Smithsonian Astrophysical Observatory (SAO)

Charles Alcock, Director

The Smithsonian Astrophysical Observatory (SAO) was established in 1890 as a research unit of the Smithsonian Institution concentrating on studies of solar radiance. Sixty-five years later, SAO assumed responsibility for establishing an optical network for tracking the first artificial satellites. From this pioneering effort, the size and scope of SAO grew with the international space program to include major research in virtually all branches of astrophysics, as well as in areas of earth and planetary sciences.

Since 1955, when its headquarters moved to Cambridge, Massachusetts, SAO has pursued such research in close collaboration with the Harvard College Observatory (HCO) and the Harvard University Department of Astronomy. On July 1, 1973, the Smithsonian Institution and Harvard University formalized their collaboration now known as the Center for Astrophysics | Harvard & Smithsonian (CfA) to coordinate the related research activities of the two observatories under a single director. Today the observatories retain their separate identities, each responsible to its parent organization; however, the joint venture draws on the coordinated strengths of the two organizations and the combined staffs in six research divisions: Atomic and Molecular Physics; High Energy Astrophysics; Optical and Infrared Astronomy; Radio and Geoastronomy; Solar, Stellar, and Planetary Sciences; and Theoretical Astrophysics. In addition, the CfA has a Science Education Department.

Facilities

Observational facilities include the multipurpose Fred Lawrence Whipple Observatory (FLWO) on Mt. Hopkins in Arizona and the Submillimeter Array Telescope (SMA) on Mauna Kea, Hawaii, the latter a collaboration with the Academia Sinica's Institute of Astronomy and Astrophysics of Taiwan. The major instrument on Mt. Hopkins is the 6.5-m-diameter optical telescope of the MMT Observatory, a facility operated jointly with the University of Arizona. SAO scientists have developed and deployed a suite of advanced wide-field imagers and spectrographs for the MMT including the Hectospec/Hectochelle fiber-fed optical spectrographs, the Megacam imager, and MMIRS, an infrared spectrograph and imager. VERITAS, the Very Energetic Radiation Imaging Telescope Array System, is a major ground-based gamma-ray observatory at FLWO with an array of four 12-m optical reflectors for gamma-ray astronomy in the GeV – TeV energy range. Also located at the FLWO are: the MINiature Exoplanet Radial Velocity Array (MINERVA), the MEarth planet hunter, a 1.2-m imaging optical/infrared telescope, and the 1.5-m Tillinghast spectroscopic telescope. FLWO is also home to HAT, the Hungarian Automated Telescope, a completely automated set of small aperture telescopes that search for transiting extra-solar planets; four HAT-Net telescopes are at FLWO, and two are at the SMA site in Hawaii.

In addition to these SAO-operated facilities, the Center for Astrophysics has a 20% share of the twin 6.5-m Magellan telescopes in Chile, operated by a five-institution consortium headed by the Observatories of the Carnegie Institution of Washington. A set of f/5 wide-field optics, identical to those at the MMT, have been installed at the Magellan Clay Telescope. These new Magellan optics allow the operation of Megacam and MMIRS in the Southern Hemisphere. Not least, SAO/CfA is involved in the development of both the 25-m Giant Magellan Telescope, with its partners in the Magellan consortium and others, and the Large Synoptic Survey Telescope.
Special laboratories are maintained for the development of telescope instrumentation and for the spectroscopy of atoms and molecules. A 1.2-m radio telescope on the roof of the Observatory in Cambridge is used for the study of molecular clouds and the structure of the Milky Way through the spectral lines of CO and other molecules.

SAO instrumentation is also operating in space. The Chandra X-ray Observatory, the third of the National Aeronautics and Space Administration's (NASA) Great Observatories, carries the High Resolution Mirror Assembly X-ray telescope whose development SAO oversaw. Chandra's High Resolution Camera (HRC), which SAO designed and built and operates for NASA, is used to study X rays from high-energy regions of the Universe. SAO proposed and manages the Spitzer Space Telescope's Infrared Array Camera (IRAC), a 3-to-10 micron camera for the study of both the very deep, early universe and the formation of stars and planets locally. Ongoing Solar and Stellar X-ray Group space-based mission participation includes Hinode, Solar Dynamics Observer, IRIS and DSCOVR. Division scientists are principals in the Solar Wind Electrons Alphas and Protons (SWEAP) investigation for NASA's Solar Probe Plus mission to the Sun. During the 2017 solar eclipse, the Solar and Stellar X-ray Group will use an NSF funded airborne spectrograph that they are building to open the mid-IR window to coronal studies.

Numerous facilities serving the general scientific community are located at the CfA in Cambridge. The Institute for Theoretical Atomic, Molecular and Optical Physics, established in 1988 to attract and encourage talented graduate students to enter this field, emphasizes theoretical study of fundamental questions in atomic and molecular physics, hosts many visitors, both long- and short-term, and conducts conferences and workshops. The Center for X-ray Technology, established in 2003 as a collaborative effort with other institutions, promotes the development of detectors and optics leading to space telescope applications, including X-ray interferometers. The Institute for Theory and Computation (ITC), also hosted by the CfA, is dedicated to research in high-end astrophysical computing. The ITC consists of members of the Harvard Department of Astronomy, Smithsonian astrophysicists, postdoctoral researchers, graduate students, and associates at other institutions.

Other services at SAO include the Minor Planet Center, which disseminates information on asteroid and comet discoveries worldwide. The United States' gateway for SIMBAD, an international astronomical computer database, is also located at the Cambridge site, as is Harvard's extensive collection of astronomical photographic plates, the largest in the world. In addition, SAO conceived, developed, and now operates the Astrophysics Data System (ADS), funded by NASA. This service includes on-line access to more than 12 million abstracts of articles in the fields of astronomy, astrophysics, space instrumentation, and space physics. Full-text on-line journals are also available. The HITRAN database of molecular parameters for transmission through and emission from planetary atmospheres is maintained at SAO for more than 5000 users worldwide. SAO participates in the National Virtual Observatory (NVO) and the International Virtual Observatory (IVOA) collaborations, whose aims are to implement improved connectivity between the various astronomical data archives in the world.

SAO, on behalf of NASA, serves as the site of both the Chandra X-ray Observatory Science Center (CXC) and the Chandra Operations and Control Center, the latter of which conducts Chandra flight operations on an around-the-clock basis. The CXC develops and oversees the General Observer program for this mission, as well as calibrates, manages, and distributes data received from Chandra.

The CfA's library, which includes the SAO collection as well as that of HCO, is available to the staff and to visitors. Located near the center of a community of universities, government agencies, and corporate scientific enterprises, SAO investigators enjoy access to a variety of facilities and counsel, and they may avail themselves of opportunities to pursue academic interests within the community. Smithsonian staff, research fellows, and their Harvard colleagues at the CfA publish more than 800 refereed papers each year in internationally known journals.

