

Steven R. Cranmer

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CURRENT POSITION Astrophysicist, Solar, Stellar, & Planetary Physics Division (UVCS program).
Smithsonian Astrophysical Observatory, 1996–present.

EDUCATIONAL BACKGROUND University of Delaware, Newark, Delaware, 1992–1996.
Ph.D. Physics and Astronomy, August 1996, *Advisor*: Stanley P. Owocki.
Dissertation: “Dynamical Models of Winds from Rotating Hot Stars.”
Ohio State University, Columbus, Ohio, 1990–1991.
M.S. Astronomy, August 1991, *Advisor*: George W. Collins, II.
Drexel University, Philadelphia, Pennsylvania, 1985–1990.
B.S. Physics and Atmospheric Science, June 1990, *summa cum laude*.

RESEARCH INTERESTS * Acceleration of stellar winds; heating of stellar coronae and chromospheres
* Plasma physics and kinetic theory of waves and turbulence
* Rotating hot (O, B, Wolf-Rayet) stars, circumstellar fluid dynamics
* Radiative transfer and spectroscopy

TEACHING INTERESTS * Astronomy of the Sun, solar system, and stars
* Light and color in the atmosphere and the natural world
* Involving students in the analysis of data from space missions

HONORS 2006 Karen Harvey Prize, Solar Physics Division of AAS
1999, 2000, 2001, 2003, 2006 SAO Superior Accomplishment/Performance awards
1997 Theodore Wolf Dissertation Prize, University of Delaware
1994–1996 NASA Graduate Student Researchers Program Fellowship
1989 M. Russell Wehr Physics Award, Drexel University

PUBLICATIONS 56 papers in refereed journals, more than 127 conference presentations (26 invited).
Co-edited *Coronal Holes and Solar Wind Acceleration* (Kluwer Academic, 1999).
Wrote article for Macmillan/IOP *Encyclopedia of Astronomy & Astrophysics*.

MAJOR GRANTS RECEIVED PI, 50% support, NASA Supporting Research and Technology (SR&T), 2009–2012:
“*Definitive tests of competing models of coronal heating and solar wind acceleration*”
PI, 100% support, NASA Long-Term Space Astrophysics (LTSA), 2004–2009:
“*Waves and turbulence in stellar winds across the H–R diagram*”
PI, 35% support, NASA Supporting Research and Technology (SR&T), 2002–2005:
“*Unified models of turbulence & nonlinear wave evolution in the extended solar corona*”

PROFESSIONAL SOCIETIES American Astronomical Society, Solar & Historical Divisions (served on SPD Committee from 2003 to 2005), American Physical Society, American Geophysical Union.

EMPLOYMENT HISTORY

- 08/1996—present Astrophysicist, Smithsonian Astrophysical Observatory, Cambridge, MA
Theoretical modeling of solar/stellar wind heating and acceleration processes; analysis of Ultraviolet Coronagraph Spectrometer (UVCS) data.
- 09/1992–08/1996 Graduate Fellow, Bartol Research Institute, Newark, DE
Basic research into the nature of winds around rapidly rotating hot stars, using analytic methods and numerical simulations of dynamical wind structure.
- 01/1994–05/1994 Adjunct Professor of Physics, Drexel University, Philadelphia, PA
Developed and taught PHYS-181, “Introductory Astronomy” night course for non-science majors.
- 03/1989–09/1989 Cooperative Education Program, Princeton Plasma Physics Laboratory, Princeton, NJ
Developed and optimized X-ray spectroscopy diagnostic software; supervised tokamak data acquisition.

TEACHING EXPERIENCE

- ★ Guest lecturer for Harvard Astronomy 201a stellar atmospheres course in 2006 (D. Sasselov).
- ★ Instructor for Harvard Astronomy 191 undergrad. lab course in 2006 (P. Thaddeus; J. Grindlay).
- ★ Guest lecturer for Harvard Solar Astrophysics graduate course in 2000 (A. van Ballegoijen).
- ★ Guest lecturer for U. Delaware Stellar Astrophysics graduate course in 1996, (S. Owocki).
- ★ Developed and taught undergraduate astronomy course at Drexel University in 1994.

PUBLIC OUTREACH EXPERIENCE

- ★ Appeared on radio program *Earth and Sky*, May 2007.
- ★ Co-Investigator on funded education partnership program between CfA and Southern University.
- ★ Developed web pages, text, and animations for UVCS/SOHO news releases, 1997–present.
- ★ Appeared on NASA–TV Space Science Update (“*Surfing the Solar Wind*”) in July 1999.
- ★ Presented high-level overviews of UVCS program research to: former senator Howard Baker and Smithsonian Institution (SI) Secretary I. Heyman (1997), SAO Visiting Committee (2001), SI Under-Secretary D. Evans (2002), SI CIO D. Shaw (2004).

