

- **Microwave Heating, Current Drive and Diagnostics of Plasmas** - First extension to overdense fusion plasmas, by means of Electron Bernstein Waves (EBWs), of the following techniques formerly restricted to low-density plasmas:
 - Temperature profile diagnostic by ECE [*Rev. Sci. Instrum.* 2003]
 - Generation and detection of heat waves, for heat transport studies [*Rev. Sci. Instrum.* 2003]
 - Ray tracing modeling, including mode conversions and 3D stellarator geometry [*Rev. Sci. Instrum.* 2003]
 - Electron Cyclotron Current Drive (with H.P. Laqua) [*Phys. Rev. Lett.* 2003]
 Also: first diagnostic (spinning mirror) for rapid angular scans of EBW emission, to measure the profile of safety factor, q [*Rev. Sci. Instrum.* 2010]
- **Stellarator Simplification**
 - First generation of rotational transform by tilted toroidal-field planar coils
 - First coil-misalignment inference from comparison of experimental and numerical flux-surfaces [*Plasma Phys. Controll. Fusion* 2016]
- **Electromagnetic Metamaterials**
 - First metamaterial lens of reverse chromatic aberration by design [*Optics Express* 2012]
- **Liquid Metal Walls**
 - First active electromagnetic stabilization of free-surface flows [*Magnetohydrodyn.* 2017]

Academic Appointments

- 2015 -date** **Associate Professor**
- 2012 -15** **Assistant Professor** Dept Appl. Physics & Appl. Math., **Columbia Univ.**, NY, U.S.A.
- Physics and control of locked modes, NTMs and their relation to disruptions (collab. with GA San Diego and several groups worldwide, under ITPA-WG11)
 - Error Field detection from mode interaction (collab. with KTH Stockholm and GA San Diego).
 - Stellarators: CIRCUS (new, to study coil-simplification), CNT (modified from earlier non-neutral experiment, to study high β stability, overdense heating, error fields and new diagnostics), TARALLO (conceptual, ion source for accelerators).
 - Waves in plasmas - New numerical methods and modeling of new microwave diagnostics of magnetic field.
 - Metamaterial lens of reverse chromatic aberration for microwave diagnostic.
 - Liquid Metal Walls - gravity-defying, free-surface, feedback-stabilized flows.
- 2012**, summer **Visiting Assistant Professor, Kyoto University, Japan**
- Built radiometer for EBW emission at Heliotron J.
- 2009 -11** **Assistant Professor** Engineering Physics Dept, **Univ. Wisconsin, Madison**, U.S.A.
- Physics and control of locked modes and NTMs at DIII-D (collab. GA San Diego).
 - Error Field detection from interaction with stable RWMs (collab. KTH Stockholm).
 - Magnetic barriers in plasma edge stochasticized by Resonant Magnetic Perturbations for Edge Localized Mode (ELM) in DIII-D (collab. GA San Diego).
 - NTM dependence on impurities and Lithium wall (collab. PPPL Princeton).
 - Full-wave modeling mode-conversions in Pegasus sph. tok. (collab. IPF Stuttgart).
 - Metamaterials of reverse chromatic aberration