Office of the Director

RESEARCH STAFF

ALCOCK, Charles Roger, Director, Harvard-Smithsonian Center for Astrophysics; Professor of Astronomy, Harvard University. B.Sc. (1972) Auckland University, New Zealand; Ph.D. (1977) California Institute of Technology. Research specialties: Large astronomical surveys; outer solar system; cosmic dark matter; astronomical data mining; virtual observatory technologies. Contact: CAlcock@cfa.harvard.edu

BRICKHOUSE, Nancy Susan, Astrophysicist; Senior Science Advisor, Harvard-Smithsonian Center for Astrophysics. B.S. (1977) University of North Carolina; Ph.D. (1984) University of Wisconsin. Research specialties: Plasma physics; solar and stellar coronae; plasma emission line spectroscopy; ultraviolet and X-ray spectroscopy of astrophysical sources; laboratory astrophysics. Contact: NBrickhouse@cfa.harvard.edu

Research Programs

The scientific objectives of the CfA are intentionally flexible so that response to new research opportunities can be prompt and effective. By design, the research programs reflect the strongest areas of the two observatories and concentrate in fields where the contribution to national goals and scientific excellence can best be realized.

Atomic and Molecular Physics

Quantitative information about atomic and molecular processes required for interpreting astronomical observations is obtained from combinations of laboratory and theoretical studies. Laboratory research includes centimeter-wave through ultraviolet spectroscopy of non-terrestrial molecules, and stored light experiments in quantum optics. Fundamental precision measurements to test time-reversal symmetry-violating phenomena and applications of new magnetic resonance imaging techniques using spin-polarized noble gases are pursued. Tests of general relativity and the underlying equivalence principle use laboratory experimental techniques as well as radio observations of solar-system objects, spacecraft, and quasars and measurements of the round-trip timing of laser pulses sent to the moon. The application of the laser frequency comb to astrophysical measurements has been developed and is being refined. The development of precise laser-based distance measurement techniques supports both the equivalence principle work and future space missions. Measurements of trace gases (primarily atmospheric pollutants and greenhouse gases) and other atmospheric constituents are made from satellite-based spectrometers operating in the ultraviolet, visible, and infrared.

Theoretical research with applications to astrophysics includes calculations of atomic and molecular structure, cross-sections for recombination and molecular collisional processes, photoionization, photodissociation, charge transfer, and the interactions between matter and anti-matter. These studies are used in the Division to explain the characteristics of X rays stemming from interactions of comets with the flux of ions and electrons streaming from the Sun (the solar wind), to examine the distributions of energetic atoms in atmospheres of the terrestrial planets, to develop new radiative transfer tools for the modeling of planetary atmospheres, and to measure and model photochemistry and pollution in the Earth's atmosphere. AMP is a worldwide center for the development and archiving of fundamental spectroscopic parameters of molecular gases. These data are employed for calculations of transmittance and radiance for the Earth's atmosphere and for astrophysics. The Institute for Theoretical Atomic, Molecular and Optical Physics, funded primarily by the National Science Foundation and situated in the AMP division, has now been in existence for more than 25 years. The main goals of the Institute are to educate both students and postdoctoral fellows in theoretical AMO Physics, to maintain a world-class visitor program, and to organize and support workshops in forefront areas of AMO Physics research.

RESEARCH STAFF

BABB, James F., Physicist. A.B. (1982) Oberlin College; M.S. (1986), Ph.D. (1988) New York University. Research specialties: Applications of atomic and molecular physics to astrophysics and atmospheric physics; molecular structure; long-range forces. Contact: JBabb@cfa.harvard.edu

CHANCE, Kelly V., Senior Physicist;. B.S. (1970) University of Hawaii; A.M. (1972), Ph.D. (1977) Harvard University. Research specialties: Molecular spectroscopy, structure, and dynamics and their application to atmospheric studies; laboratory spectroscopy and satellite-based measurements of the Earth's atmosphere, particularly of atmospheric pollutants and greenhouse gases; atmospheric composition and radiative transfer. Contact: KChance@cfa.harvard.edu

GONZALEZ ABAD, Gonzalo, Physicist, B.S. (2008) University of Valencia, Ph.D. (2011) University of York. Research specialties: Space-based measurements of Earth's atmosphere trace gases, air quality, radiative transfer and instrument calibration. Contact: ggonzalezabad@cfa.harvard.edu

GORDON Iouli E. Physicist. Diploma. (1999) Moscow Institute of Physics and Technology; MSc (2001) University of Toronto, Ph.D. (2006) University of Waterloo. Research specialties: Spectroscopy of molecules of atmospheric and astrophysical interest, Development and management of spectroscopic databases (HITRAN and HITEMP). Contact: igordon@cfa.harvard.edu

KHARCHENKO, Vasili A., Physicist. M.Sc. (1974) Politechnic Institute (Leningrad); Ph.D. (1978), D.Sc. (1988) Ioffe Physico-Technical Institute (St. Petersburg). Research specialties: Atmospheric physics; atomic collision theory. Contact: vkharchenko@cfa.harvard.edu

LIU, Xiong, Research Scientist, Smithsonian Astrophysical Observatory. B.S. (1995) Nankai University; M.A. (1998) Research Center for Eco-environmental Sciences, Chinese Academy of Sciences; M.S. (2002) University of Alabama in Huntsville; Ph.D. (2002) University of Alabama in Huntsville. Research specialties: Remote sensing of atmospheric trace gases, aerosols, and clouds; Atmospheric radiative transfer modeling and instrument calibration; Tropospheric chemistry studies integrating satellite measurements, chemical transport models, and in situ observations. Contact: XLiu@cfa.harvard.edu

McCARTHY, Michael C., Senior Physicist; Associate Director, Atomic and Molecular Physics Division. B.Sc. (1986) University of Alaska; Ph.D. (1992) Massachusetts Institute of Technology. Research specialties: Astrochemistry; laboratory astrophysics of reactive molecules; microwave and laser spectroscopy. Contact: MMcCarthy@cfa.harvard.edu

NOWLAN, Caroline R., Physicist. B.Sc. (1999) Mount Allison University; M.Sc. (2000), Ph.D. (2006) University of Toronto. Research specialties: Atmospheric remote sensing; space and airborne instrumentation for atmospheric measurements; radiative transfer; retrieval theory; air quality; atmospheric chemistry and composition. Contact: cnowlan@cfa.harvard.edu

PHILLIPS, David Forrest, Physicist. B.S. (1988) California Institute of Technology; Ph.D. (1996) Harvard University. Research specialties: Development and applications of atomic clocks; precise tests of fundamental physical laws; quantum optics. Contact: DPhillips@cfa.harvard.edu

SADEGHPOUR, Hossein R., ITAMP Director. B.S. (1981), M.S. (1983), Ph.D. (1990) Louisiana State University. Research specialties: Atomic and molecular collisions and spectroscopy; formation and collision of cold antihydrogen and protonic atoms, quantum mechanical interference effects; rydberg collisions; absorption and scattering of light for astrophysical applications, recombination and reionization, and two-photon processes, coherent control and manipulation on the nanoscale, coherent light interaction with nanotubes, ultracold collision of dipolar systems. Contact: HSadeghpour@cfa.harvard.edu

WALSWORTH, Ronald L., Senior Physicist. B.S. (1984) Duke University; Ph.D. (1991) Harvard University. Research specialties: Development of atomic clocks and precision measurement tools; precise tests of fundamental physical laws; bioimaging and brain science; searches for extrasolar planets. Contact: RWalsworth@cfa.harvard.edu

WANG, Huiqun (Helen), Physicist. B.S. (1997) University of Science and Technology of China; Ph.D. (2004) California Institute of Technology. Research specialties: Martian atmosphere data analysis and numerical modeling; Martian dust storms and clouds; Atmospheric trace gasses. Contact: Hwang@cfa.harvard.edu

AFFILIATED RESEARCH STAFF

MARTIN, Randall V., Research Associate, Dalhousie University. B.A. (1996) Cornell University; M.Sc. (1998) Oxford University; M.S. (2001), Ph.D. (2002) Harvard University. Research specialties: atmospheric chemistry; satellite remote sensing; global modelling of atmospheric composition.