RELATED PROFESSIONAL EXPERIENCE

- ★ Associate Editor, *J. Geophys. Res.*, 2006–2009.
- ★ Elected to AAS SPD Division Committee in June 2003 (term: 2003–2005).
- ★ Scientific Organizing Committees: 2006 AAS/SPD meeting, COSPAR 2006 session D2.3/E3.3, 2009 *Solar Wind 12* meeting, 2009 *SOHO–23* meeting (co-chair).
- ★ Served on 4 NASA proposal review panels (1999, 2000, 2004, 2007).
- ★ Refereed >60 papers for journals; reviewed >25 various agency funding proposals by mail.
- ★ Co-Investigator on 5 NASA Explorer Program proposals (1997, 1998, 2001, 2003, 2007).
- ★ Served on Local Organizing Committees of *Solar Wind 9*, *SOHO-7*, and two UVCS meetings.
- ★ Serving as mentor/liaison to postdocs in CfA’s SSP Division, May 2007 to present.
- ★ Serving on CfA Predoctoral Research Oversight Committee, 2007–2009.

A unifying theme of my research over the past decade has been the study of *stars as laboratories for fundamental physics*. I have been fortunate to have opportunities to perform both observations and theoretical modeling that have contributed to new determinations of the physical processes that act in solar and stellar plasmas. The following topics represent my main research interests and goals for the near future.

I. The extended **solar corona** (i.e., the acceleration region of the solar wind) is where the plasma properties in interplanetary space are determined by processes that are still not well understood. I intend to continue the work that I began with the UVCS team at the CfA in exploring the mechanisms of coronal heating.

★ *Magnetohydrodynamic (MHD) turbulence and nonlinear wave evolution:* The solar wind contains strong nonlinear fluctuations characteristic of MHD turbulence. Two key unknowns are *where* the turbulence develops (i.e., at the solar surface, in the corona, or in interplanetary space) and *how* it dissipates (thus determining how protons, electrons, and heavy ions are heated and accelerated). I plan to continue refining and testing models of turbulent wave evolution in fast and slow solar wind plasmas.

★ *New ultraviolet spectroscopic diagnostics:* As the capabilities of coronal remote-sensing instruments improve, our understanding of the radiative transfer of emission line formation must also improve. I plan to investigate new ways of deconvolving line-of-sight effects, deriving the properties of non-Maxwellian velocity distributions, and probing coronal plasma properties with spectropolarimetry.

II. The physical processes that drive outflows from **cool stars**—both young (T Tauri) and old (giants and supergiants)—are largely unknown. Recent advancements in our understanding of solar wind physics (from, e.g., *SOHO*) are being applied to the study of cool-star winds at a rapid pace.

★ *Evolution of coronae and winds:* My work on turbulence-driven solar wind models is being extended to predict the properties of winds across a wide region of the H-R Diagram. These models are approaching a point where the only “free parameters” involve the sub-photospheric convection, which can be modeled reliably. Existing problems, such as the existence of coronae in evolved giants or the level of mass loss from the young Sun, are starting to be addressed seriously.

★ *Observational determination of “weak” mass loss rates:* It is notoriously difficult to measure the winds of solar-type stars. Traditional spectroscopic and radio techniques are sensitive to mass loss rates at least 100 to 1000 times stronger than the Sun’s rate. I am exploring hybrid constraints that combine existing observables (e.g., wind-sensitive lines like He I 10830 Å; X-ray fluxes sensitive to coronal heating) in new ways and also fold in theoretical models where possible.

III. The atmospheres of **hot stars** (O, B, Wolf-Rayet) are unique environments for the study of radiation hydrodynamics, in which photons play a key role in the momentum and energy budgets of the plasma.

★ *Formation of Be-star “decretion” disks:* Be-type stars are surrounded by dense, Keplerian equatorial disks, but the underlying stars seem to rotate too *slowly* for the disk material to be ejected centrifugally. I plan to continue investigating models of mutual interaction between pulsations, radiation-driven winds, and convectively unstable surface shear flows to find an explanation for the Be phenomenon.