Research Appointments

- 2008** **Staff Physicist, Max-Planck-Inst. für Plasmaphysik (IPP)**, Garching, Germany
- Electron Cyclotron Reson. Heating (ECRH) operator, ASDEX Upgrade Tokamak.
 - Fast version of TORBEAM beam/ray tracing code, for real-time use.
 - Feasibility of EBW Current Drive in RFX-mod reversed field pinch (with R. Bilato and IPF Stuttgart).
- 2007 -08** Oak Ridge Associated Univ. **Post-doctoral Fellow, General Atomics**, San Diego
2006 -07 Otto-Hahn Medal **Post-doctoral Fellow, General Atomics**, San Diego, U.S.A.
- Physics and control of locked modes and NTMs
 - Oblique and horizontal Electron Cyclotron Emission (ECE)
 - Spinning mirror Electron Bernstein Wave (EBW) emission (collab. UKAEA).
- 2006** **Adv. Training Sch., Max-Planck-Inst. Plasmaphys. (IPP)**, Greifswald, Germany
- Weakly relativistic dielectric tensor valid for arbitrary wavenumbers.
 - Incorporated EBWs and mode conversions in TRAVIS ray tracing (with N.Marushchenko). Interfaced code to EFIT tokamak equilibria (with Yu.Turkin).
- 2004 -05** **Physicist, Fircroft, UKAEA Fusion**, Culham, U.K.
2002 -04 **Post-doc, UKAEA Fusion**, Culham, U.K.
- Ray tracing, Fokker-Planck optimization of ITER ECRH Upper Launcher for NTM stabilization (with several groups worldwide).
 - EBW emission, heating (exp.) and current drive (num.) at MAST sph.tokamak. Spinning mirror for ang. scan of emission, for q -profile meas. and heating optimiz.
 - MAST Session Leader¹
 - Internal collaborations: 1) double-null-merging non-solenoid startup, 2) optics for MAST Interferom., 3) interpretation JET Interferometer signals during ELMs.
 - External: 1) Collective Thomson Scattering (CTS) at FTU (ENEA Frascati), 2) Ray tracing for mode-converted EBWs in TCV tokamak (CRPP-EPFL Lausanne).
- 1998-2002** **PhD student IPP**, Garching bei München, Germany
- EBW emission measurements at Wendelstein 7-AS (W7-AS) stellarator
 - Analytical solution of OX conversion
 - Ray tracing of mode-converted EBWs, applied to emission and current drive
- 1998, summer** **Fellow, Consorzio di Magnetofluidodinamica, Univ. of Trieste**, Italy
- 2D finite difference code for liquid metal flows of industrial interest
- 1997 -98** **Undergraduate student, ENEA**, Frascati (Rome), Italy
- Collective Thomson Scattering (CTS) at FTU tokamak.

¹A.k.a. physics operator, leads an experimental session, programs the coil-currents, gas injection, density and position feedbacks and gives directives to the pellet, heating and data acquisition operators. His/her aim is to create a plasma with certain characteristics of density, temperature, shape etc., agreed with the physicists in charge of the experiment.

Securing and Managing Research Funds

Total: > \$1,350,000

- 08/2017 - 07/2018** Department of Energy (DOE), Renewal of DE-SC0016372
“Island Rotation and Locking at DIII-D”
PI: Francesco Volpe. Co-PI: Andrew Cole. \$155,000
Post-doc started in 08/2017. 1 journal paper submitted.
- 08/2016 - 07/2018** National Science Foundation (NSF), PHY-1632802
“Modeling Ion Extraction from First Toroidal Electron-Cyclotron-Resonance Ion Source”
PI: Francesco Volpe. \$194,000
Post-doc started in 08/2017
- 08/2016 - 07/2017** Department of Energy (DOE), DE-SC0016372
“Physics and Control of Disruptive Locked Modes at DIII-D”
PI: Francesco Volpe. \$175,000
Trained 2 graduate students, 1 undergraduate. 1 PhD thesis. 1 journal paper.
- 07/2012 - 07/2016** Department of Energy (DOE), DE-SC008520
“Physics and Control of Locked Modes in the DIII-D Tokamak” (Early Career Award)
PI: Francesco Volpe. \$600,000
Trained 2 post-docs and 2 graduate students. 1 PhD thesis. 12 journal papers. 6 invited talks at int. conferences. 1 major software (eigspec). 1 database (locked modes and disruptions).
- 07/2011 - 07/2012** Department of Energy (DOE), DE-SC0006415
“Physics and Control of Locked Modes in the DIII-D Tokamak” (Early Career Award)
PI: Francesco Volpe. \$150,000
Trained 2 graduate students, 1 undergraduate. 2 journal papers.
- 05/2011 - 05/2012** Graduate School, Univ. of Wisconsin, Madison
“Electron Bernstein Wave Studies in the MST Plasma Experiment”
PI: Francesco Volpe. \$57,126
Calibrated MST radiometer. Built: low-noise amplifiers, hot/cold calibration source.
- 08/2010 - 09/2010** General Atomics
“Analysis of Locked Mode Control”
PI: Francesco Volpe. \$26,437
1 invited talk at international conference.