ROTHMAN, Laurence S., Senior Physicist. B.S. (1961) Massachusetts Institute of Technology; A.M. (1964), Ph.D. (1971) Boston University. Research specialties: Molecular spectroscopy; HITRAN (high-resolution transmission) spectroscopic database compilation. Contact: LRothman@cfa.harvard.edu

High Energy Astrophysics

Research in the High Energy Astrophysics Division focuses on astronomical objects and processes that emit and absorb energy as X-rays, which include planets, all types of stars including the Sun, neutron stars, supernova remnants, supermassive and stellar-mass black holes, galaxies, and galaxy clusters. Observations are made from spacecraft, notably the Earth-orbiting Chandra X-ray Observatory, one of NASA's Great Observatories, as well as other space-based X-ray telescopes. The division's scientific studies are directed at a broad range of topics, including a) cosmology, b) the structure, interactions, and evolution of astronomical objects, and c) processes that generate X-ray radiation. In support of their scientific studies, members of the division use telescopes at all major observatories covering all available wavelengths. Division scientists also play a role in advancing instrumentation and are working to develop novel X-ray optics and detectors. In addition, the Division operates the NASA Astrophysics Data System, the premier digital library of astrophysics publications. Staff members participate in planning and developing major new X-ray missions, and operate the Chandra X-ray Center, which conducts flight operations and science activities for the Chandra X-ray Observatory. The Division has a strong and active Solar and Stellar X-ray Group (SSXG), which participates in the development of new experiments and in the operation of ongoing missions. Ongoing SSXG space-based mission participation includes Hinode, Solar Dynamics Observer, IRIS and DSCOVR. Division scientists are principals in the Solar Wind Electrons Alphas and Protons (SWEAP) investigation for NASA's Solar Probe Plus mission to the Sun. During the 2017 solar eclipse, the Solar and Stellar X-ray Group will use an NSF funded airborne spectrograph that they are building to open the mid-IR window to coronal studies. In support of its research and educational goals, the Division funds approximately 20 postdoctoral fellows, hosts visiting scientists, runs two NSF summer intern programs – one with a broad focus on astrophysics and a second targeted at solar physics – and conducts extensive education and public outreach activities.

RESEARCH STAFF

ACCOMAZZI, Alberto, Program Manager, Astrophysics Data System Project. Ph.D. (1988) University of Milan. Research specialties: Digital Libraries; Scientific Information Systems; Semantic Web Technologies; Natural Language Processing; Image Analysis and Classification. Contact: AAccomazzi@cfa.harvard.edu

ALDCROFT, Thomas L., Astrophysicist. B.S. (1987) California Institute of Technology; Ph.D. (1993) Stanford University. Research specialties: X-ray constraints on the intergalactic medium; quasar absorption line systems; quasar multiwavelength spectral energy distribution. Contact: TAldcroft@cfa.harvard.edu

BRENNEMAN, Laura W., Astrophysicist. B.A. (1999) Williams College; Ph.D. (2007) University of Maryland. Research specialties: X-ray spectroscopy of accretion and outflows in AGN and black hole binaries; studies of black hole spin, coronal physics and absorption signatures in the innermost accretion disk. Contact: LBrenneman@cfa.harvard.edu

BURKE, Douglas, Astrophysicist. B.Sc. (1992), M.Sc. (1993) Imperial College of Science, Technology and Medicine (London); Ph.D. (1997) University of Durham. Research specialties: Galaxy clusters; observational cosmology; extragalactic astronomy; Astroinformatics; Semantic Web. Contact: DBurke@cfa.harvard.edu

CHYLA, Roman, Information Scientist, Astrophysics Data System Project. M.A. (2003); Ph.D. (2012) Charles University, Prague. Research specialties: Digital Libraries; Scientific Information Systems; Semantic Web Technologies; Natural Language Processing. Contact: RChyla@cfa.harvard.edu

D'ABRUSCO, Raffaele, Astrophysicist. Master Degree (2004): University of Napoli "Federico II"; Ph.D. (2007): University of Napoli "Federico II". Research specialties: multi-wavelength observations of blazars; properties of globular clusters population in external galaxies, galaxy evolution; machine learning applied to complex/massive astronomical datasets. Contact: rdabrusc@cfa.harvard.edu

DAVID, Laurence P., Astrophysicist. B.A. (1980) Drexel University; M.A. (1983), Ph.D. (1985) Indiana University. Research specialties: Early-Type Galaxies; Groups of Galaxies; Clusters of Galaxies; Cosmology. Contact: LDavid@cfa.harvard.edu

DELUCA, Edward E., Senior Astrophysicist. B.A. (1979), M.A. (1980) Wesleyan University; Ph.D. (1986) University of Colorado. Research specialties: Solar coronal physics; Solar Active Region Modeling; Solar Instrumentation; Magnetohydrodynamics. Contact: EDeLuca@cfa.harvard.edu

DRAKE, Jeremy J., Astrophysicist. B.Sc. (1985) University of Newcastle-Upon-Tyne; D.Phil. (1989) Brasenose College, Oxford University. Research specialties: Star and planet formation; protoplanetary disks, stellar atmospheres; stellar magnetic activity; element abundances and stellar evolution; novae; extreme ultraviolet and X-ray astronomy. Contact: JDrake@cfa.harvard.edu

EDGAR, Richard J., Research Astrophysicist. B.A. (1976) University of Colorado; M.S. (1983), Ph.D. (1985) University of Wisconsin. Research specialties: X-ray astronomy; spectroscopy; diffuse soft X-ray background; hot interstellar medium supernova remnants; nonequilibrium ionization solar wind, x-ray instrument calibration. Contact: REdgar@cfa.harvard.edu

EDMONDS, Peter D., Astrophysicist. B.S. (1988), Ph.D. (1994) University of Sydney. Research specialties: Globular clusters; compact binaries, especially accreting systems; HST studies of globulars; optical identifications of X-ray sources; X-ray studies of compact binaries; millisecond pulsars; stellar pulsations. Contact: PEdmonds@cfa.harvard.edu