★ *Pulsation leakage and clumped winds:* Hot-star winds are observed to exhibit variability on time scales ranging from hours to years. Many classes of these stars are also seen to pulsate radially or nonradially. It has been suspected for some time that these oscillations can induce periodic modulations in the surrounding stellar wind and explain many observed features. Surprisingly little theoretical work has been devoted to the “leakage” of pulsational energy into hot-star winds, and I plan to continue studying this potentially key driver of wind inhomogeneity.

I have tried to convey my own enthusiasm and enjoyment of physics in the various undergraduate and graduate courses that I have taught and planned. I intend to take advantage of the considerable resources available from the science education community so that I maximize the effectiveness of my time in the classroom without “re-inventing the wheel.” Several specific ideas are listed below.

All Courses

- ★ In my experience, the most effective teachers have been those that prepared their courses from a synthesis of at least 3–4 primary sources, not from just one textbook. This breadth allows the best mode of exposition to be chosen for each topic, and helps solidify the concepts in the instructor’s own mind.
- ★ The Internet has been shown to enhance the learning process in several ways (e.g., easy access to course materials, opportunities for student feedback and participation, and linkage to large amounts of supporting context material). However, the Internet is just one tool among many, and it should not replace direct interaction with students or take time away from other learning activities.

Undergraduate Introductory Survey Courses

- ★ Non-science majors often perceive science to be irrelevant to everyday experience. Two main goals of the introductory survey course should thus be: (1) to convey a sense of *connectedness* to a comprehensible universe, and (2) to have the students realize that science is a human activity that has impacted world history. Occasional digressions for on-topic quotations from literature, inspiring music, and biographies of interesting scientists enhance the students’ long-term retention of the basic material.
- ★ Specific misconceptions about, e.g., the seasons, precession, time and distance scales, and even UFOs and astrology should be addressed head-on where appropriate. It should also be stressed that having misconceptions about science does *not* imply any lack of intelligence.

Undergraduate Math-Based Preparatory Courses

- ★ The preparatory course for science and engineering majors is often a battleground between the instructor’s desire to *convey understanding* and the students’ desire to *memorize and pass tests*. One key aspect of winning this battle is to present many examples of manipulating and applying a small number of “master equations,” rather than presenting a large number of equation variants that students are tempted to memorize separately. (It is an important sub-goal of these courses to help students reach a point where algebraic manipulation becomes second nature.)

Advanced Undergraduate and Graduate Courses

- ★ Physics and astronomy majors must be weaned from the idea that every problem has an exact and unique solution. The idea of *justifiable approximation* must be introduced explicitly in an increasingly wider array of contexts; this helps transform good problem-solvers into good researchers.

Research Projects for Undergraduate and Graduate Students

- ★ Space-based observatories are returning gigabytes of data per day, and this rate will only increase over the coming decades. My experience with the UVCS program has shown me that ample data analysis projects can be constructed for undergraduate and graduate students at varying levels of experience.
- ★ An engaging, but under-utilized, set of student research projects is the direct simulation of atmospheric effects such as the blue sky, rainbows, clouds, and sunrise/sunset phenomena. Tabulated spectra can easily be transformed into vibrant color images. These studies provide a tangible introduction to astronomical radiative transfer, and industrious students can be motivated to go on to model the naked-eye colors of, e.g., galaxies, emission nebulae, stars, and planets.

SELECTED RESEARCH PUBLICATIONS

A more complete list of papers and presentations, including links to the presentations, online data, and unpublished technical notes, can be found at: <http://www.cfa.harvard.edu/~scanmer/>

