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# **An X-ray to Extreme Ultraviolet Spectroscopic Look at the Sun's Atmosphere**

**Presented by:**

**Dr. George Doschek,**

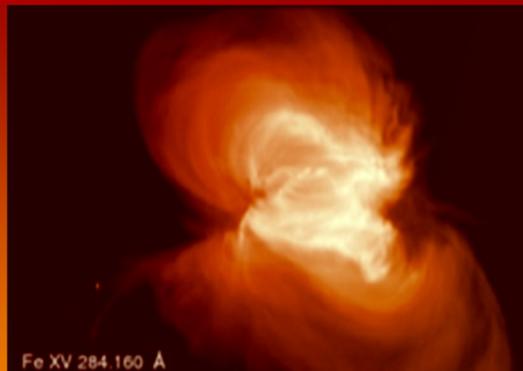
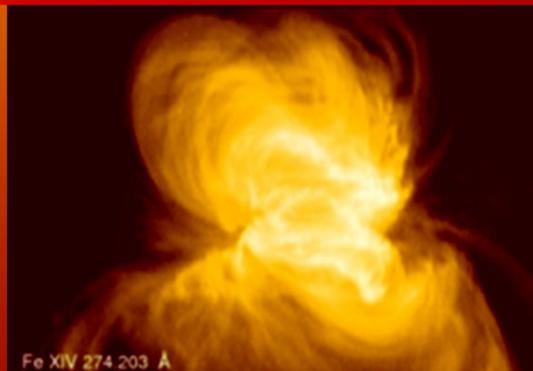
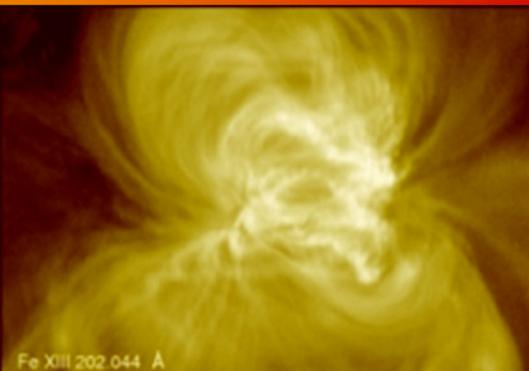
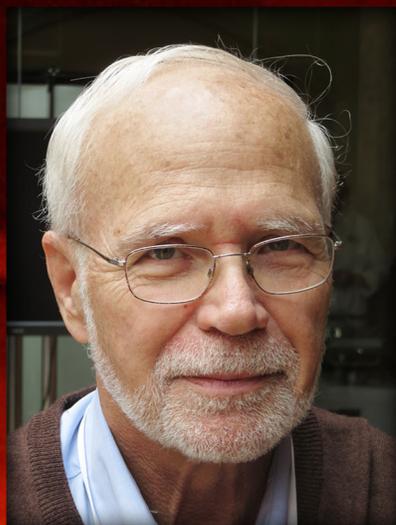
An NRL Research Physicist in Solar and  
Heliospheric Physics

**Tuesday, June 7, 2016**

**11 a.m. - Noon**

Office of Naval Research  
875 N. Randolph St., Arlington, Virginia  
Junker Center, 14<sup>th</sup> Floor

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# An X-ray to Extreme Ultraviolet (EUV) Spectroscopic Look at the Sun's Atmosphere

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Much of our knowledge of physical conditions in the solar chromosphere, transition region, and corona, such as temperature, electron density, element abundances, mass motions and turbulent motions, depends on analysis of high resolution X-ray-EUV spectroscopic data. The analysis of spectroscopic data depends in turn on spectral line identifications, and the atomic processes governing the production of the spectral lines in the solar atmosphere. In terms of solar physics, X-ray and EUV spectroscopy is relatively new and is a product of the space age combined with laboratory programs such as the inertial confinement laser fusion program and spectra obtained from tokamak plasmas. In addition there are parallel developments in the theory of atomic structure and

the calculation of essential atomic parameters. This all began in the 1960s and continues even today. The 1960s and 1970s saw the launch of multitudinous spacecraft to study the solar atmosphere. I have been privileged to be a participant in this solar/cosmic adventure to understand plasmas far from home. I will review how we got from very little knowledge of the X-ray and EUV solar spectrum to the excellent data that we have today as well as theoretical tools such as CHIANTI. I will also highlight some of the achievements in the development of high-resolution spectrometers. I will review the major results learned about the solar atmosphere from spectroscopy and how they bear on understanding the fundamental physical processes that heat the corona, drive solar flares, and generate coronal mass ejections.

