Dr. Craig E. DeForest

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Education

Ph.D., Applied Physics, Stanford University, 1995
B.A., Physics, Reed College, 1989

Summary, Management & Technical experience

Dr. Craig DeForest leads the heliophysics group in SwRI's Department of Space Studies, in Boulder, CO, and is PI of NASA's PUNCH Small Explorer mission. He has over 25 years experience in solar physics, instrumentation, data analysis, modeling, and project management. He analyzed the first data from the *MSSTA* sounding rocket payload that prototyped modern EUV imaging telescopes, operated *SOHO*/MDI throughout the early SOHO mission, and pioneered solar use of then-novel analysis techniques in common use today. He standardized and promoted the use of computer vision techniques to reduce solar data, and invented and/or first reduced to practice the techniques of "fluxon modeling" for magnetohydrodynamics and "stereoscopic magnetography" for rapid measurement of the Zeeman splitting over an image field. More recently, he developed the first fully successful technique for quantitative analysis of heliospheric images. His image analysis work includes deep-field heliospheric imaging and coronagraphy, and extensive research interpreting EUV and visible light solar images. He has successfully managed many instrumentation, analysis, and software efforts and is known for his ability to extract useful information from noisy data sets.

Selected publications (over 100 publications & conf. proceedings):

"The Highly Structured Outer Solar Corona", 2018: C.E. DeForest et al., *ApJ* **862**, 18.
"3D Polarized Imaging of CMEs", 2017: C.E. DeForest et al., *ApJ* **850**, 130.
"Noise-gating to clean astrophysical image data", 2017: C.E. DeForest, *ApJ* **838**, 155.
"Fading ... Structure and ... Turbulence in the Young Solar Wind", 2016: C.E. DeForest et al., *ApJ* **828**, 66.
"Turbulence in the Solar Wind ... with Comet Tail Test Particles", 2015: C.E. DeForest et al., *ApJ* **812**, 108.
"Inbound waves in the outer corona", 2014: C.E. DeForest, D.J. McComas, & T.A. Howard, *ApJ*, **787**, 124.
"Tracking ... Corona to Earth", 2013: C.E. DeForest, T.A. Howard & D.M. McComas, *ApJ*, **769**, 43.
"Disconnecting Solar Magnetic Flux", 2012: C.E. DeForest, T.A. Howard, & D.J. McComas, *ApJ,* **745**, 36.
"Detailed Structure in the Solar Wind ...", 2011: C.E. DeForest, T.A. Howard & J. Tappin, *ApJ,* **738**, 103.
"Symetric Coronal Jets: A Reconnection-Controlled Study", L.A. Rachmeler, et al., 2010: *ApJ* **715**, 1556.
"Stray light in *TRACE* ...", 2009: C.E. DeForest, & M.J. Wills-Davey, *ApJ,* **690**, 1264.
"Fluxon Modeling of Low-Beta Plasmas", 2007: C.E. DeForest & C.C. Kankelborg, *JASTP* **693**, 1431.
"On the Size of Structures in the Solar Corona", 2007: C.E. DeForest, *ApJ,* **661**, 532.
"Solar Mag. Tracking", 2007: C. E. DeForest, Hagenaar, Lamb, Parnell, & Welsch, *A*pJ, **666**, 576.
"...Photosphere to Heliosphere", 2005: DeForest, Hassler, & Schwadron, *Sol. Ph.*, **229**, 161.
"...Polar Plumes at High ... Altitudes", 2001: C.E. DeForest, Plunkett, & Andrews, *Astrophys. J.* **546**, 569.
"...Quasi-Periodic Waves in...Polar Plumes", 1998: C.E. DeForest and Gurman, *Astrophys. J.L.* **501**, 217L.
"Polar Plume Anatomy: ... Coordinated Observation", 1997: C.E. DeForest, et al. , *Sol. Phys.* **175**, 393.
"*MSSTA*: Quantitative Measurements of the...Corona", 1995: C.E. DeForest et al., *Proc. SPIE* **2515**, 273.

