 2016; PhD awarded), Thesis title: “Some analytical techniques for partial differential equations on periodic structures and their applications to the study of metamaterials”.

MPhil students:

R. Hicks (Sep 2010 – Jun 2013; Project title: “Boundary effects in high-contrast composite media”), A. Burgmann (Sep 2008 – Nov 2009; Project title: “Averaging for spectral problems in high-contrast materials”)

MMath students:

D. Gardham (Jun 2016 – May 2017; Project title: “The derivation and numerical analysis of dispersion relations for surface waves in stratified elastic media”); M. Corkhill (Sep 2011 – May 2012; Project title: “Ray theory and its applications in mechanics”); J. Evans (Sep 2011 – May 2012; Project title: “Calculus of variations and its applications in the mechanics of solids”)

Undergraduate project students: J. Larsson (Sep 2010 – Jun 2011); D. Hughes, N. Prowse (Sep 2008 – Jun 2009)

Mentoring and Network Activities

- EPSRC Postdoctoral Fellowships: M. Cherdantsev (2010–2013, Cardiff), S. Cooper (2015–2017, Bath)
- Bath-UNAM-CIMAT (“BUC”) Research Series (Apr 2015 – present): <http://buc.cimat.mx/>
- Weekly research seminar “Operators, Asymptotics and Functionals” (Jan 2016 – present): <http://people.bath.ac.uk/kc525/Seminar/programme.html>

Visiting Research Appointment

Jul – Sep 2012: Visiting CNRS Researcher, Fresnel Institute, Aix-Marseille Université, France

Invited Research Visits

Apr 2018: University of Santiago, Chile; Mar 2018: University of Helsinki, Finland; Feb 2017, Jan 2018: University of Freiburg, Germany; May 2017: University of Zagreb; Oct 2015: TU Dresden, Germany; May 2015: University of Utah; Apr 2012, Nov 1998: Max Planck Institute for Mathematics in the Sciences, Leipzig, Germany; Jun 2015, Dec 2013, Aug 2007, Dec 2003: Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas (IIMAS), UNAM, Mexico; Aug 2018, Aug 2016, Sep 2012, Jan 2003, Nov 2001: Département de Mécanique et Génie Civil, Université Montpellier II, France; Mar-Apr 2015, Sep-Dec 1999: Isaac Newton Institute for Mathematical Sciences, Cambridge, UK.

Conferences Organised

- Jan 2019: “Operators, Operator Families, and Asymptotics II” (University of Bath);
- Sep 2018: BUC-XV Meeting (Bath-UNAM-CIMAT): “Function spaces meet materials science: recent developments in spectral theory and scattering” (CIMAT Guanajuato, Mxico);
- Mar 2018: BUC-XII Meeting: “Asymptotic and operator-theoretic techniques for the analysis of time-dispersive media” (University of Bath);
- Nov-Dec 2017: BUC-XI Meeting: “Advances in the Mathematics of Multiple Scales” (CIMAT Mérida, Mexico);
- Mar-Apr 2017: BUC-VII Meeting: “Spring School on Analysis and Applications to Mathematical Physics and Materials Science” (UNAM, Mexico City) and Research workshop “Applied Analysis of Operators, PDE, and Functionals” (UNAM and CIMAT Mérida, Mexico);
- May 2016: “Operators, Operator Families, and Asymptotics” (University of Bath);
- Dec 2015 (University of Bath), Jan 2014 (Cardiff University): “LMS-WIMCS Analysis Day”;
- Dec 2012, May 2012: “Dissipative Spectral Theory: Operator Theory, PDEs and Numerics” (Cardiff University);
- Jun 2011: “Metamaterials and high-contrast homogenisation: analysis, numerics and applications” (Cardiff University);
- Jan 2009: “South-West UK Analysis Meeting” (University of Bath);
- Aug 2008: “Non-classical, boundary and localisation phenomena in mathematical homogenisation” (Cardiff University);
- Sep 2007: “Perturbed periodic PDE, problems with singular boundaries and their numerical aspects” (Cardiff University).