## ABOUT

### Dr. George A. Doschek

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George Doschek was Branch Head of the Solar-Terrestrial Relationships Branch in the Space Science Division at the Naval Research Laboratory (NRL) from 1979 until January 2011. He is currently a Research Physicist in the Solar & Heliospheric Physics Branch and the Heliospace Environment Task Area Coordinator at NRL. Between 1970 and 1979 he was a Research Astrophysicist at NRL, and between 1968 and 1970 he was an E.O. Hulburt Fellow at NRL. George Doschek's research areas are solar physics, atomic physics, and solar physics spectroscopic space instrumentation. He has analyzed data from many solar space missions and has been a key player in the design and construction of new solar space experiments such as the SOLFLEX Bragg crystal spectrometers on P78-1 and was the NRL PI of the BCS Bragg spectrometer package on Yohkoh. He is PI to NASA for the Extreme-ultraviolet Imaging Spectrometer on Hinode.

Education: 1963 - B.S. (Physics, Magna Cum Laude) University of Pittsburgh; 1968 - Ph.D. (Physics) University of Pittsburgh

Awards, Honors: Honorary Woodrow Wilson Fellow – 1963; Fellow, Optical Society of America; NRL Publications Awards - 1972, 1978, 1979, 1980, 1984, 1993; NRL 1994 E.O. Hulburt Science and Engineering Award; Honorary Professor (2010-2015) in the Department of Space & Climate Physics, University College London; An international conference to celebrate the careers of Prof. George Doschek and Prof. Tetsuya Watanabe, "Spectroscopy of the Dynamic Sun", 18-20 April 2012, University College London, London, UK; 2015 George Ellery Hale Prize

Professional Societies: American Astronomical Society (Solar Physics Division); Optical Society of America (Fellow); American Geophysical Union; International Astronomical Union; Sigma Xi

Publications: 341 papers in refereed scientific journals, proceedings, 94 invited talks, 170 contributed (oral and poster) papers.

Committees, Working Groups: Chairperson, Solar physics Division of AAS (1986-1988); Vice Chairperson, Solar Physics

Division of AAS (1985-86, 1988-89); Committee member, Solar Physics Division of AAS (1983-84, 1989-90); Facility Scientist, Science Working Group for the NASA Orbiting Solar Laboratory (OSL); Member, NAS Committee for Solar and Space Physics (June 1985-June 1987); Member, NASA Management and Operations Working Group for Solar and Heliospheric Physics (1984-1986); Member, MAX'91 Science Study Working Group (Feb. 1985-Feb. 1986); Leader, Chromospheric Explosions Team, NASA Solar Maximum Mission Workshop (1983-1984); Member, NRC Committee of line Spectra of the Elements - Atomic Spectroscopy (1978-1980); Chairperson and Organizer of the Eighth International Colloquium on Ultraviolet and X-ray; Spectroscopy of Astrophysical and Laboratory Plasmas, IAU Colloquium No. 86, 27-29 August, 1984, proc. published by NRL; Member, Solar Panel of the Astronomy and Astrophysics Survey Committee (1989-1991); Member, UV/Optical from Space Panel of the Astronomy and Astrophysics Survey Committee (1989-1991); Member, NASA Space Physics Subcommittee (1991-1994); Member, EUVE User's Committee (1994-1996); Member, Solar-B Science Definition Team (1996-March 1998); Member, Hinode Science Working Group (2003-present); Member, NASA SH-MOWG (2008-2011); Member, Japanese Solar-C International Working Group; Co-Chair, The Solar-C Sub-Working group for the Plan B EUV Spectrometer; Member, NASA Joint Solar-C Science Assessment Committee (2010-2011)

Example Publications: Doschek, G. A., Warren, H. P., & Feldman, U. 2015, "Anomalous Relative Ar/Ca Coronal Abundances Observed by the Hinode/EUV Imaging Spectrometer Near Sunspots", *ApJ*, 808, L7; Doschek, G. A., Warren, H. P., Dennis, B. R., Reep, J. W., & Caspi, A. 2015, "Flare Footpoint Regions and a Surge Observed by Hinode/EIS, RHESSI, and SDO/AIA", *ApJ*, 813, 32; Doschek, G. A. 2015, "Some Results from the Exploration of the Solar Atmosphere with High Resolution X-ray – EUV Spectroscopy at the Naval Research Laboratory", *Applied Optics*, 54, No. 31, November 1, F50.