ELVIS, Martin S., Astrophysicist. B.Sc. (1973) University of Bristol; M.Sc. (1974) University of Sussex; Ph.D. (1978) University of Leicester. Research specialties: Extragalactic X-ray astronomy, quasars, and active galactic nuclei; large scale multi-waveband surveys (X-ray, uv, ir, mm, and radio) esp. of continuum and lines in quasars; models for quasars, winds from quasars. Asteroids studies to enable human exploration. Contact: MElvis@cfa.harvard.edu

EVANS, Ian N., Astrophysicist. B.Sc. (1982) University of Western Australia; Ph.D. (1987) Australian National University. Research specialties: Physics of active galactic nuclei, including the impact of nuclear activity on the host galaxy; HII region abundances and physics of the interstellar medium; image-processing algorithms. Contact: IEvans@cfa.harvard.edu

FABBIANO, Giuseppina, Senior Astrophysicist. Ph.D. (1973) University of Palermo. Research specialties: X-ray astronomy; normal galaxies; populations of X-ray sources in galaxies; silent supermassive black holes; multiwavelength astrophysics archives and data analysis in the Virtual Observatory. Contact: GFabbiano@cfa.harvard.edu

FORMAN, Christine Jones, Astrophysicist. A.B. (1971) Radcliffe College; A.M. (1972), Ph.D. (1974) Harvard University. Research specialties: X-ray observations of hot gas in galaxies and clusters of galaxies to determine their mass, structure, and cosmological evolution. Contact: CJones@cfa.harvard.edu

FORMAN, William R., Astrophysicist. B.A. (1969) Haverford College; M.A. (1970), Ph.D. (1973) Harvard University. Research specialties: X-ray astronomy; high-energy astrophysics; hot gas in galaxies, galaxy groups, and clusters of galaxies; feedback from supermassive black holes in galaxies. Contact: WForman@cfa.harvard.edu

FRUSCIONE, Antonella, Astrophysicist. Laurea Doctoral Degree (1986) University of Milan; Degree of Advanced Studies (1987) University of Paris. Research specialties: Multiwavelength studies of active galactic nuclei; EUVE and X-ray astronomy; astronomical data analysis. Contact: AFruscione@cfa.harvard.edu

GAETZ, Terrance, Astrophysicist. S.B. (1977) Massachusetts Institute of Technology; M.S. (1980), Ph.D. (1985) Cornell University. Research specialties: X-ray astronomy; supernova remnants; shock physics (radiative and nonradiative); astrophysical gas dynamics; computational physics and astrophysics. Contact: TGaetz@cfa.harvard.edu

GARCIA, Michael R., Astrophysicist. B.A. (1978) Massachusetts Institute of Technology; Ph.D. (1987) Harvard University. Research specialties: multi-wavelength observations of black holes and neutron stars; X-ray binaries; X-ray instrumentation. Contact: MGarcia@cfa.harvard.edu

GOLUB, Leon, Senior Astrophysicist. B.S. (1967) City College of New York; Ph.D. (1972) Massachusetts Institute of Technology. Research specialties: High-resolution X-ray and extreme ultraviolet instrumentation; solar and stellar coronal plasma dynamics and dynamo theory. Contact: LGolub@cfa.harvard.edu

GRAESSLE, Dale E., Astrophysicist. B.S. (1981) University of Missouri, Columbia; Ph.D. (1989) University of Wisconsin. Research specialties: X-ray astronomy; high-energy astrophysics; AGN spectra; instrument calibration; synchrotron radiation. Contact: DGraessle@cfa.harvard.edu

GREEN, Paul J., Astrophysicist. B.A. (1981) Oberlin; Ph.D. (1992) University of Washington, Seattle. Research specialties: Extragalactic X-ray astronomy; quasars and AGN; optical variability surveys; quasar variability; X-ray survey multiwavelength followup; wide separation quasar pairs or lenses; quasar emission and absorption lines; dwarf carbon stars, optical variability surveys for quasars and stars. pgreen@cfa.harvard.edu

JERIUS, Diab, Astrophysicist. B.S. (1984) Wayne State University; Ph.D. (1992) University of Michigan. Research specialties: Numerical cosmology; galaxy cluster evolution. Contact: DJerius@cfa.harvard.edu

KASHYAP, Vinay L., Astrophysicist. M.S. (1993), Ph.D. (1994) University of Chicago. Research specialties: Solar and stellar coronae; diffuse X-ray emission; X-ray analysis algorithms. Contact: Vkashyap@cfa.harvard.edu

KIM, Dong-Woo, Astrophysicist. B.A. (1980) Seoul National University; M.A. (1982) Seoul National University, Ph.D. (1988) University of California, Los Angeles. Research specialties: Multi-wavelength study of ISM in Early Type Galaxies; X-ray Astronomy; Normal Galaxies; Identification of Serendipitous X-ray Sources. Contact: dkim@cfa.harvard.edu

KORRECK, Kelly, Astrophysicist. B.S. (1999), M.S. (2002), Ph.D. (2005) University of Michigan. Research specialties: Space weather, particle acceleration near the Sun, shock physics in supernova remnants and the heliosphere. Contact: kkorreck@cfa.harvard.edu

KRAFT, Ralph P., Physicist. B.S. (1988) University of Pittsburgh; Ph.D. (1995) Pennsylvania State University. Research specialties: Instrumentation for X-ray astronomy, astrophysical jets, hydrodynamics, galaxy mergers, formation of structure. Contact: RKraft@cfa.harvard.edu

McCOLLOUGH, Michael L., Archival Astrophysicist. B.S. (1975), M.S. (1981) Auburn University; Ph.D. (1989) Indiana University. Research specialties: X-ray binaries; microquasars; high-energy astrophysics; multi-wavelength studies; X-ray astronomy; gamma-ray astronomy; supernova remnants. Contact: MMcCollough@cfa.harvard.edu

McDOWELL, Jonathan C., Astrophysicist. B.A. (1981), Ph.D. (1987) Cambridge University. Research specialties: Quasars; black holes; multiwaveband studies; astronomical software. Contact: JMcDowell@cfa.harvard.edu

MONTEZ, Rodolfo, Astrophysicist. Ph.D. (2010) Rochester Institute of Technology. Research specialties: Nebulae; late-type evolved stars;interacting binaries; X-ray astronomy; multiwavelength imaging;imaging science. Contact: rmontez@cfa.harvard.edu

MOORE, Christopher, Samuel, Astrophysicist. B.S. (2010) University of Iowa; M.S. (2014) University of Colorado Boulder, Ph.D. (2017) University of Colorado Boulder, Research specialties: Solar and stellar coronal physics; magnetic field morphology of the solar photosphere, elemental abundance determinations in solar and stellar atmospheres, X-ray and UV instrumentation development, UV-Vis optical coating development, Instrument characterization. Contact: Christopher.s.moore@cfa.harvard.edu