Honors, Fellowships and Awards

- 2015** Excellence in Fusion Engineering Award, Fusion Power Associates, USA
- 2012** Visiting Professorship in Kyoto University, Japan
- 2012** Finalist at ISSNAF Award for Young Investigators
- 2012** Torkil Jensen Award, General Atomics
- 2011** DOE Early Career Award
- 2007** Oak Ridge Associated Universities (ORAU) Fellowship
- 2003** Otto-Hahn Medal - thesis prize of the Max-Planck Gesellschaft (Germany)
- 2002** Marie Curie Individual Fellowship, European Commission Research Directorate

Publications and other Research Products

Publication and Citation Summary

72 journal articles published, +2 journal articles under review
20 refereed International Atomic Energy Agency (IAEA) conference papers
113 conference papers, reports and other publications

h-index = 15 and >800 citations according to ISI Web of Knowledge
(<http://www.researcherid.com/rid/D-2994-2009>).

h-index = 19 and >1,300 citations according to Google Scholar.

Selected Publications

Criteria for selection: *Physical Review Letters* and/or highly cited journal articles (≥ 30 citations). A wavy underline denotes advised students and post-docs.

For the full list of publications, please refer to <http://www.columbia.edu/~fv2168/Publ/1Pub.pdf>.

- F.A. Volpe, A. Hyatt, R.J. La Haye, M.J. Lanctot, J. Lohr, R. Prater, E.J. Strait, A. Welander
Avoiding Tokamak disruptions by applying static magnetic fields that align locked modes with stabilizing wave-driven currents
Phys. Rev. Lett., **115**, 175002 (2015)
- B. Esposito, G. Granucci, S. Nowak, J.R. Martin-Solis, L. Gabellieri E. Lazzaro, P. Smeulders, M. Maraschek, G. Pautasso, J. Stober, W. Treutterer, L. Urso, F. Volpe, H. Zohm, FTU, ECRH and ASDEX Upgrade teams
Disruption Control on FTU and ASDEX Upgrade with ECRH
Nucl. Fusion **49**, 065014 (2009)
- F.A.G. Volpe, M.E. Austin, R.J. La Haye, J. Lohr, R. Prater, E.J. Strait and A.S. Welander
Advanced techniques for neoclassical tearing mode control in DIII-D
Phys. Plasmas **16**, 102502 (2009)
- R. Prater, D. Farina, Yu. Gribov, R.W. Harvey, Y.R. Lin-Liu, E. Poli, A.K. Ram, A.P. Smirnov, F. Volpe, E. Westerhof, A. Zvonkov and ITPA Steady State Operations Topical Group
Benchmarking of codes for electron cyclotron heating and electron cyclotron current drive under ITER conditions
Nucl. Fusion **48**, 035006 (2008)
- V. Shevchenko, G. Cunningham, A. Gurchenko, E. Gusakov, B. Lloyd, M. O'Brien, J. Preinhaelter, A. Saveliev, A. Surkov, F. Volpe, M. Walsh
Development of Electron Bernstein Wave Research in MAST
Fusion Science & Technology **52**, 202 (2007)
- A. Mueck, L. Curchod, Y. Camenen, S. Coda, T.P. Goodman, H.P. Laqua, A. Pochelon, L. Porte, F. Volpe, TCV Team
Demonstration of Electron-Bernstein-Wave Heating in a Tokamak via O-X-B Double-Mode Conversion
Phys. Rev. Lett. **98**, 175004 (2007)
- W.A. Houlberg, C. Gormezano, J.F. Artaud, E. Barbato, V. Basiuk, A. Becoulet, P. Bonoli, R.V. Budny, L.G. Eriksson, D. Farina and 14 coauthors including F. Volpe
Integrated Modeling of the Current Profile in Steady-State and Hybrid ITER Scenarios

Nucl. Fusion **45**, 1309 (2005)

- F.Wagner, S.Bäumel, J.Baldzuhn, N.Basse, R.Brakel, R.Burhenn, A.Dinklage, D.Dorst, H.Ehmler, M.Endler and 43 coauthors including F.Volpe
W7-AS: One step of the Wendelstein stellarator line
Phys. Plasmas **12**, 072509 (2005)
- H.P.Laqua, H.Maassberg, N.Marushchenko, F.Volpe, A.Weller, W7-AS Team, W.Kasperek and ECRH-Group
Electron-Bernstein-Wave Current Drive in an Overdense Plasma at the Wendelstein 7-AS Stellarator
Phys. Rev. Lett. **90**, 75003 (2003)
- F.Volpe, H.P.Laqua and the W7-AS Team
BXO mode-converted electron Bernstein emission diagnostic (invited)
Rev. Sci. Instrum. **74**, 1409 (2003)

Talk Summary

13 invited talks at international conferences, +4 invited talks by group members
51 seminars and colloquia
3 summer school lectures
44 contributed talks at international conferences

Selected Invited Talks at International Conferences

For the full list of talks, please refer to <http://www.columbia.edu/~fv2168/Publ/1Pres.pdf>.