Total number of speakers: 130

Prizes and Awards

Junior Research Fellowship, St. John's College, University of Oxford: Sep 2001 – Sep 2005.

Overseas Research Studentship (ORS), CVCP: Nov 1998 – Nov 2001.

Soros Studentship in Mathematics: Mar 1997 – Oct 1998.

Research Highlights (in reverse chronological order)

11. Establishing the link between time/frequency dispersion in equations of continuum mechanics and the averaging (coarse-graining) of heterogeneous media: Publications [R3, R5, R6].

10. Stochastic formulation of the homogenisation problem for degenerate PDE and new results for the overall behaviour of high-contrast composites and their spectral properties: [32].

9. Phenomenon of super-exponential decay of localised eigenfunctions in composite media with high contrast: [34].

8. Connecting abstract results of operator theory (Krein formula, functional model for non-selfadjoint operators) and the asymptotic analysis of differential operators in materials science: [29, 25].

7. Bending of periodic nonlinearly elastic plates: settling the case when plates are described by isometric surfaces on the microscale; the derivation of a new set of nonlinear constraints" [22]

6. Discovery and quantitative description of a new type of surface waves in stratified elastic media, for which the boundary displacement vanishes: [20].

5. A new transform-asymptotic approach for the analysis of periodic problems with degeneracies, proof of sharp operator-norm resolvent estimates, a new rationale for mathematical homogenisation via "operator asymptotics": [30, 23].

4. The new method of two-scale Γ -convergence for the analysis of a class of nonlinear multiscale problems with degeneracies: [26, 18].

3. Existence and the analysis of properties of guided, surface and interface elastic and electromagnetic waves: [15, 13, 12, 11, 8, 6].

2. Mathematical framework for phenomenological theories of size effects in the elasticity (linearised and nonlinear) and plasticity of continuous media with microstructure: [4, 3].

1. Uniform asymptotic expansions for solutions of second-order ordinary differential equations with degeneracies: [2, 1].

Invited Talks at International Conferences

Dynamic Phenomena in Media with Microstructure (October 2018) — Title : "Time-dispersive behaviour as a feature of critical-contrast media"

Calculus of Variations and Applications (September 2018) — Title: "Unified approach to critical-contrast homogenisation of PDEs, and their link to time-dispersive media"

SIAM Conference of Mathematical and Computational Issues in the Geosciences 2017 (September 2017) — Title: “Homogenisation of thin periodic frameworks with high-contrast inclusions”

Partial Differential Equations, Optimal Control and Numerics, Benasque, Spain (August 2017) — Title: “Boundary triples, Krein formula, and resolvent estimates for one-dimensional high-contrast periodic problems”

9th St. Petersburg Conference in Spectral Theory, dedicated to the memory of M. Sh. Birman (July 2017) — Title: “Functional model for extensions of symmetric operators and applications to scattering theory”

International Conference on Elliptic and Parabolic Problems, Gaeta, Italy (May 2017) — Title: “Resolvent estimates for high-contrast elliptic problems with periodic coefficients”

InterPore: 9th International Conference on Porous Media, TU Delft, The Netherlands (May 2017) — Title: “Extreme localisation property for eigenfunctions of one-dimensional high-contrast periodic problems with a defect”

Mathematical and Computational Aspects of Maxwell’s Equations, EPSRC Durham Symposium (July 2016) — Title: “Homogenisation of the system of high-contrast Maxwell equations”

New Trends in Nonlinear PDEs: from Theory to Applications, Cardiff University (June 2016) — Title: “Homogenisation in finite elasticity for composites with a high contrast in the vicinity of rigid-body motions”

Computational and Analytic Problems in Spectral Theory, Cardiff University (June 2016) — Title: “Boundary triples, Krein formula and resolvent estimates for one-dimensional high-contrast periodic problems”

Spectral Theory of Novel Materials, CIRM, Marseille (April 2016) — Title: “Asymptotic behaviour of the spectra of systems of Maxwell equations in periodic composite media with high contrast”;