Refereed Journals

- ★ Cranmer, S. R. 2009, “A Pulsational Mechanism for Producing Keplerian Disks around Be Stars,” *Astrophys. J.*, **701**, in press [arXiv:0906.2772].
- ★ Landi, E., and Cranmer, S. R. 2009, “Ion Temperatures in the Low Solar Corona: Polar Coronal Holes at Solar Minimum,” *Astrophys. J.*, **691**, 794.
- ★ Cranmer, S. R. 2008, “Turbulence-driven Polar Winds from T Tauri Stars Energized by Magnetospheric Accretion,” *Astrophys. J.*, **689**, 316.
- ★ Cranmer, S. R., Panasyuk, A. V., and Kohl, J. L. 2008, “Improved Constraints on the Preferential Heating and Acceleration of Oxygen Ions in the Extended Solar Corona,” *Astrophys. J.*, **678**, 1480.
- ★ van Ballegooijen, A. A., and Cranmer, S. R. 2007, “Hyperdiffusion as a Mechanism for Solar Coronal Heating,” *Astrophys. J.*, **682**, 644.
- ★ Cranmer, S. R., van Ballegooijen, A., and Edgar, R. J. 2007, “Self-consistent Coronal Heating and Solar Wind Acceleration from Anisotropic Magnetohydrodynamic Turbulence,” *Astrophys. J. Suppl.*, **171**, 520.
- ★ Kohl, J. L., Noci, G., Cranmer, S. R., and Raymond, J. C. 2006, “Ultraviolet Spectroscopy of the Extended Solar Corona,” *Astron. Astrophys. Review*, **13**, 31 (127-page review paper).
- ★ Cranmer, S. R. 2005, “A Statistical Study of Threshold Rotation Rates for the Formation of Disks around Be Stars,” *Astrophys. J.*, **634**, 585.
- ★ Cranmer, S. R., and van Ballegooijen, A. 2005, “On the Generation, Propagation, and Reflection of Alfvén Waves from the Solar Photosphere to the Distant Heliosphere,” *Astrophys. J. Suppl.*, **156**, 265.
- ★ Cranmer, S. R. 2004, “New views of the solar wind with the Lambert W function,” *American J. Phys.*, **72**, 1397.
- ★ Miralles, M. P., Cranmer, S. R., and Kohl, J. L. 2004, “Low-latitude coronal holes during solar maximum,” *Adv. Space Res.*, **33**, no. 5, 696.
- ★ Cranmer, S. R., and van Ballegooijen, A. 2003, “Alfvénic Turbulence in the Extended Solar Corona: Kinetic Effects and Proton Heating,” *Astrophys. J.*, **594**, 573.
- ★ Cranmer, S. R. 2002, “Coronal Holes and the High-Speed Solar Wind,” *Space Sci. Rev.*, **101**, 229 (65-page review paper).
- ★ Dobrzycka, D., Cranmer, S. R., Raymond, J. C., Biesecker, D. A., and Gurman, J. B. 2002, “Polar Coronal Jets at Solar Minimum,” *Astrophys. J.*, **565**, 621.
- ★ Cranmer, S. R. 2001, “Ion Cyclotron Diffusion of Velocity Distributions in the Extended Solar Corona,” *J. Geophys. Res.*, **106**, 24937.
- ★ Miralles, M. P., Cranmer, S. R., and Kohl, J. L. 2001, “Ultraviolet Coronagraph Spectrometer Observations of a High-latitude Coronal Hole with High Oxygen Temperatures and the Next Solar Cycle Polarity,” *Astrophys. J. Letters*, **560**, L193.