NICHOLS, Joy S., Astrophysicist. B.A. (1968), M.S. (1970) Northwestern University; Ph.D. (1992) University of Amsterdam. Research interests: Winds of massive stars; high-energy plasma physics; high resolution X-ray spectroscopy; variable stars jnichols@cfa.harvard.edu

NULSEN, Paul E.J., Astrophysicist. B.Sc. (1975) University of Western Australia; Ph.D. (1980) Cambridge University. Research specialties: X-ray astronomy; dynamics and gas dynamics; hot gas in galaxies and clusters; active galactic nuclei. Contact: PNulsen@cfa.harvard.edu

PATNAUDE, Daniel, Astrophysicist. B.S. (1995) University of Massachusetts, Amherst; Ph.D. (2005) Dartmouth College. Research specialties: Supernova Remnants; ISM Studies; Cosmic Rays; X-ray Astronomy; Computational Physics; Accretion; Supernovae. Contact: DPatnaude@cfa.harvard.edu

PLUCINSKY, Paul P., Astrophysicist. S.B. (1987) Massachusetts Institute of Technology; Ph.D. (1993) University of Wisconsin, Madison. Research specialties: Local X-ray background; supernova remnants; Interstellar Medium; Nearby Galaxies; X-ray detectors. Contact: PPlucinsky@cfa.harvard.edu

PRESTWICH, Andrea H., Astrophysicist. B.Sc. (1984) Queen Mary College, London; M.Sc. (1985) University of Manchester; Ph.D. (1989) Imperial College, London. Research specialties: Multiwavelength studies of clusters of galaxies; extragalactic star formation. Contact: APrestwich@cfa.harvard.edu

PRIMINI, F. Research Interests: Observational X-ray astronomy, including number counts and distributions of X-ray source populations in the Milky Way and other similar galaxies; surveys of extragalactic X-ray sources; X-ray binaries; searches for compact objects in gravitational microlensing surveys; time-series analysis of X-ray sources; X-ray data analysis. Contact: fprimini@cfa.harvard.edu

RANDALL, S. W., Astrophysicist. B.A. (1997) Wesleyan University; M.S. (2000) University of Virginia; Ph.D. (2005) University of Virginia. Research interests: Galaxy clusters and groups; X-ray astronomy; AGN feedback; physics of the intrascluster medium; large scale structure; numerical astrophysics; dark matter. Contact: srandall@cfa.harvard.edu

REEVES, Katharine, Astrophysicist. B.A. (1996) Reed College; M.S (1999) Northeastern University; Ph.D. (2006) University of New Hampshire. Research specialties: Modeling and data analysis of solar flares and coronal mass ejections. Contact: KReeves@cfa.harvard.edu

REID, Paul B., Senior Astrophysicist. B.A. (1975), M.A. (1977), Ph.D. (1982) Columbia University. Research specialties: X-ray optics. Contact: PReid@cfa.harvard.edu

ROMAINE, Suzanne E., Physicist. B.S. (1974) Michigan State University; S.M. (1986) Harvard University; Ph.D. (1992) Boston University. Research specialties: X-ray optics, deposition of multilayer coatings, thin film coatings, materials science of thin films; low-temperature physics; semiconductor and superconductor device physics. Contact: sromaine@cfa.harvard.edu

SAAR, Steven H., Astrophysicist. B.A. (1980) Northwestern University; Ph.D. (1987) University of Colorado. Research specialties: Solar/stellar magnetic fields, dynamos, and related activity; stellar rotation, convection, and surface features; detection of extrasolar planets. Contact: SSaar@cfa.harvard.edu

SCHWARTZ, Daniel A., Senior Physicist. B.S. (1963) Washington University (St. Louis); M.S. (1966), Ph.D. (1969) University of California, San Diego. Research specialties: X-ray astronomy; Active Galactic Nuclei (AGN) and Extragalactic Jets; Observational Cosmology; X-ray mirror and detector instrumentation. Contact: Dschwartz@cfa.harvard.edu

SIEMIGINOWSKA, Aneta L., Astrophysicist. M.S. (1985) University of Warsaw; Ph.D. (1991) Copernicus Astronomical Center, Poland. Research specialties: Physics of Active Galaxies and Quasars. Evolution of Radio Galaxies. X-ray emission associated with relativistic outflows. Astrostatistics. Contact: asiemiginowska@cfa.harvard.edu

SLANE, Patrick O., Astrophysicist. B.S.E. (1977) University of Wisconsin, Whitewater; M.S. (1983) University of Wisconsin, Milwaukee; Ph.D. (1988) University of Wisconsin, Madison. Research specialties: Galactic X-ray and gamma-ray astronomy; supernova remnants; pulsar wind nebulae; young neutron stars. Contact: pslane@cfa.harvard.edu

SLAVIN, Jonathan David, Astrophysicist. B.S. (1984) Georgetown University; Ph.D. (1990) University of Wisconsin. Research specialties: Theories of the interstellar medium (ISM), especially local ISM (including our local interstellar cloud) and interactions of hot gas and cooler gas; supernova remnant (SNR) evolution; interstellar dust; X-ray, ultraviolet and infrared observations of SNRs and the hot ISM; intracluster medium in rich clusters. Contact: JSlavin@cfa.harvard.edu

SMITH, Randall K., Astrophysicist. B.S (1991) Carnegie Mellon University; Ph.D (1996) University of Wisconsin. Research specialties: X-ray Astronomy: Interstellar Medium, Interstellar Dust, Galaxy Clusters; Atomic Physics: Theoretical Calculations, X-ray Spectroscopy. Contact: rsmith@cfa.harvard.edu

TANANBAUM, Harvey D., Senior Astrophysicist; B.A. (1964) Yale University; Ph.D. (1968) Massachusetts Institute of Technology. Research specialties: X-ray astronomy; quasars. Contact: HTananbaum@cfa.harvard.edu

TESTA, Paola, Astrophysicist. Laurea in Physics (2001), PhD (2005) University of Palermo. Research specialties: Solar and stellar coronal physics; stellar magnetic activity; modeling of coronal loops; X-ray astronomy. Contact: PTesta@cfa.harvard.edu

VIKHLININ, Alexey A., Astrophysicist. B.S. (1993) Moscow Institute of Physics and Technology; Ph.D. (1995) Russian Space Research Institute. Research specialties: X-ray astronomy; clusters of galaxies. Contact: Avikhlinin@cfa.harvard.edu

VRTILEK, Jan M., Astrophysicist. B.A. (1975) University of Wisconsin; A.M. (1976), Ph.D. (1983) Harvard University. Research specialties: Clusters and groups of galaxies; X-ray astronomy; astronomical instrumentation. jvrtilek@cfa.harvard.edu

VRTILEK, Saeqa Dil, Senior Astrophysicist. B.S. (1975) Massachusetts Institute of Technology; M.A. (1979) Brandeis University; Ph.D. (1985), M.Phil. (1985) Columbia University. Research specialties: Optical tomography of X-ray binaries; physics of accretion disks and jets; multiwavelength studies of X-ray binaries and planetary nebulae; science education/public outreach; 3d modeling and classification of XRBs. Contact: svrtilek@cfa.harvard.edu