- **Using 3D Fields to control Islands, aid ECCD-Stabilization and measure Error-Fields at DIII-D**
41st European Physical Society (EPS) Conf. on Plasma Physics, Berlin (Germany), June 2014
- **Advanced Techniques for Neoclassical Tearing Mode Control in DIII-D**
50th Annual Meeting, Division of Plasma Phys., American Phys. Society (APS), Dallas, TX, Nov. 2008
- **BXO mode-converted electron Bernstein emission diagnostic of electron temperature profiles at W7-AS Stellarator**
14th Topical Conf. High Temperature Plasma Diagnostics (HTPD), Madison, WI, July 2002

Patents

“Systems and methods for adjustable aberration lens”

US Publication No.: WO/2014/004918, US Publication Date: 03.01.2014

International Application No.: PCT/US2013/048337 International Filing Date: 27.06.2013

Teaching and Lecturing

Courses taught

at Columbia University:

Spring	2018	APPH E9143y	Stellarator Physics	graduate level
Fall	2015 - 2017	APPH E4200x	Physics of Fluids also taught remotely on Columbia Video Network (CVN)	undergraduate level
Spring	2012 - 2017	APPH E4018y	Applied Physics Laboratory ²	undergraduate level
Fall	2012 - 2014	APPH E6101y	Plasma Physics I	graduate level

at the University of Wisconsin, Madison:

Fall 2009 & Spring 2011	ECE 525	Introduction to Plasmas	undergrad level
Spring 2010 & Fall 2011	NE 427	Nuclear Instrumentation Laboratory	undergrad level

Lectures given

- Lecture on “Locked Mode Disruptions: Stability, Dynamics, Control” at the 9th ITER International School, “Physics of disruptions and control”, 20-24 March 2017 Aix-en-Provence (France)
- Lecture on “Waves in Plasmas” at the Mirai Summer School, 9-10 August 2012, Suzukaji (Japan)
- Lecture on “Plasma Waves and Heating” at the IPP Summer University on Plasma Physics and Fusion Research, 22-26 Sept. 2008 Garching (Germany)

Research Advising, Group Members

Total of 60 people in 19 years, most of them in the last 9 years, both at Universities (Columbia Univ. and UW-Madison) and National Facilities (GA San Diego and IPP Garching).

Current Group

- Undergraduates
 2. **Anthia Prapa** (2019-) *Exp. demonstration of rotational transform in tilted coil configuration*
 1. **Jacob Austin** (2017-) *Field-line tracing in tilted coil torsatrons*

Previous Group Members

- Scientists
 2. **Claudia Caliri** (2013-14) *Ion extraction from toroidal plasma-based ion source for accelerators*
 1. **Myunghee Choi** (2013) *Numerical Modeling of Waves in Plasmas*
- Visiting scientists and unfunded collaborators
 3. **Orso Meneghini** (collaborated from GA San Diego, 2013)
Full-wave Feasibility Study of Mode-Conversion Oblique Reflectometry Imaging of q-profile
 2. **Xabier Sarasola** (visited Columbia from IPP Greifswald, 2012)
Operation of CNT as a Neutral Stellarator
 1. **Alf Köhn** (visited UW from IPP Stuttgart, 2010) *Full-wave Modeling of EBWs in Pegasus*

² Laboratory of vacuum, microwaves, solid state, plasmas, superconductivity and optics.

- Post-docs
 5. **Wilkie Choi** (2017-18) *Iterative Learning Approach to Simultaneous Error Field Control and Mode Entrainment in DIII-D Tokamak*, currently a post-doc at PPPL Princeton.
 4. **Sharad K. Yadav** (2017-18) *Modeling Ion Extraction from First Toroidal Electron-Cyclotron-Resonance Ion Source*
 3. **Seyyed (Taha) M.H. Mirhoseini** (2015-16) *Control of liquid metal flows and walls*, currently Electromagnetic Scientist at Apple, Cupertino.
 2. **Erik Olofsson** (2012-14) *Physics and Control of Locked Modes at DIII-D* currently a scientist at General Atomics
 1. **Daisuke Shiraki** (2012-13) *Physics and Control of Locked Modes at DIII-D* currently a scientist with Oak Ridge National Laboratory (ORNL) seconded to DIII-D
- PhD Theses
 3. **Wilkie Choi** (2013-17) *Magnetic feedback control of 2/1 locked modes in tokamaks*, currently a post-doc at PPPL Princeton).
 2. **Kenneth Hammond** (2012-17) *Heating and stability of neutral CNT stellarator plasmas* currently a post-doc at IPP Greifswald, Germany
 1. **Ryan Sweeney** (2012-16) *Relationship between locked modes and disruptions in the DIII-D tokamak*, currently a post-doc at the MIT Plasma Science Fusion Center (PSFC).
- MSc students (13)

