

# Enson Chang

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## Education

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- Ph.D. Physics, UC Santa Barbara, 1988
- B.S. Physics and Math, Harvey Mudd College, 1983

## Summary of Experience

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## Teaching Experience

### APU Courses

- MATH 110 College Algebra
- MATH 263 Multivariable Calculus
- MATH/PHYC 430 Mathematical Methods in Physics
- MATH/CS 455 Numerical Analysis
- PHYC 111 Physical Sciences Lab
- PHYC 151 Physics for Life Sciences I
- PHYC 152 Physics for Life Sciences II
- PHYC 140 L Introduction to Astronomy Lab
- PHYC 282 Dynamics
- PHYC 300 Research Seminar
- PHYC 361 Electricity and Magnetism
- PHYC 380 Classical Mechanics and Math Methods
- PHYC 431 Computational Methods for Physics
- PHYC 470 Writing 3: Advanced Lab
- WRIT 240 Writing 2: Scientific Writing

## Research Experience

- Developing and productizing an advanced underwater imaging technology, synthetic aperture sonar (SAS), which achieved 10 - 100X image resolution improvement compared to conventional sonar

- Numerical modeling, signal/image processing algorithms, data analysis for a variety of sensors, including imaging and towed array sonar, SAS, synthetic aperture radar, interferometric sonar/radar, other land and airborne radars, optical or IR imaging systems, lidar, underwater optical sensors, total-field and vector magnetic sensors

### **Business Experience**

- Program Manager (PM) and Principal Investigator (PI) of projects ranging from 1- 2 persons over 6 months to larger multi-year efforts
- Department manager for developing advanced sensors employed in ocean remote sensing.
- Business development lead for sonar and radar initiatives

### **Professional Societies**

- Administrative Committee Member of IEEE Oceanic Engineering Society (elected position) for 2004 – 2006
- Acoustical Society of America member

### **Employment History**

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**2011 – Present**

**Azusa Pacific University**

**Associate Professor, Math and Physics Dept**

**2008 – Present**

**EC Analysis, Rancho Palos Verdes, CA**

**Owner/Consultant**

- Support R&D efforts in synthetic aperture radar, chipless RFID, MIMO radar, Radar/sonar imaging techniques

**1988 – 2008**

**Applied Signal Technology, Inc., Torrance, CA**

**Department Manager (2006 – 2008)**

**Technical Fellow/Chief Scientist (2000 – 2006)**

**Senior Research Scientist (1992 – 2000)**

**Research Scientist (1988 – 1992)**

- Image deconvolution
- Speckle suppression in sonar and radar imagery
- Feature extraction and clutter suppression

- Optical scattering from rough surfaces. Correlated clutter subtraction
- MIE scattering from spheroids in optics and low-frequency electromagnetics
- Optical propagation and multiple scattering in the ocean
- Radar scattering from ocean surface
- Acoustic propagation in the ocean
- Ocean internal wave propagation in the presence of shear currents
- Langmuir circulations in the ocean
- Synthetic aperture sonar simulation and signal processing algorithms
- Real-time SAS processor architecture and algorithms
- Impact of turbulence, internal waves, rough surface scattering on signal coherence and SAS image quality
- Simulation and analysis of passive and active magnetic systems in multi-layer environments
- Underwater particle flux monitoring system with shadowgraph and laser inverse scattering
- Assessment of domestic and international sensor technology trends

**1986 – 1988**

**General Research Corp., Goleta, CA**

**Member of Technical Staff**

- Radiative transfer modeling of  $x$  and  $\gamma$  rays
- Design and fabrication support of nuclear underground testing experiments

**1983 – 1986**

**Jet Propulsion Laboratory, Pasadena, CA**

**Intern**

- Analysis of ionospheric total electron content data from geostationary satellites
- Numerical routines and graphics software for data analysis

**1982**

**GTE Laboratories, Waltham, CA**

**Intern**

- Optically bistable system for fast optical switching

## **Selected Publications and Reports**

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- B. Christensen, S. Petry, N. Tamminga, T. Chang, and E. Chang, "A Hybrid Synthetic Aperture and Time-Reversal MUSIC Algorithm for Subwavelength Radar Imaging," in preparation