- ★ Miralles, M. P., Cranmer, S. R., Panasyuk, A. V., Romoli, M., and Kohl, J. L. 2001, “Comparison of Empirical Models for Polar and Equatorial Coronal Holes,” *Astrophys. J. Letters*, **549**, L257.
- ★ Cranmer, S. R. 2000, “Ion Cyclotron Wave Dissipation in the Solar Corona: The Summed Effect of More than 2000 Ion Species,” *Astrophys. J.*, **532**, 1197.
- ★ Cranmer, S. R., Smith, M. A., and Robinson, R. D. 2000, “A Multiwavelength Campaign on γ Cassiopeiae. IV. The Case for Illuminated Disk-Enhanced Wind Streams,” *Astrophys. J.*, **537**, 433.
- ★ Dobrzycka, D., Raymond, J. C., and Cranmer, S. R. 2000, “Ultraviolet Spectroscopy of Polar Coronal Jets,” *Astrophys. J.*, **538**, 922.
- ★ Cranmer, S. R., Field, G. B., and Kohl, J. L. 1999, “Spectroscopic Constraints on Models of Ion Cyclotron Resonance Heating in the Polar Solar Corona and High Speed Solar Wind,” *Astrophys. J.*, **518**, 937.
- ★ Cranmer, S. R., Kohl, J. L., Noci, G., Antonucci, E., Tondello, G., Huber, M. C. E., Strachan, L., Panasyuk, A. V., Gardner, L. D., Romoli, M., Fineschi, S., Dobrzycka, D., Raymond, J. C., Nicolosi, P., Siegmund, O. H. W., Spadaro, D., Benna, C., Ciaravella, A., Giordano, S., Habbal, S., Karovska, M., Li, X., Martin, R., Michels, J. G., Modigliani, A., Naletto, G., O’Neal, R. H., Pernechele, C., Poletto, G., Smith, P. L., and Suleiman, R. M. 1999, “An Empirical Model of a Polar Coronal Hole at Solar Minimum,” *Astrophys. J.*, **511**, 481.
- ★ Kohl, J. L., Esser, R., Cranmer, S. R., Fineschi, S., Gardner, L. D., Panasyuk, A. V., Strachan, L., Suleiman, R. M., Frazin, R., and Noci, G. 1999, “EUV Spectral Line Profiles in Polar Coronal Holes from 1.3 to 3.0 R_{\odot} ,” *Astrophys. J. Letters*, **510**, L59.
- ★ Dobrzycka, D., Cranmer, S. R., Panasyuk, A. V., Strachan, L., and Kohl, J. L. 1999, “Study of the Latitudinal Dependence of H I Lyman Alpha and O VI Emission in the Solar Corona: Evidence for the Superradial Geometry of the Outflow in the Polar Coronal Holes,” *J. Geophys. Res.*, **104**, 9791.
- ★ Cranmer, S. R., Field, G. B., and Kohl, J. L. 1999, “Spectroscopic Constraints on Models of Ion-Cyclotron Resonance Heating in the Polar Solar Corona,” *Space Sci. Rev.*, **87**, 149.
- ★ Kohl, J. L., Fineschi, S., Esser, R., Ciaravella, A., Cranmer, S. R., Gardner, L. D., Suleiman, R., Noci, G., and Modigliani, A. 1999, “UVCS/SOHO Observations of Spectral Line Profiles in Polar Coronal Holes,” *Space Sci. Rev.*, **87**, 233.
- ★ Suleiman, R. M., Kohl, J. L., Panasyuk, A. V., Ciaravella, A., Cranmer, S. R., Gardner, L. D., Frazin, R., Hauck, R., Smith, P. L., and Noci, G. 1999, “UVCS/SOHO Observations of H I Lyman Alpha Line Profiles in Coronal Holes at Heliocentric Heights above 3.0 Solar Radii,” *Space Sci. Rev.*, **87**, 327.
- ★ Gayley, K. G., Owocki, S. P., and Cranmer, S. R. 1999, “Line-Driven Ablation and Wind Tilting by External Irradiation,” *Astrophys. J.*, **513**, 442.
- ★ Cranmer, S. R., Kohl, J. L., and Noci, G. 1998, “UVCS/SOHO: The First Two Years,” *Space Sci. Rev.*, **85**, 341.
- ★ Cranmer, S. R. 1998, “Non-Maxwellian Redistribution in Solar Coronal Lyman Alpha Emission,” *Astrophys. J.*, **508**, 925.
- ★ Kohl, J. L., Noci, G., Antonucci, E., Tondello, G., Huber, M. C. E., Cranmer, S. R., Strachan, L., Panasyuk, A. V., Gardner, L. D., Romoli, M., Fineschi, S., Dobrzycka, D., Raymond, J. C., Nicolosi, P., Siegmund, O. H. W., Spadaro, D., Benna, C., Ciaravella, A., Giordano, S., Habbal, S., Karovska, M., Li, X., Martin, R., Michels, J. G., Modigliani, A., Naletto, G., O’Neal, R. H., Pernechele, C., Poletto, G., Smith, P. L., and