WARGELIN, Bradford, Astrophysicist. S.B. (1985) Massachusetts Institute of Technology; Ph.D. (1993) University of California, Berkeley. Research specialties: Laboratory X-ray astrophysics: high-resolution spectroscopy, electron impact excitation, and charge exchange; stellar coronae; solar wind charge exchange and soft X-ray background; calibration of X-ray instrumentation. Contact: Bwargelin@cfa.harvard.edu

WEBER, Mark, Astrophysicist. B.S. (1991) Harvey Mudd College; M.S. (1995), Ph.D. (1999) Montana State University. Research specialties: Coronal differential rotation; large-scale structure of corona; magnetic loop models; variation of solar neutrino flux. Contact: MWeber@cfa.harvard.edu

WILKES, Belinda J., Senior Astrophysicist; Director, Chandra X-ray Center. B.Sc.(Hons)(1978) St. Andrews University; Ph.D. (1982) Cambridge University. Research specialties: X-ray and multifrequency studies of quasi-stellar objects including powerful 3CRR radio sources; Multi-wavelength surveys (ChaMP,SWIRE). Contact: BWilkes@cfa.harvard.edu

WOLK, Scott J., Senior Astrophysicist. A.B. (1988) Cornell University; Ph.D. (1996) State University of New York, Stony Brook. Research specialties: Multiwavelength studies of regions of star formation; Evolution of young stars; Stellar flares; Stellar disks; Brown dwarfs; X-ray astronomy; X-ray studies of exoplanets, planets and comets; Next generation of X-ray telescopes. Contact: SWolk@cfa.harvard.edu

ZHAO, Ping, Astrophysicist. B.S. (1981) Peking University; Ph.D. (1986) Yale University. Research specialties: High Energy Astrophysics: X-ray telescopes and their mirrors; multi-wavelength studies of X-ray binaries; black holes; neutron stars; Atomic physics: atomic beams; laser physics; high precision measurements. Contact: PZhao@cfa.harvard.edu

ZUHONE, John A., Astrophysicist. B.S. (2002) University of Illinois at Urbana-Champaign; Ph.D. (2009) University of Chicago. Research specialties: magnetohydrodynamics simulations and X-ray observations of clusters of galaxies; development of software for astrophysical research jzuhone@cfa.harvard.edu

AFFILIATED RESEARCH STAFF

BRISSENDEN, Roger J., Deputy Director, Harvard-Smithsonian Center for Astrophysics; Manager, Chandra X-ray Center. B.S. (1985) University of Adelaide; Ph.D. (1989) Australian National University. Research specialties: Multiwavelength studies of active galactic nuclei; BL Lac objects; Science Center and Mission Operations. Contact: RBrissenden@cfa.harvard.edu

EVANS, Nancy R., Astrophysicist. B.A. (1966) Wellesley College; M.Sc. (1969), Ph.D. (1974) University of Toronto. Research specialties: Cepheid masses and luminosities; binary stars (star formation); visual and ultraviolet observations of intermediate mass stars; X-ray observations of star clusters.

GORENSTEIN, Paul, Senior Astrophysicist. B.E.P. (1957) Cornell University; Ph.D. (1962) Massachusetts Institute of Technology. Research specialties: X-ray astronomy; grazing incidence and diffractive X-ray telescopes; instrumentation for X-ray astronomy; supernova remnants; clusters of galaxies.

GRINDLAY, Jonathan E., Robert Treat Paine Professor of Astronomy, Harvard University. A.B. (1966) Dartmouth College; A.M. (1969), Ph.D. (1971) Harvard University. Research specialties: High energy astrophysics; X-ray observations and models of compact Objects in binaries in globular clusters; active galaxies; gamma-ray bursts; development of hard X-ray imaging detectors and telescopes; time domain astrophysics and surveys. Contact: JGrindlay@cfa.harvard.edu

KAROVSKA NEILY, Margarita, Astrophysicist. Ph.D. (1984) Universite de Nice. Research specialties: Late-spectral-type stars; interacting binaries; AGN; multiwavelength high angular resolution imaging, and interferometry; X-ray astronomy; solar corona. Contact: MKarovska@cfa.harvard.edu

KENTER, Almus, Astrophysicist. B.S. (1982) Columbia University; M.S. (1984), Ph.D. (1989) University of Wisconsin. Research specialties: X-ray detector and instrumentation development; X-ray astronomy of compact objects; TeV gamma-ray astronomy and detector technology. Contact: Akenter@cfa.harvard.edu

MACHACEK, Marie Esther, Astrophysicist. B.A. (1969) Coe College; M.S. (1970) University of Michigan; Ph.D. (1973) University of Iowa. Research specialties: Galaxy interactions and evolution; X-ray studies of hot gas in galaxies, clusters, and groups. Contact: MMachacek@cfa.harvard.edu

MATTISON, Edward M., Physicist. B.S. (1963) Queens College of the City University of New York; Ph.D. (1974) Massachusetts Institute of Technology. Research specialties: Hydrogen masers; high-stability frequency standards. Contact: Emattison@cfa.harvard.edu

ROTS, Arnold H., Astrophysicist. B.Sc. (1967), M.Sc. (1971), Ph.D. (1974) University of Groningen, Netherlands. Research specialties: Interstellar medium in extended galaxies; dynamics of galaxies; study of pulsars, in particular timing; data analysis algorithms; time keeping; data archives; Virtual Observatory. Contact: ARots@cfa.harvard.edu

SEWARD, Frederick D, Astrophysicist. AB (1953) Princeton University; PhD (1958) University of Rochester. Research specialties: X-ray astronomy; Supernova remnants; Neutron Stars. fseward@cfa.harvard.edu

TUCKER, Wallace H., Astrophysicist, Senior Theoretician. B.S. (1961), M.S. (1962) University of Oklahoma; Ph.D. (1966) University of California. Research specialties: High-energy astrophysics. Contact: WTucker@cfa.harvard.edu

ZEZAS, Andreas, Astrophysicist. B.Sc. (1997) University of Patras, Greece; Ph.D. (2000) University of Leicester, United Kingdom. Research specialties: X-ray astronomy; discrete X-ray sources in galaxies; X-ray binaries, supernova remnants; multiwavelength observations of galaxies; galaxy interactions; low-luminosity active galactic nuclei. Contact: Azezas@cfa.harvard.edu

Optical and Infrared Astronomy

Research in this division spans extragalactic and galactic astronomy, with special emphases on cosmology, the large-scale structure of the universe, cosmic gamma-ray sources, clusters of galaxies, clusters of stars, the halo of our galaxy, and the formation and evolution of stars and galaxies. Observations are made from orbiting observatories including the Hubble Space Telescope and the Spitzer Space Telescope, as well as from ground-based observatories such as the MMT, Magellan, and FLWO. SAO/CfA astronomers were the first to uncover the large-scale structure of the distribution of galaxies in space and the acceleration of the Universe. Division scientists have also led the exploration of the very high energy (TeV) gamma-ray universe using atmospheric Cherenkov telescopes. OIR scientists are heavily involved in the analysis of Spitzer data and led the development of the Infrared Array Camera (IRAC) for Spitzer. They are active in the development of both advanced optical and infrared instruments for existing ground-based facilities, and instruments for the next generation of large optical/infrared telescopes, including the Giant Magellan Telescope (GMT). GMT is a 25-m telescope with seven 8.4-m primary segments, four of which have already been cast. Division scientists are developing concepts for next generation space satellite missions.