Matthias Werl (2018, from TU Wien), **Emmanouil Maragkoudakis** (2018, from TU Eindhoven, 2018-), **Michel Doumet** (2013-14), **Anthony Clark** (2012-13), **Aileen Nielsen** (2012), **Chuteng Zhou** (2012), **William J. Capecchi** (2011-12), **Kent Haeger** (2011), **Sang-heum Kim** (2010), **Dinh Truong** (2010-12), **Sara Gallian** (2010), **Derek Thompson** (2009), **François Beaudé** (2009-10)
- Undergraduates (32)

James J. Borovilas (2018), **Jessica Li** (2016-18), **Ruben Rui Diaz-Pacheco** (2015-18), **Chengcheng Xin** (2017), **Shah Faisal Bin Mazhar** (2017), **Tommy Polanco** (2017), **Albert Tai** (2017), **Veronica Mulila** (2017), **Tyler Cowan** (2016-17), **Justin Mann** (2015-17), **Ben Yehuda Israeli** (2013-17), **Yumou Wei** (2015-16), **Jacob B. Simmonds** (2015-16), **Alek Anichowski** (2015), **Lucas Randall Zeppetello** (2014-15), **Anji Zhao** (2014-15), **Omar Naziruddin Mahmood** (2014-15), **Elise Burch** (2013-14), **Yosef Kornbluth** (2013), **Adrian Febre** (2013), **Scott Massidda** (2012-13), **Samuel Reiss** (2010-11), **Mohamad Ali Bitar** (2010), **Kyle Luh** (2010), **Jonathan Jacquot** (2010), **Shifan Mao** (2009-11), **Jonathan Kessler** (2010), **Hans Rinderknecht** (2007), **2 groups of 2 students** (Technische Universität München, Plasma interferometry experiment (2000-01))

Service

Service to Columbia

- APAM Department Student Admissions and Financial Aid Committee member (2016-date).
- Applied Physics (AP) Program Committee member (2015-date).
- General AP Undergraduate Advisor (2015-date).
- Speaker & guide for Columbia Engineering Days on Campus, for admitted undergraduates (2014-date).

- Chair or member of 9 Thesis Defense committees and 8 Thesis Proposal committees (2012-date).
- Advisor of undergraduates majoring in AP, class of 2016 (2014-16).
- Organizer of weekly Plasma Physics Colloquia (2012-15 and 2016-date).
- Organizer of weekly APAM Research Conference seminars (2012-14).

Service to UW-Madison

Member of several Thesis Defense committees and Preliminary Examination committees (2009-11).

Community Research Leadership

- 2014** Member of National Stellarator Coordination Committee
- 2013 -16** Invited Leader of International Tokamak Programmatic Activities (ITPA) Working Group 11, "Control of Locked Modes".

Conference Organization and Selection Committees

- *Member* of International Advisory Board of 4th and 5th International Conf. Frontiers in Diagnostic Technologies, Frascati (Italy), March-April 2016 and 2018
- *Member* of Program Committee of
 - 21th Workshop on MHD Stability Control, San Diego, CA (USA), Nov. 2016
 - 20th Workshop on MHD Stability Control, Princeton, NJ (USA), Nov. 2015
 - 19th Workshop on MHD Stability Control, Auburn, AL (USA), Nov. 2014
 - 18th Workshop on MHD Stability Control, Santa Fe, NM (USA), Nov. 2013
 - 16th Workshop on MHD Stability Control, San Diego, CA (USA), Nov. 2011
- *Chair* of Local Organizing Committee 15th Workshop on MHD Stability Control combined with "US-Japan Workshop on 3D Magnetic Field Effects in MHD Control", Madison, WI (USA), Nov. 2010.