- Suleiman, R. M. 1998, "UVCS/SOHO Empirical Determinations of Anisotropic Velocity Distributions in the Solar Corona," *Astrophys. J. Letters*, **501**, L127.
- ★ Kohl, J. L., Noci, G., Antonucci, E., Tondello, G., Huber, M. C. E., Gardner, L. D., Nicolosi, P., Strachan, L., Fineschi, S., Raymond, J. C., Romoli, M., Spadaro, D., Panasyuk, A., Siegmund, O. H. W., Benna, C., Ciaravella, A., Cranmer, S. R., Giordano, S., Karovska, M., Martin, R., Michels, J., Modigliani, A., Naletto, G., Pernechele, C., Poletto, G., and Smith, P. L. 1997, "First Results from the SOHO Ultraviolet Coronagraph Spectrometer," *Solar Phys.*, **175**, 613.
 - ★ Raymond, J. C., Kohl, J. L., Noci, G., Antonucci, E., Tondello, G., Huber, M. C. E., Gardner, L. D., Nicolosi, P., Fineschi, S., Romoli, M., Spadaro, D., Siegmund, O. H. W., Benna, C., Ciaravella, A., Cranmer, S., Giordano, S., Karovska, M., Martin, R., Michels, J., Modigliani, A., Naletto, G., Panasyuk, A., Pernechele, C., Poletto, G., Smith, P. L., Suleiman, R. M., Strachan, L., and van Ballegoijen, A. A. 1997, "Composition of Coronal Streamers from the SOHO Ultraviolet Coronagraph Spectrometer," *Solar Phys.*, **175**, 645.
 - ★ Kohl, J. L., Noci, G., Antonucci, E., Tondello, G., Huber, M. C. E., Gardner, L. D., Nicolosi, P., Fineschi, S., Raymond, J. C., Romoli, M., Spadaro, D., Siegmund, O. H. W., Benna, C., Ciaravella, A., Cranmer, S. R., Giordano, S., Karovska, M., Martin, R., Michels, J., Modigliani, A., Naletto, G., Panasyuk, A., Pernechele, C., Poletto, G., Smith, P. L., and Strachan, L. 1997, "Measurements of H I and O VI Velocity Distributions in the Extended Solar Corona with UVCS/SOHO and UVCS/Spartan 201," *Adv. Space Res.*, **20**, no. 1, 3.
 - ★ Fullerton, A. W., Massa, D. L., Prinja, R. K., Owocki, S. P., and Cranmer, S. R. 1997, "Wind Variability of B Supergiants: III. Corotating Spiral Structures in the Stellar Wind of HD 64760," *Astron. Astrophys.*, **327**, 699.
 - ★ De Mey, K., Aerts, C., Waelkens, C., Cranmer, S. R., Schrijvers, C., Telting, J. H., Daems, K., and Meeus, G. 1997, "The Line-Profile Variable Lambda Scorpii is a Spectroscopic Triple System," *Astron. Astrophys.*, **324**, 1096.
 - ★ Cranmer, S. R. and Owocki, S. P. 1996, "Hydrodynamical Simulations of Corotating Interaction Regions and Discrete Absorption Components in Rotating O-Star Winds," *Astrophys. J.*, **462**, 469.
 - ★ Owocki, S. P., Cranmer, S. R., and Gayley, K. G. 1996, "Inhibition of Wind Compressed Disk Formation by Nonradial Line-Forces in Rotating Hot-Star Winds," *Astrophys. J. Letters*, **472**, L115.
 - ★ Gayley, K. G., Owocki, S. P., and Cranmer, S. R. 1996, "Sudden Radiative Braking in Colliding Hot-Star Winds," *Astrophys. J.*, **475**, 786.
 - ★ Owocki, S. P., Cranmer, S. R., and Fullerton, A. W. 1995, "Periodic Variations in UV Spectral Lines of the B0.5 Ib Star HD 64760: Evidence for Corotating Wind Streams Rooted in Surface Variations," *Astrophys. J. Letters*, **453**, L37.
 - ★ Gayley, K. G., Owocki, S. P., and Cranmer, S. R. 1995, "Momentum Deposition in Wolf-Rayet Winds: Nonisotropic Diffusion with Effective Gray Opacity," *Astrophys. J.*, **442**, 296.
 - ★ Cranmer, S. R. and Owocki, S. P. 1995, "The Effect of Oblateness and Gravity Darkening on the Radiation Driving in Winds from Rapidly Rotating B Stars," *Astrophys. J.*, **440**, 308.
 - ★ Owocki, S. P., Cranmer, S. R., and Blondin, J. 1994, "Two-Dimensional Hydrodynamical Simulations of Wind Compressed Disks around Rapidly Rotating B Stars," *Astrophys. J.*, **424**, 887.
 - ★ Cranmer, S. R. and Collins, II, G. W. 1993, "The Effects of Zonal Atmospheric Currents on the Spectra of Rotating Early Type Stars," *Astrophys. J.*, **412**, 720.

- ★ Cranmer, S. R. 1993, “Some Aspects of Illuminated Model Atmosphere Theory as Applied to Close Binary Systems,” *Mon. Not. R. Astr. Soc.*, **263**, 989.
- ★ Collins, II, G. W. and Cranmer, S. R. 1991, “Rotationally Induced Polarization in Pure Absorption Spectral Lines,” *Mon. Not. R. Astr. Soc.*, **253**, 167.
- ★ Collins, II, G. W., Truax, R. J., and Cranmer, S. R. 1991, “Model Atmospheres for Rotating B Stars,” *Astrophys. J. Suppl.*, **77**, 541.
- ★ Ali, B., Blum, R., Bumgardner, T., Cranmer, S. R., Ferland, G. J., Haefner, R., and Tiede, G. 1991, “The [Ne III–O II] Line Ratio as an Indicator of Helium Content in H II Regions,” *Publ. Astron. Soc. Pac.*, **103**, 1182.