- N. Guido, E. Hiatt, and E. Chang, "CSAR Imaging of Electromagnetically Coupled Conducting Scatterers," *Progress In Electromagnetics Research M*, Vol. 79, 113-126, 2019.
- R. Sturdivant, C. Quon, and E. Chang, *System Engineering of Phased Arrays*, Artech House, Nov 30, 2018.
- E. Chang, R. Sturdivant, B. Quilici, and E. Patigler, "Micro and mini drone classification based on coherent radar imaging," *Proceedings of IEEE Radio and Wireless Symposium*, 15 – 18 Jan. 2018, Anaheim, CA.
- R. Sturdivant, E. Chang, D. Bartholomew, R. Brown, S. De Pillis-Lindheim, J. Rohweller, "Systems Engineering a Low Cost Digital Beam Formed Phased Array for IoT Connectivity," *Proceedings of the 2017 International Conference on Computational Science and Computational Intelligence*, Las Vegas, USA, December 14-16, 2017.
- E. Chang, "Irregular array motion and extended integration for the suppression of spatial aliasing in passive sonar," *J. Acoust. Soc. Am.* Volume 129, Issue 2, pp. 765-773 (2011).
- J. Campbell and E. Chang, "Concepts for synthetic aperture sonar performance prediction and mission planning," *Proceedings of IEEE/MTS Oceans Conference*, 2005.
- E. Chang, Synthetic aperture sonar tutorial, *IEEE/MTS Oceans Conference 2004*, Kobe, Japan.
- E. Chang, Synthetic aperture sonar tutorial, *IEEE/MTS Oceans Conference 2003*, San Diego, CA.
- E. Chang, "Image deconvolution techniques for extending the area coverage rate of synthetic aperture sonar," *Proceedings of the IEEE/MTS Oceans Conference*, 2003.
- E. Chang, "Synthetic aperture sonar imaging in a random ocean," *J. Acoust. Soc. Am.* Volume 111, Issue 5, pp. 2457-2457 (2002)
- E. Chang, Synthetic aperture sonar tutorial, *IEEE/MTS Oceans Conference 2001*, Honolulu, HI.
- E. Chang and M.D. Tinkle, "Coherence of pulsed signal and implications to synthetic aperture sonar Processing," *Proceedings of the IEEE/MTS Oceans 2001 Conference*, Nov. 5-8, 2001, Honolulu, Hawaii.
- M. Tinkle and E. Chang, "Synthetic aperture sonar point response for buried objects," *Proceedings of IEEE/MTS Oceans Conference*, 2001.
- A. Putney, E. Chang, R. Chatham, D. Marx, M. Nelson, K. Warman, "Synthetic aperture sonar – the modern method of underwater remote sensing," *Proceedings of the IEEE Aerospace Conference*, 2001.
- E. Chang, D.S. Marx, M.A. Nelson, W.D. Gillespie, A. Putney, L.K. Warman, R.E. Chatham, and B.N. Barrett, "Long range active synthetic aperture sonar results," *IEEE/MTS Proceedings of the Oceans 2000 Conference*, September 11-14, 2000, Providence, Rhode Island.

- E. Chang, R. Chatham, D. Marx, M. Nelson, A. Putney, K. Warman, "Rough sea surface limitations on high frequency SAS imaging," *J. Acoust. Soc. Am.* Volume 108, Issue 5, pp. 2485-2486 (2000)
- D. Marx, M. Nelson, E. Chang, W. Gillespie, A. Putney, K. Warman, "An introduction to synthetic aperture sonar," *Proceedings of the 10<sup>th</sup> IEEE Workshop on Statistical Signal and Array Processing*, 2000.
- E. Chang, R. Patton, and R. Gran, "Moored optical particle flux instrument," *Proc. SPIE* 2258, 831 (1994)
- E. Chang and D. Hone, "Anharmonic and screening corrections to the melting of a two-dimensional charged colloidal crystal," *Phys. Rev. A* **38**, 5825 – 5832 (1988).
- E. Chang and D. Hone, "Melting of a Two-Dimensional Colloidal Crystal Confined between Charged Plates," *Europhys. Lett.* **5**, 635 (1988).