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 Chair of the AAS/SPD and PI of NASA's PUNCH Small Explorer mission. He has over 30 years experience in solar physics, instrumentation, data analysis, modeling, and project management and is especially known for his work in scientific image processing - including imaging the solar corona and the solar wind in interplanetary space. DeForest helped prototype modern solar EUV imaging with the *1991 MSSTA* rocket, operated *SOHO*/MDI throughout the 1990s, and pioneered solar use of then-novel analysis techniques in common use today. He standardized computer vision techniques for solar data and invented the techniques of "fluxon modeling" for magnetohydrodynamics and "stereoscopic magnetography" for rapid imaging of the photospheric magnetic field, and developed the first photometric pipeline for heliospheric solar wind imaging. He is dedicated to broadly communicating the importance and impact of the scientific enterprise, and served as AAS/SPD press officer for over 15 years. As AAS/SPD Chair, he works to advance heliophysics by fostering diversity of research approach, background, and culture within the field.

Selected publications (4 patents and over 100 publications; H=41, i10=84):

"3-Polarizer Treatment of Linear Polarization", 2022: C.E. DeForest et al., *ApJ*, **927**, 98.
"Polarimeter to UNify the Corona & Heliosphere", 2022: C.E. DeForest et al., *IEEE AERO*, **2022,** 1-11.
"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.
"*MSSTA*: Quantitative Measurements of the...Corona", 1995: C.E. DeForest et al., *Proc. SPIE* **2515**, 273.

DeForest is Director of the Department of Solar and Heliospheric Physics at Southwest Research Institute, Chair of the American Astronomical Society's Solar Physics Division, and PI of NASA's PUNCH mission to image the corona and solar wind. 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. His undergraduate work was at Reed College (B.A. Physics 1989). There, he was NRC-licensed as a senior nuclear reactor operator for the Reed Reactor Facility; and received special commendation for his honors thesis, addressing the hydrodynamics of golf using analytic, numerical, and wind tunnel approaches.

During DeForest's graduate work at Stanford University (Ph. D. Applied Physics, 1996), 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 NASA's flagship mission SDO. 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 conducted the first science operations with the famous SOHO mission, in February 1996: a study of the solar south pole that, among many other results, revealed propagating waves in the solar corona and opened the currently rich field of coronal seismology. Other work included novel observations of solar coronal holes and polar plumes, including demonstrating that plumes require mixed-but-asymmetric magnetic structure; support rapid dynamics but survive for days; and extend into the heliosphere 45 solar radii from the Sun itself.

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 (with colleague C. Kankelborg) and reduced to practice a new approach to numerical MHD modeling (the fluxon approach) to eliminate numerical resistivity, helped (as the leader of the Magnetic Tracking Workshop series) to standardize methodology for pre-AI computer vision techniques applied to the Sun. 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, and advanced the science of Thomson-scattered imaging of the corona and the solar wind itself.

Instruments DeForest has either developed or had a major role in developing in the past 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 and flown twice into the upper stratosphere). He invented and (with colleague T. Howard) exploited the first quantitative heliospheric imaging analysis pipeline, which enables the polarization analysis to be exploited by PUNCH. His experience with large software project architecture and management includes: 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 500,000 line Perl Data Language; and the STEREO pipeline processing that enabled 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. He spent over a decade as Press Officer of the AAS/SPD, scouting and preparing press stories. He has advised three graduate students: one current, and two who have gone on to successful research careers.