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Education

B.S.	(Physics)	University of Minnesota (Minneapolis), 1978
M.S.	(Physics)	University of Wisconsin (Madison), 1979
Ph.D.	(Physics)	University of Wisconsin (Madison), 1984

Areas of Experience

Dr. Nickisch is a Senior Research Scientist and Vice President at NorthWest Research Associates, joining NWRA in 2005 after twenty years at Mission Research Corporation (MRC). Dr. Nickisch heads the NWRA Monterey office and performs contract research, primarily in the area of electromagnetic wave propagation in the ionosphere. He is currently serving as the Principal Investigator on four efforts for AFRL, including development of models for radio wave propagation in the ionosphere, ionospheric sporadic-E layer modeling, OTH radar backscatter from terrain, and assimilative modeling of small-scale ionospheric structure. He is also currently the Principal Investigator on an ONR HF communications model development project. He served as the Principal Investigator of the FINESSE team of DARPA's Space Environment Exploitation (SEE) program. Recently he led his team in the development of an advanced assimilative ionospheric modeling capability for the IARPA HFGeo program that yields unprecedented accuracy in predicting the angle-of-arrival deviations caused by traveling ionospheric disturbances. Dr. Nickisch was also the developer of HiCIRF, a software HF channel simulator that includes propagation mode geometry and scintillation effects and generates signal realizations at the antenna element level. He was instrumental in the specification of the coordinate registration component of the Roadmap for a next-generation Over-the-Horizon radar system. He is a co-developer of GPSII, a real-time ionospheric modeling capability that assimilates GPS beacon data as well as a host of other ionospheric diagnostic data. GPSII has been used in investigations of anomalous ionospheric perturbations that occur up to two weeks in advance of major earthquakes. Under the auspices of the Air Force Coverage Analysis Program (AFCAP), HiCIRF and GPSII form the basis of an ongoing program of record.

Dr. Nickisch joined Mission Research Corporation in 1984 after receiving his doctorate in physics. He served as Head of the Radar and Propagation Effects Group of MRC's Communications and Radar Systems Division. He applied his expertise in HF propagation to the areas of OTH radar Coordinate Registration and Spread Doppler Clutter Modeling. Under the CREDO effort, a threefold improvement in OTH radar range registration accuracy was demonstrated by coupling Hamiltonian ray tracing and flexibly parameterized ionosphere models derived from backscatter sounding inversion. Dr. Nickisch developed PDM, a theory for HF small-scale stochastic scatter, during his analysis of data from the DNA HF Channel Probe (which measured scintillations of HF signals due to propagation through the structured ionization of the polar region). Dr. Nickisch co-originated a unique FDTD computational capability for dispersive plasmas and applied this method to study the limitations of random media propagation theory and the theory for the backscatter cross section of geomagnetic field-aligned ionization irregularities. In an effort called SIFTER, a novel signal processing algorithm for the enhanced detection of very weak targets (invented by Dr. Sergey Fridman) was applied to OTH radar. Rather than applying a CFAR threshold to the radar measurements to detect targets, SIFTER solves the inverse problem of determining what scatterers will reproduce the entire radar measurement. This distribution of scatterers is evolved in time using a smoothing criterion and knowledge of what constitutes target-like motion to enhance weak targets while suppressing clutter. SIFTER has also been adapted to the CODAR SeaSonde, an HF surface wave radar.

Dr. Nickisch received his doctoral degree in theoretical physics from the University of Wisconsin – Madison. His dissertation research regarded the theoretical and numerical solution of the Bethe-Salpeter equation in quantum chromodynamics for bound quark-antiquark states (mesons). He used the meson mass spectrum and leptonic decay widths to study the behavior of the strong nuclear force in the intermediate regime between the Coulomb region (small quark separation) and linear-confinement region (large quark separation). Since 1997 he has been performing both

theoretical and computational investigations into the electrodynamic effects of the electromagnetic vacuum fields (the so-called Zero Point Field, or ZPF). He has developed a fully relativistic three-dimensional two-body Lorentz-Dirac equation solver. This he used in numerical simulations of a classical atom immersed in the ZPF to demonstrate the quasi-stability provided to atoms by the ZPF against radiative collapse. With this code he also validated the Cole-Zou result that the radial probability distribution function of the ZPF-immersed classical atom agrees with the quantum theoretical one. He is the originator of the theory of Connectivity. In this theory the electromagnetic fields (including the ZPF) are treated as space-time distortions in an extension of General Relativity. An important consequence of the theory is that massless charges naturally develop the property of inertia. Connectivity also resolves the quantum theory discrepancy that apparently massive particles undergo speed-of-light zitterbewegung motions, and it furthermore produces particle spin as a ZPF-driven effect.

- Theoretical physics including quantum field theory and relativity
- Computational physics and numerical simulation
- Electromagnetic propagation in randomly structured ionization
- Finite-Difference Time Domain (FDTD) propagation in ionization
- HF communication and signal specification in nuclear environments
- Over-the-Horizon radar coordinate registration and clutter modeling
- VHF/UHF radar ionization-induced propagation effects
- Stochastic Electrodynamics and ZPF-related physics

Key Professional Accomplishments

- Created an infinitesimal flux tube formulation for accurate focusing computations in Hamiltonian raytracing
- Invented the Phase-Screen/Diffraction Method (PDM) for computing scintillation effects in structured ionization
- Major contributor to the DNA HF Signal Specification for disturbed nuclear environments
- Co-originator a general technique for extending FDTD to dispersive media
- Codeveloper of CREDO and GPSII, assimilative ionospheric inversion capabilities that provide accurate representations of the 3D ionosphere corresponding to diverse types of measurements
- Developer of HiCIRF, a propagation channel simulator for HF links and OTH radar
- Developer of PROPMOD, a merging of DTRA-sanctioned random media propagation algorithms with the WBMOD environment model, for VHF/UHF and higher frequency radar systems
- Originator of Connectivity theory, an electromagnetic extension of General Relativity that explains the origin of inertia