DeForest is a Program Director (Solar Astrophysics) at the Southwest Research Institute, and leads the solar and heliospheric research group there. DeForest's current research topics include remote sensing of the heliospheric plasma and solar wind; field-plasma interaction in the solar atmosphere; and understanding the relationship between magnetic and other initial conditions in solar eruptive events including CMEs. His broad experience base includes project and group management, instrument development, observatory and spacecraft operations, data analysis, and data management and dissemination.

DeForest has been studying plasmas since the age of 15, when (in 1984) he developed control and analysis code for the Charge Exchange Recombination spectrometer in the D3D Tokamak at General Atomic. He did his undergraduate work at Reed College (B.A. Physics 1989), where he was NRC-licensed as a senior nuclear reactor operator for the Reed Reactor Facility, and received special commendation for his honors thesis addressing golf ball dynamics using simultaneous analytic, numerical, and wind tunnel approaches.

His graduate work at Stanford University was under Prof. A.B.C. Walker (Ph. D. Applied Physics, 1996), where he was involved in every aspect of the Multi-Spectral Solar Telescope Array EUV sounding rocket program. MSSTA, with its sister rocket NIXT, was a pathfinder for every EUV imaging solar telescope in use today, including SDO/AIA. His experience with the MSSTA included optical design, alignment, and assembly; designing and working with thin-foil EUV filters; calibrating optical components with a synchrotron EUV monochromator; designing and implementing ground-support and flight software; image and data analysis; and pioneering work on diagnosis of plasma conditions from multiple-band EUV images.

DeForest was the Resident Observer for SOHO/MDI for the first four years of that mission, and conducted the first science operations with SOHO in February 1996, a coordinated study of the solar south pole that, among many other results, led to the discovery of propagating waves in the solar corona and opened the currently rich field of coronal seismology. Other work in the period 1995-1999 included deep-field observations of solar polar plumes. DeForest demonstrated that polar plumes arise from nearly unipolar footpoints, in contrast to the previous bipolar model; showed that they undergo periodic heating episodes; and observed plumes to projected altitudes greater than 45 solar radii, demonstrating that they extend into the heliosphere.

Since 2000, DeForest has worked at SwRI, where his diverse interests have flourished. He has successfully developed and deployed new types of solar instrument, co-invented and reduced to practice a new approach to numerical MHD modeling (the fluxon approach, which eliminates numerical resistivity), helped (as the leader of the Magnetic Tracking Workshop series) to standardize methodology for computer vision techniques applied to the Sun that are now in common use for SDO, and developed novel applications of microsatellites for space weather monitoring. He has participated in the design of several NASA and ESA mission concepts, including Solar Probe and the European Solar Orbiter mission, and invented new data-compression formats for spectral imaging. Most recently he has developed new techniques for imaging the solar wind from wide-field imagers on board NASA's *STEREO* spacecraft.

Instruments DeForest has either developed or had a major role in developing include MSSTA (rocket EUV imager prototype), SHaZaM (ground-based novel magnetograph using spectral stereoscopy), RAISE (rocket high speed EUV spectrograph), SPICE (Solar Orbiter EUV spectrograph), DASH (ground-based demonstration heliospheric imager), and SSIPP (solar observatory for manned rocketplanes, since converted for balloon use). He invented and (with colleague T. Howard) exploited the first quantitative heliospheric imaging analysis pipeline, which enables the polarization analysis to be exploited by DELPHI. He has extensive experience with large software projects and software architecture and management, including: the ZTOOLS scientific image processing suite; the SOHO/MDI mission operations suite (1995-1999), the 50,000 line FLUX simulation code (2007); major contributions to the 350,000 line Perl Data language; and the recent STEREO post-processing pipeline that enables quantitative heliospheric imaging.

DeForest is interested both in advancing heliophysics and in making physics and astronomy accessible to the public. In addition to his research, he spends time teaching periodically at the University of Colorado, Boulder, and scouting and preparing press activities for the AAS/SPD. He has advised two graduate students (D. Lamb and L. Rachmeler), both of whom have gone on to successful careers in heliophysics.