Mathematics of Novel Materials, Mittag-Leffler Institute, Sweden (June 2015); Partial Differential Equations, Optimal Control and Numerics, Benasque, Spain (August 2015) – Title: “Resolvent estimates for high-contrast elliptic problems with periodic coefficients”

Periodic and Other Ergodic Problems, Isaac Newton Institute, Cambridge, UK (April 2015) – Title: “Bending of thin periodic plates”

Crimean International Mathematics Conference, Sudak, Ukraine (Sep 2013) – Title: “On resolvent estimates for homogenisation problems with high contrast”

ETOPIM9, Marseille, France (Sep 2012) — Title: “Band-gap effects in one-dimensional high-contrast periodic media”

Analytic and Computational Techniques in Spectral Theory and Related Topics, Gregynog, UK (June 2011) – Title: “High-frequency spectral analysis of thin periodic acoustic strips”

“Multiscale Methods and Qualitative Properties of Differential Operators (V. V. Zhikov’s 70th Anniversary)”, Naples, Italy (May 2011); “Equadiff”, Loughborough University, UK (Sep 2011) — Title: “Homogenization in finite elasticity for composites with a high contrast in the vicinity of rigid-body motions”

“Differential Equations and Dynamical Systems”, Suzdal, Russia (Jul 2010) — Title: “Homogenisation of nonlinear composites via two-scale Γ -convergence”

“Microscopic Models of Plastic Evolution”, University of Warwick, UK (Sep 2007) — Title: “Plastic shear of a thin film via homogenisation of the dislocation transport”

”Multi-scale problems: modelling, analysis and applications”, University of Bath, UK (Sep 2005) — Title: “Variational and asymptotic approaches to higher-order effects in periodic composites via homogenisation”

“Multiscale Methods in Nonlinear PDE”, Isaac Newton Institute, Cambridge, UK (Apr 2001) — Title: “On full asymptotic expansion of the solutions of nonlinear periodic rapidly oscillating problems”

Invited Seminars at Mathematics Departments

Aberystwyth (2009), Bath (2008, 2010), Birmingham (2010), Bristol (2009), University of Buenos Aires (2017), Cambridge (2007), Cardiff (2003, 2015, 2018), CMM, University of Chile (2018), TU Dresden (2015), Freiburg (2017, 2018), Helsinki (2018), Imperial College London (2006, 2012), King’s College London (2011), Liverpool (2006), TU Munich (2009), Pontificia Universidad Católica, Santiago de Chile (2018), Surrey (2014), Sussex (2017), University College London (2010, 2012), Kings College London (Paris-London Analysis Seminar, 2014), University of Utah (2015), Zagreb (2018)

Academic Community Service

— Member of the London Mathematical Society

— EPSRC College member

— Editorial reviewer for international mathematics and mechanics journals:

American Mathematical Society Translations, Annales de l’Institut Henri Poincaré (C) Analyse Non Linéaire, Archive for Rational Mechanics and Analysis, European Journal of Applied Mathematics, European Journal of Mechanics A, Journal de Mathématiques Pures et Appliquées, Journal of the Mechanics and Physics of Solids, Networks and Heterogeneous Media (AIMS), Proceedings of the Royal Society A, Proceedings of the Royal Society of Edinburgh A, Quarterly Journal of Mechanics and Applied Mathematics, SIAM Journal on Applied Mathematics, SIAM Journal on Mathematical Analysis, Multiscale Modelling and Simulation (SIAM), Wave Motion.

LIST OF PUBLICATIONS

Journal Papers: Refereed

34. (with M. Cherdantsev and S. Cooper) Extreme localisation of eigenfunctions to one-dimensional high-contrast periodic problems with a defect, *To appear in SIAM Journal on Mathematical Analysis*, 29 pp. (arXiv:1702.03538).

33. (with A. V. Kiselev and L. O. Silva) Scattering theory for a class of non-selfadjoint extensions of symmetric operators. *To appear in Operator Theory: Advances and Applications*, 31pp. (arXiv:1712.09293)

32. (with M. Cherdantsev and I. Velčić) Stochastic homogenisation of high-contrast media. *To appear in Applicable Analysis*, 24 pp. (arXiv:1712.00333)

31. (with P. Dondl and F. Rösler) Norm-resolvent convergence in perforated domains. *Asymptotic Analysis*, **110**(3–4), 163–184.