Book Edited

- ★ Kohl, J. L., and Cranmer, S. R. (eds.) 1999, *Coronal Holes and Solar Wind Acceleration*, Proceedings of the SOHO-7 Workshop, Northeast Harbor, Maine, 28 September to 1 October 1998, (Dordrecht: Kluwer), ISBN 0-7923-5828-7. Also published as vol. 87, no. 1–2 of *Space Science Reviews*.

Selected Conference/Workshop Presentations

- ★ Cranmer, S. R. 2009, “Ion Heating in the Solar Corona and Solar Wind,” *Bull. Am. Phys. Soc.*, April 2009 APS Meeting, **54**, (4), 61 (**Invited Talk**).
- ★ Cranmer, S. R. 2008, “Applications of MHD Turbulence to Modeling Solar (and Stellar) Coronal Heating and Winds,” *Interface Between Plasma Dissipation Processes and MHD Turbulence in Space Plasmas*, Santa Fe, New Mexico, October 6–10, 2008 (**Invited Talk**).
- ★ Cranmer, S. R. 2008, “Turbulence and Waves as Sources for the Solar Wind,” *Eos Trans. AGU*, 89 (23), Joint Assembly Suppl., abstract SH34B-03 (**Invited Talk**) [arXiv:0804.3058]. Cranmer, S. R. 2008, “Modeling the solar wind: A survey of theoretical ideas for the origins of fast and slow streams,” *HELIOS-2008: The Second Heliospheric Network Workshop*, Kefalonia, Greece, May 6–9, 2008 (**Invited Talk**).
- ★ Cranmer, S. R. 2007, “Propagating Waves in Hot-Star Winds: Leakage of Long-Period Pulsations,” *IAU Symposium 250: Massive Stars as Cosmic Engines*, Kauai, Hawaii, December 10–14, 2007.
- ★ Cranmer, S. R. 2007, “Ion Heating in the Solar Corona,” *2007 General Meeting of the Center for Magnetic Self-Organization (CMSO)*, Durham, New Hampshire, June 4–6, 2007 (**Invited Talk**).
- ★ Cranmer, S. R. 2007, “Turbulence in the Solar Corona,” *Turbulence and Nonlinear Processes in Astrophysical Plasmas*, 6th Annual IGPP Astrophysics Conference, (**Invited Talk**), AIP Conf. Ser. 932, ed. D. Shaikh and G. P. Zank, p. 327. [arXiv:0706.2843v1].
- ★ Cranmer, S. R. 2006, “Winds of Main-Sequence Stars: Observational Limits and a Path to Theoretical Prediction,” *14th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun*, Pasadena, CA, November 6–10, 2006 (**Invited Talk**) [astro-ph/0701561].
- ★ Cranmer, S. R., and Saar, S. H. 2006, “Exoplanet-Induced Chromospheric Activity: Realistic Light Curves from Solar-type Magnetic Fields,” *14th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun*, Pasadena, CA, November 6–10, 2006 [astro-ph/0702530].
- ★ Cranmer, S. R. 2006, “Turbulent Origins of the Solar Wind,” *SHINE 2006 Workshop*, Zermatt, Utah, July 31–August 4, 2006 (**Invited Talk**).

- ★ Cranmer, S. R. 2006, “Turbulence and wave dissipation in the chromosphere, corona, and solar wind,” *Bull. Am. Astr. Soc.*, **38**, p. 249 (SPD meeting 37, **Invited Talk** 21.01).
- ★ Cranmer, S. R. 2005, “UVCS Observations of Solar Wind and its Modeling,” *6th Solar-B Science Meeting*, Kyoto, Japan, November 8-11, 2005 (**Invited Talk**).
- ★ Cranmer, S. R. 2005, “Why is the Fast Solar Wind Fast and the Slow Solar Wind Slow? A Survey of Geometrical Models,” *Solar Wind 11/SOHO-16: Connecting Sun and Heliosphere*, June 13-17, 2005, ESA SP-592, p. 159, [astro-ph/0506508].
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Informal Talks, Seminars, and General-Interest Articles

- ★ Cranmer, S. R., “Plasma Unbound: New Insights into Heating the Solar Atmosphere and Accelerating the Solar Wind,” March 27, 2009, Weekly Seminar, University of Massachusetts Lowell, Center for Atmospheric Research.
- ★ Cranmer, S. R., “Plasma Unbound: New Insights into Coronal Heating and Solar/Stellar Winds,” March 4, 2009, Colloquium, High Altitude Observatory (HAO).