Reviewer for Funding Agencies

- 2016-17** National Science Foundation (NSF)
- 2011-17** US Department of Energy (DOE)
- 2016** Research Foundation Flanders (FWO)
- 2016** Italian Scientists and Scholars of North America Foundation
- 2014** Chilean National Commission for Scientific and Technological Research
- 2013** Swiss National Science Foundation
- 2012** Helmholtz Stiftung (Germany)
- 2004** Czech Science Foundation

Reviewer for Journals and Book Publishers

- Regular referee, since 2003, for *Nucl. Fusion* and for *Plasma Phys. Control. Fusion*.
- Ad-hoc referee, since 2006, for other 20 journals and book publishers: *Appl. Phys. Lett.*, *Fusion Eng. Design*, *Fusion Sci. Technol.*, *IEEE Trans. Plasma Sci.*, *Indian Journ. Phys.*, *J. Appl. Phys.*, *J Infrared Millim. Terahertz Waves*, *J.Phys.D: Appl. Phys.*, *J. Plasma Phys.*, *Nuclear Materials & Energy*, *Phys. Lett. A*, *Phys. Plasmas*, *Phys. Rev. E*, *Phys. Rev. Lett.*, *Plasma Sci. Technol.*, *Plasma Sources Sci. T.*, *Radiation Eff. Defect S.*, *Rev. Sci. Instrum.*, *Springer Books*, *Waves Random Complex Media*.

Outreach

- 2014 -18** School tours of Columbia Plasma Physics Laboratory.
- 2016 -17** Scientific advisor for “Blackout”, a Sloan-awarded film on a nuclear fusion scientist, written and directed by Nick Singer
- 2010 -11** Judge at the CSEF and BSSEF Science Fairs (UW-Madison and Marquette University, Milwaukee, WI)
- 2006 -07** ”Scientist in the Classroom”: lectures and demonstrations organised by PPPL and General Atomics in schools of Southern California
- 2004 -05** Toured dozens of groups (hundreds of visitors) from schools, universities and general public around MAST and COMPASS tokamaks at Culham, UK.

Other Information

Professional Associations

- 2010 -18** US-BPO United States Burning Plasma Organization
- 2008 -18** APS American Physical Society and its Division of Plasma Physics (DPP)
- 2009 -16** UFA University Fusion Association
- 2011 -12** ISSNAF Italian Scientists and Scholars of North America Foundation
- 2011 -12** AAAS American Association for the Advancement of Science
- 2010 -11** IEEE Institute of Electrical and Electronics Engineers and its Microwave Theory and Techniques Society (MTT-S) and Nuclear & Plasma Sciences Society (NPSS)

Further Training Received

- *Project Management* (Greifswald, Germany, 2006),
- All major schools in plasma physics and controlled fusion: Greifswald (1997), Trieste (1999), Carolus Magnus (2001), Culham (2004).
- Specialistic schools in plasma physics: *Ionospheric Plasma Physics* (Greifswald, Germany, 2004), *MAST Session Leader¹ Training* (Culham, UK, 2004), *EFDA “GOTiT” Course on Gyrokinetics* (Garching, Germany, 2008), *Instabilities in Laboratory, Space and Astrophysical Plasmas* (UCLA, USA, 2008),
- Scientific software training: FEMLAB (2004), LabView (2010), COMSOL (2010).
- Other: *Advanced Turbulent Flow Computations* (CISM Udine, Italy, 1998), *Magnets, Cryogenics, Thermometry and Vacuum* (Oxford Instruments, UK, 2004), *Bayesian Analysis* (Culham, UK, 2005), STEM Education Scholars Program by CIRTLL (Nashville, USA, 2009), CERN Accelerator School on RF for Accelerators (Ebeltoft, Denmark, 2010).

Languages

Only most advanced class or certificate is indicated for each language.

- 1) **Italian** native
- 2a) **English** proficient (Certificate in English Language Skills (CELS) “Higher”, English for Speakers of Other Languages (ESOL), University of Cambridge, 2004)

- 2b) **Spanish** proficient (Classes at University of California San Diego "Extension", 2006-07)
- 4) **German** proficient (*Zertifikat Deutsch*, Goethe Institut München, 2000)
- 5) **French** elementary (30% fluent on DuoLingo, 2016-17)
- 6) **Portuguese** elementary (30% fluent on DuoLingo, 2016-17)
- 7) **Japanese** elementary (Classes at Amity College New York and Kyoto University, 2012)