30. (with S. D’Onofrio) Operator-norm convergence estimates for elliptic homogenisation problems on periodic singular structures. *Journal of Mathematical Sciences* **232**(4), 558–572 (2018).
29. (with A. V. Kiselev and L. O. Silva) Functional model for extensions of symmetric operators and applications to scattering theory. *Networks and Heterogeneous Media* **13**(2), 191–215 (2018)
28. (with M. Waurick) Resolvent estimates in homogenisation of periodic problems of fractional elasticity. *Journal of Differential Equations* **264**(6), 3811–3835 (2018).
27. (with S. Cooper) Asymptotic behaviour of the spectra of systems of Maxwell equations in periodic composite media with high contrast. *Mathematika* **64**(2), 583–605 (2018).
26. (with M. Cherdantsev and S. Neukamm) Homogenisation in finite elasticity for composites with a high contrast in the vicinity of rigid-body motions. *Asymptotic Analysis*, **104**(1–2), 67–102 (2017).
25. (with A. Kiselev) Norm-resolvent convergence of one-dimensional high-contrast periodic problems to a Kronig-Penney dipole-type model, *Communications in Mathematical Physics* **349**, 441–480 (2017).
24. (with J. Evans) Full two-scale asymptotic expansion and higher-order constitutive laws in the homogenisation of the system of Maxwell equations, *Multiscale Modeling and Simulation (SIAM)* **14**(4), 1513–1539 (2016).
23. (with S. Cooper) Resolvent estimates for high-contrast homogenisation problems. *Archive for Rational Mechanics and Analysis* **219**(3), 1061–1086 (2016).
22. (with M. Cherdantsev) Bending of thin periodic plates. *Calculus of Variations and Partial Differential Equations* **54**(4), 4079–4117 (2015).
21. (with S. Cooper) Homogenisation of the system of high-contrast Maxwell equations. *Mathematika* **61**(2), 475–500 (2015).
20. (with S. Cooper) On the existence of high-frequency boundary resonances in layered elastic media. *Proceedings of the Royal Society A* **471**, 20140878 (2015).
19. (with S. Cooper and S. Guenneau) Spectral analysis of one-dimensional high-contrast elliptic problems with periodic coefficients. *Multiscale Modeling and Simulation (SIAM)* **13**(1), 72–98 (2015).
18. (with M. Cherdantsev) Two-scale Γ -convergence and its application to homogenisation of high-contrast variational integrals. *Archive for Rational Mechanics and Analysis* **204**(2) 445–478 (2012).
17. Some analogues of the double-porosity models and the associated effect of micro-resonance. *Journal of Mathematical Sciences* **176**(6), 818–827 (2011).
16. An approach to constitutive modelling of elasto-plasticity via averaging of the dislocation transport. *Journal of the Mechanics and Physics of Solids* **58**(5), 798–809 (2010).
15. (with S. D. M. Adams, R. V. Craster and S. Guenneau) High-frequency spectral analysis of thin periodic acoustic strips: theory and numerics. *European Journal of Applied Mathematics* **21**(6), 557–590 (2010).