RESEARCH STAFF

ASHBY, Matthew L. N., Astrophysicist. B.A. (1988) University of Colorado; M.S. (1991), Ph.D. (1995) Cornell University. Research specialties: Infrared properties of nearby and distant galaxies; active galactic nuclei; galaxy evolution; radiative transfer. Contact: mashby@cfa.harvard.edu

BENBOW, Wystan, Astrophysicist, VERITAS. B.S. (1996) University of Iowa; M.S. (1998) University of California, Santa Cruz; Ph.D. (2002) University of California, Santa Cruz. Research specialties: Very-high-energy (E > 100 GeV) Gamma-ray Astronomy; Active Galactic Nuclei; PI of the VERITAS experiment (http://veritas.sao.arizona.edu); Member of the CTA experiment http://www.cta-observatory.org). Contact: wbenbow@cfa.harvard.edu

BROWN, Warren R., Astrophysicist. B.S. (1995) University of Arizona; A.M. (1998), Ph.D. (2002) Harvard University. Research specialties: Hypervelocity stars; Merging white dwarf binaries; Stellar halo of the Milky Way; Optical and infrared instruments for ground-based telescopes. Contact: wbrown@cfa.harvard.edu

CALDWELL, Nelson, Astronomer. B.A. (1976) University of South Florida; Ph.D. (1982) Yale University. Research specialties: M31; star clusters in galaxies; dwarf galaxies; star formation in galaxies. Contact: ncaldwell@cfa.harvard.edu

CHILINGARIAN, Igor, Astronomer, Telescope Data Center, Optical and Infrared Astronomy Division. M.Sc. (2003) Moscow State University, (Russia); Ph.D. (2006) University of Lyon-1, (France) and Moscow State University, (Russia). Research interests: Galaxy evolution; stellar populations; data archives; Virtual Observatory; astronomical data analysis. Contact: igor.chilingarian@cfa.harvard.edu

DANIEL, Michael K., Physicist; VERITAS. M.Phys (1999) University of Leeds; Ph.D. (2002) University of Durham. Research specialties: instrumentation for ground-based gamma ray astronomy; astroparticle physics; fundamental physics; stellar intensity interferometry; atmospheric monitoring. Contact: michael.daniel@cfa.harvard.edu

FABRICANT, Daniel G., Senior Physicist; Associate Director, Optical and Infrared Astronomy Division, Harvard-Smithsonian Center for Astrophysics. B.S. (1974) Massachusetts Institute of Technology; Ph.D. (1978) Harvard University. Research specialties: Galaxy clusters; galaxy evolution; large-scale structure; instrumentation for optical and infrared astronomy. Contact: dfabricant@cfa.harvard.edu

FALCO-ACOSTA, Emilio, Astronomer. B.S., M.S. (1983), Ph.D. (1986) Massachusetts Institute of Technology. Research specialties: Observational cosmology; estimation of cosmological parameters and studies of galaxy evolution; searches for and studies of gravitational lenses in all-sky surveys; searches for extrasolar planets. Contact: efalco@cfa.harvard.edu

FAZIO, Giovanni G., Senior Physicist. B.S. (1954), B.A. (1954) St. Mary's University, Texas; Ph.D. (1959) Massachusetts Institute of Technology. Research specialties: Infrared astronomy, including satellite and ground-based observations using infrared array cameras; the early universe; star formation and evolution; brown dwarfs; and ultraluminous galaxies. Contact: gfazio@cfa.harvard.edu

FORTIN, Pascal, Physicist, Site Director, Fred Lawrence Whipple Observatory, Optical and Infrared Astronomy Division, Harvard-Smithsonian Center for Astrophysics. B. Sc. (1999) McGill University; PhD (2005) McGill University. Research specialties: Active galactic nuclei; gamma-ray astronomy; astroparticle physics. Contact: pafortin@cfa.harvard.edu

GELLER, Margaret, Senior Astronomer. A.B. (1970) University of California, Berkeley; Ph.D. (1975) Princeton University; DSHC (1995) Connecticut College; DSHC (1997) Gustavus Adolphus College; DSHC (2000) University of Massachusetts (Dartmouth); DSHC (2009) Colby College; DSHC (2009) Universitat Rovira i Virgili (Tarragona, Spain); DSHC (2014) Dartmouth College; DSHC (2017) University of Turin (Italy). Research specialties: Extragalactic astronomy and cosmology; mapping the universe; the formation and history of galaxies like the Milky Way; matter distribution in the universe; structure of the Milky Way; black holes and hypervelocity stars. Contact: mgeller@cfa.harvard.edu

HORA, Joseph L., Astronomer; IRAC Program Scientist. B.A. (1985) Northwestern University; Ph.D. (1991) University of Arizona. Research specialties: Infrared astronomy; infrared instrumentation; star formation; planetary nebulae. Contact: jhora@cfa.harvard.edu

HUGHES, Gareth, Astrophysicist, VERITAS. M.Phys (2003) University of Manchester, UK; Ph.D. (2009) Rutgers University. Research specialties: Very-high-energy (E > 100 GeV) Gamma-ray Astronomy; Active Galactic Nuclei. Deputy Operations Manager for the VERITAS experiment (http://veritas.sao.arizona.edu);Member of the CTA experiment (http://www.cta-observatory.org). Contact: gareth.hughes@cfa.harvard.edu

KOPON, Derek, Instrument scientist, Central Engineering Division, Smithsonian Astrophysical Observatory. B.S. (2002) Cornell University; M. Eng. (2003) Cornell University; Ph.D. (2012) University of Arizona. Research specialties: optical and infrared astronomical instrumentation; adaptive optics; high resolution imaging. Contact: derek.kopon@cfa.harvard.edu

KURTZ, Michael J., Senior Astronomer. B.A. (1977) San Francisco State University; Ph.D. (1982) Dartmouth College. Research specialties: Observational cosmology; galaxy photometry and spectroscopy; image- processing techniques; numerical classification methods; scientific information systems; digital libraries. Contact: mkurtz@cfa.harvard.edu

LACASSE, Marc G., Engineer/Instrument Support Scientist. B.A. (1976) Dartmouth College; M.A. (1978), Ph.D. (1984) University of Rochester. Research specialties: Instrument support, astronomical spectroscopy & imaging, interferometry; image reconstruction; light scattering; polarization. Contact: mlacasse@cfa.harvard.edu