Professional Honors, Memberships

Phi Beta Kappa
Tau Beta Pi
Sigma Xi
American Physical Society
American Geophysical Union
URSI, Commission G

Selected publications and reports of Dr. L. J. Nickisch

Sergey Fridman, L.J. Nickisch, Mark Hausman, Michael Matthews, "Target Detection and Tracking via Sparsity-Promoting Tikhonov Regularization," Proceedings of the 2018 IEEE Radar Conference, 978-1-5386-4167-5/18, 2018.

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"High Frequency Geolocation (HFGeo) -- Phase 1 A," Final technical report for contract FA8650-12-C-7232, AFRL-RY-WP-TR-2014-0005, 2014 (with Chad Spooner, Sergey V. Fridman, Mark A. Hausman, Greg Bullock, Dennis L. Knepp, and George Zunich).

"Ionospheric Measurement and Modeling: IARPA HFGeo Phase 1B Interim Technical Report," Interim Technical Report for contract IARPA 2013-13082600004, NorthWest Research Associates report NWRA-14-RM550, 2014 (with Sergey V. Fridman, Mark A. Hausman, Shawn Kraut, Greg Bullock, George Zunich, and Geoff Crowley).

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"Inversion of Backscatter Ionograms and TEC Data for Over-the-Horizon Radar," Radio Sci., 47, doi:10.1029/2011RS004932, 2012 (with S. V. Fridman and M. A. Hausman).

"Multiple phase screen calculation of wide bandwidth propagation," Radio Science, 44, RS0A09, doi:10.1029/2008RS004054, 2009 (with D. L. Knepp).

"PC-based system for real time reconstruction of the three-dimensional ionosphere using data from diverse sources," Radio Sci., 44, RS3008, doi:10.1029/2008RS004040, 2009 (with S. V. Fridman and M. A. Hausman).

"Investigation of Plasma Phenomena in the Ionosphere Under Natural Conditions and Under Conditions Artificially Perturbed by HAARP," AFRL Final Technical Report for Contract FA8718-04-C-0001, AFRL-RV-HA-TR-2008-1139, J.A. Secan, L. J. Nickisch, D. L. Knepp, A.L. Snyder, E. J. Kennedy, 8-31-2008.

"Practical Applications of Haselgrove's Equations for HF Systems," URSI Radio Science Bulletin, No. 325, June 2008, Invited Paper.

"Traveling Ionospheric Disturbance Mitigation for OTH Radar," Proceedings IEEE Radar 2007 Conference, 2007 (with Mark A. Hausman and Sergey Fridman).

"Mitigation of the Effects of Scintillation on Radar Object Classification," Final Technical Report, NWRA-BELL-07-R348, AFRL-SN-HS-TR-2007-0020, 15 June 2007 (with Dennis L. Knepp).

"Ionospheric Effects Mitigation for Radar Systems Using GPS Ionospheric Inversion (GPSII)," AFRL Technical Report AFRL-VS-HA-TR-2007-1064, 1 December 2006 (with Sergey V. Fridman, Mark A. Hausman, and James A. Secan).

"Tests of SIFTER for CODAR with Tracker," with S. V. Fridman and M. A. Hausman, Final Technical Report, NWRA-Bell-06-R338, August 2006.

"SIFTER for CODAR," with S. V. Fridman and M. A. Hausman, Final Technical Report, NWRA-Bell-06-R322, May 2006.

"TID Mitigation for OTH Radar and High-Fidelity HF Propagation Modeling," with S. V. Fridman and M. A. Hausman, Final Technical Report, NWRA-BELL-06-R318, March 2006.

"Real-time reconstruction of the three-dimensional ionosphere using data from a network of GPS receivers," with S. V. Fridman, M. A. Hausman, and Mark Aiello, Radio Sci., 41, RS5S12, doi:10.1029/2005RS003341, 2006.

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"OTH Radar Propagation Analysis," with Mark A. Hausman, Sergey V. Fridman, Kevin Collins, and Mark Aiello, Mission Research Corporation report MRC/MRY-R-119, July 2005.

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"Traveling Ionospheric Disturbance Effects and Modeling for Over-the-Horizon Radar," with Mark A. Hausman and Sergey V. Fridman, Mission Research Corporation report MRC/MRY-R-117, April 2004.

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"SIFTER: Signal Inversion For Target Extraction and Registration – Coherent Processing of IQ Data," with Sergey V. Fridman and Mark A. Hausman, Final Technical Report for NSWC contract F30602-00-C-0162, MRC/MRY-R-111, July 2003.

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"Connectivity and the Origin of Inertia," with Jules Mollere, http://www.arxiv.org/abs/physics/0205086, 2002 (to be published in The Search for Unity in Physics: Proceedings of the Fourth Vigier Symposium, Ed. Richard Amoroso, 2005).

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"Finite-Difference Time-Domain Tests of Random Media Propagation Theory II: ℓ_o and f_o," with P. M. Franke, Radio Science, Vol. 36, Number 2, March-April 2001.

"CLEM Predictions for a Puerto Rico ROTHR; Model Descriptions and Ionospheric Structure Model Validation," with Carl Lauer and William Wortman, Final Technical Report, DSWA-TR-98-78, September 2000.

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