14. (with N. F. Britton, C. Carrillo and M. Mogie) Dynamic coexistence of sexual and asexual invasion fronts in a system of integro-difference equations. *Bulletin of Mathematical Biology* **71**(7), 1612–1625 (2009).
13. (with F. J. Sabina) On the existence of waves guided by a cavity in an elastic film. *Quarterly Journal of Mechanics and Applied Mathematics* **62**(3), 221–233 (2009).
12. (with G. W. Milton, N.-A. Nicorovici, R. C. McPhedran and Z. Jacob) Solutions in folded geometries and associated cloaking due to anomalous resonance. *New Journal of Physics* **10**(11), 115021 (2008).
11. Asymptotic expansion of the boundary-layer type for flexural waves along the curved edge of a Kirchhoff-Love plate. *Zapiski Nauchnykh Seminarov POMI (Scientific Notes of the Steklov Institute of Mathematics, St. Petersburg)* **332**, 286–298 (2006) (in Russian). English version in: *J. Math.Sci. (N. Y.)* **142**(6), 2682–2688 (2007).
10. (with S. Guenneau) Bloch-wave homogenisation for spectral asymptotic analysis of the periodic Maxwell operator. *Waves in Random and Complex Media* **17**(4), 627–651 (2007).
9. Two-scale asymptotics for non-local effects in composites with highly anisotropic fibres. *Asymptotic Analysis* **49**(1–2), 39–59 (2006).
8. On propagation of Scholte-Gogoladze waves along a fluid-solid interface of arbitrary shape. *Zapiski Nauchnykh Seminarov POMI (Scientific Notes of the Steklov Institute of Mathematics, St. Petersburg)* **324**, 229–247 (2005) (in Russian). English version in: *Journal of Mathematical Sciences (New York)* **138**(2), 5613–5622 (2006).
7. (with V. P. Smyshlyaev and V. V. Zhikov) Non-local homogenised limits for composite media with highly anisotropic periodic fibres. *Proceedings of the Royal Society of Edinburgh: Section A* **136**(1), 87–114 (2006).
6. On propagation of attenuated Rayleigh waves along a fluid-solid interface of arbitrary shape. *The Quarterly Journal of Mechanics and Applied Mathematics* **59**(1), 75–94 (2006).
5. (with P. Padilla) On derivation of the density of states for periodic operators by the method of asymptotic expansion. *Proceedings of the Edinburgh Mathematical Society* **48**(1), 51–60 (2005).
4. (with V. P. Smyshlyaev) On rigorous derivation of strain gradient effects in the overall behaviour of periodic heterogeneous media. *Journal of the Mechanics and Physics of Solids* **48**(6–7), 1325–1357 (2000).
3. (with V. P. Smyshlyaev) On full two-scale expansion of the solutions of nonlinear periodic rapidly oscillating problems and higher-order homogenised variational problems. *Archive for Rational Mechanics and Analysis* **174**(3), 385–442 (2004).
2. (with V. M. Babich) On a differential equation with a singular point of regular type and a large parameter. *Integral Transforms and Special Functions* **11**(2), 101–112 (2001).
1. (with V. M. Babich) On Fock’s type asymptotics of Legendre functions. *Integral Transforms and Special Functions* **5** (1–2), 1–18 (1997).

Book Chapter

“Homogenisation techniques for periodic structures”(with T. Antonakakis, S. Cooper, S. Guenneau and R. Craster) in: *Gratings: Theory and Numeric Application* (ISBN: 978-2-85399860-4), Fresnel Institute, 2012.

Papers: in Review

R1. (with J. Evans) Homogenisation of thin periodic frameworks with high-contrast inclusions, 19 pp., *arXiv:1601.00663*.

R2. (with I. Velčić) Sharp operator-norm asymptotics for linearised elastic plates with rapidly oscillating periodic properties, 25 pp., *arXiv: 1802.02639*.

R3. (with Y. Ershova and A. Kiselev) Time-dispersive behaviour as a feature of critical contrast media, 21pp., *arXiv:1803.09372*.

R4. (with W. Graham) Leontovich boundary condition and associated surface waves, 16 pp., *arXiv:1802.06921*.

R5. (with Y. Ershova, A. Kiselev and S. Naboko) Unified approach to critical-contrast homogenisation with explicit links to time-dispersive media, 37 pp., *arXiv:1805.00884*.

R6. (with Y. Ershova and A. Kiselev) Unified approach to critical-contrast homogenisation of PDEs with explicit links to time-dispersive media. I, 33pp., *arXiv:1808.03961*.

Preprint

Two-scale series expansions for travelling wave packets in one-dimensional periodic media, 11pp. *Preprint NI15048*, Isaac Newton Institute (2015).

Patent

PCT International Application No. PCT/GB2016/051124 “Subterranean Design Process” (April 2016)

18 November 2018