- ★ Cranmer, S. R., “Plasma Physics in the Solar System,” February 9, 2009, Harvard-Smithsonian CfA ITC (Institute for Theory and Computation) Monday Pizza Lunch Talk.
- ★ Cranmer, S. R., “Solar/Stellar Winds: An Overview,” October 27, 2008, New England Space Science Consortium, meeting 17, Harvard-Smithsonian CfA.
- ★ Cranmer, S. R., “MHD Turbulence in the Solar Corona and Solar Wind,” April 7, 2008, Harvard-Smithsonian CfA ITC (Institute for Theory and Computation) Turbulence Meeting.
- ★ Cranmer, S. R., “Turbulence-driven Polar Winds from T Tauri Stars Energized by Magnetospheric Accretion,” January 28, 2008, Harvard-Smithsonian CfA Solar, Stellar, and Planetary Sciences Division Seminar.
- ★ Cranmer, S. R. “Plasma Unbound: New Insights into Heating the Solar Corona and Accelerating the Solar Wind,” October 18, 2007, Colloquium, University of California Berkeley, Astronomy Department.
- ★ Cranmer, S. R. “Origin and Heating of the Solar Wind,” June 11–13, 2007, two hour-long lectures for the 2007 Solar Physics Summer School (National Solar Obs., Univ. of Arizona), Sunspot, New Mexico.
- ★ Cranmer, S. R. “Turbulence and wave dissipation in the chromosphere, corona, and solar wind,” July 11, 2006, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
- ★ Cranmer, S. R. “Alfven Waves from Photosphere to Heliosphere: Past, Present and Future,” July 1, 2006, Hollweg Symposium, Durham, NH.
- ★ Cranmer, S. R. “Leaky Stars: Pulsations, Waves, and Turbulence in Stellar Winds across the H-R Diagram,” March 9, 2006, Harvard-Smithsonian CfA Colloquium.
- ★ Cranmer, S. R. “Exploring the Solar Wind with Ultraviolet Light,” 18 January 2006, U.S. Coast Guard Academy, New London, Connecticut, DS-3 Science Lecture Series.
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- ★ Cranmer, S. R. “New Analytic Solutions to Classic Problems in Solar and Stellar Physics,” 18 October 2004, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
- ★ Kohl, J. L., and Cranmer, S. R. “Scientific Computing in the UVCS Group,” 14 April 2004, Harvard-Smithsonian CfA, presentation for visit of Dennis Shaw (Smithsonian Chief Information Officer).
- ★ Cranmer, S. R. “SOHO Observations of Ion Heating and MHD Turbulence in the Solar Corona,” 19 March 2004, Bartol Research Institute, Fluids and Plasmas Seminar.
- ★ Cranmer, S. R. “SOHO Observations of Ion Heating and MHD Turbulence in the Solar Corona,” 20 November 2003, General Seminar, Dept. of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana.
- ★ Cranmer, S. R. “Exploring the Solar Wind with Ultraviolet Light,” 19 November 2003, Special Space Science Lecture, Southern University (Dept. of Physics and Timbuktu Academy), Baton Rouge, Louisiana.
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- ★ Cranmer, S. R. “A Possible Source of Angular Momentum for Keplerian Decretion Disks around Be Stars,” 13 May 2002, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
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- ★ Cranmer, S. R. “A Unified Formation Scenario for Plumes and Jets in the Solar Corona,” 12 March 2001, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
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- ★ Cranmer, S. R. “New Insights into Solar Plasma Physics from SOHO,” 11 March 1999, Bartol Research Institute, invited Thursday seminar.
- ★ Cranmer, S. R. “What are we Learning from UVCS/SOHO Spectroscopy about Alfvén Wave Generation in the Solar Corona,” 8 February 1999, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
- ★ Cranmer, S. R. “SOHO and the Solar Wind,” 15 April 1998, Harvard-Smithsonian CfA Theory Group Wednesday Lunch Talk.
- ★ Cranmer, S. R. “Acceleration and Heating of the Fast Solar Wind: From UVCS/SOHO Diagnostics to Kinetic Theory,” 9 March 1998, Harvard-Smithsonian CfA Solar and Stellar Physics Division Seminar.
- ★ Cranmer, S. R. and Kohl, J. L. “The Ultraviolet Coronagraph Spectrometer,” 1 December 1997, Harvard-Smithsonian CfA, presentation for one-day visit of Smithsonian Institution Secretary I. Michael Heyman and former Senator Howard Baker.
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