MELNICK, Gary J., Senior Astronomer, Optical and Infrared Astronomy Division, Harvard-Smithsonian Center for Astrophysics. B.S. (1974) Cornell University; M.S. (1979) Cornell University; Ph.D. (1980) Cornell University. Research specialties: Star and planet formation, astrochemistry, instrumentation for airborne, balloon, and space-based infrared and submillimeter astronomy. Contact: gmelnick@cfa. harvard.edu

McLEOD, Brian A., Astronomer. B.A. (1988) Cornell University; Ph.D. (1994) University of Arizona. Research specialties: Optical and infrared instrumentation; gravitational lensing; galaxy evolution. Contact: bmcLeod@cfa.harvard.edu

MORAN, Sean M., IT Specialist; Instrument Support & Data Archive Scientist, Telescope Data Center, Optical and Infrared Astronomy Division. A.B. (2002) Harvard College; Ph.D. (2008) California Institute of Technology. Research specialties: Galaxy evolution; galaxy clusters; optical spectroscopy. Contact: smoran@cfa.harvard.edu

PAEGERT, Martin, IT-Specialist, Telescope Data Center (TDC), Harvard-Smithsonian Center for Astrophysics. Masters of Physics (1995) at Ruhr-Universitaet Bochum (Germany); Ph.D. (2007) at Ruhr-Universitaet Bochum (Germany). Research specialties: astro-informatics, telescope automation, exoplanets, neural networks. Contact: martin.paegert@cfa.harvard.edu

RHEE, Jaehyon (Jay), Data Archive Scientist, Optical and Infrared Astronomy Division, Harvard-Smithsonian Center for Astrophysics. B.S. (1991) Yonsei University, (S. Korea); M.S. (1993) Yonsei University, (S. Korea); Ph.D. (2000) Michigan State University. Research specialties: stellar abundance analysis; old stellar clusters and populations; Galactic structure; astrostatistics. Contact: jrhee@cfa.harvard.edu

SMITH, Howard A., Senior Astrophysicist. S.B. (1966), S.B. (2) (1966) Massachusetts Institute of Technology; Ph.D. (1976) University of California, Berkeley. Research specialties: Galactic and extragalactic star formation; infrared spectroscopy; instrumentation; Spitzer (IRAC team); Herschel Space Observatory; Infrared Space Observatory; education and public outreach activities. Contact: hsmith@cfa.harvard.edu

TOLLS, Volker, Astronomer. Diploma (1988), Ph.D. (1992) University of Cologne. Research specialties: Design and test of radio telescope instrumentation, ground-based and spaceborne, millimeter-to- infrared astronomy; interstellar chemistry; planet detection and imaging; coronagraphic techniques. Contact: vtolls@cfa.harvard.edu

WILLNER, Steven P., Astronomer. A.B. (1971) Harvard College; Ph.D. (1976) California Institute of Technology. Research specialties: Infrared observations of galaxies, both nearby and distant; Development of infrared instruments. Contact: swillner@cfa.harvard.edu

AFFILIATED RESEARCH STAFF

BERGER, Edo, Professor of Astronomy, Harvard University. B.S. (1999) University of California, Los Angeles; M.S. (2001) California Institute of Technology; Ph.D. (2004) California Institute of Technology. Research Specialties: observational time domain astrophysics, high-energy astrophysics. Contact: eberger@cfa.harvard.edu

CONROY, Charlie, Associate Professor of Astronomy, Harvard University. B.A. (2005) UC Berkeley; Ph.D. (2010) Princeton University. Research specialties: Observational and theoretical galaxy evolution, stars and stellar populations. Contact: cconroy@cfa.harvard.edu

EISENSTEIN, Daniel J., Professor of Astronomy, Harvard University. A.B. (1992) Princeton University; A.M. (1994), Ph. D. (1996) Harvard University. Research specialties: Theoretical and observational cosmology and galaxy evolution. Contact: deisenstein@cfa.harvard.edu

Radio and Geoastronomy

Research in the SAO Radio and Geoastronomy Division includes investigations of a wide range of astrophysical phenomena and the development of new technologies. Division staff operate the Submillimeter Array (SMA), an eight-element interferometer sited on Mauna Kea, Hawaii for high-resolution observations of celestial objects at submillimeter wavelengths. Other facilities include a small millimeter wavelength telescope dedicated to mapping emission from molecular clouds in the Milky Way. Astronomical observations are also carried out with major national and international radio telescopes, including the Atacama Large Millimeter/submillimeter Array, the NRAO Very Large Array and Very Long Baseline Array, the IRAM 30-m Telescope and NOEMA interferometer, and the South Pole Telescope. Astronomical research programs involve the cosmic microwave background, the epoch of reionization, the evolution of galaxies over cosmic time, the structure of the Milky Way, the formation of stars, the formation of planets in circumstellar disks, the physics and chemistry of the interstellar medium, interstellar masers, and the planets and comets in our Solar System. In addition, Division astronomers are leading the development of the Event Horizon Telescope, to directly image the immediate environment of a black hole, taking advantage of technological advances in very long baseline interferometry at millimeter and submillimeter wavelengths and digital signal processing.

RESEARCH STAFF

ANDREWS, Sean M., Astrophysicist. B.A. (1997) Northwestern University; M.S. (2003), Ph.D. (2007) University of Hawaii. Research specialties: circumstellar disks, planet formation, aperture synthesis observations, radiative transfer modeling. Contact: SAndrews@cfa.harvard.edu

BLUNDELL, Raymond, Director, Submillimeter Array. B.S. (1974), Ph.D. (1980) University of Leeds. Research specialties: Millimeter-wave and submillimeter-wave techniques and instrumentation for radio-astronomy; THz spectral line astronomy. Contact: RBlundell@cfa.harvard.edu

DAME, Thomas M., Senior Radio Astronomer. B.A. (1976) Boston University; M.A. (1978), Ph.D. (1983) Columbia University. Research specialties: Molecular clouds and star formation; galactic structure. Contact: TDame@cfa.harvard.edu

DOELEMAN, Sheperd, Director, Event Horizon Telescope. B.A. (1986) Reed College; Ph.D (1995) Massachusetts Institute of Technology. Research specialties: Wideband instrumentation and systems for interferometry; ultra-high angular resolution observations of black hole to resolve and image the event horizon. Contact: sdoeleman@cfa.harvard.edu

GOTTLIEB, Carl, Astrophysicist. Sc.B. (1963) Lawrence College; Ph.D. (1969) University of Chicago. Research specialties: Laboratory astrophysics; interstellar molecules. Contact: CGottlieb@cfa.harvard.edu

GREENHILL, Lincoln J., Radio Astronomer. B.S. (1984) Massachusetts Institute of Technology; M.A. (1985), Ph.D. (1990) Harvard University. Research specialties: Cosmology–the epoch of reionization (instrumentation/observation), extragalactic distance scale; AGN–structures < 1 pc from supermassive black holes; high-mass star formation–innermost 1000 AU; late-type stars-circumstellar shells; masers. Contact: LGreenhill@cfa.harvard.edu

GRIMES, Paul K., Physicist. B.A. (2001), M.Sc. (2001), Ph.D. (2006) University of Cambridge. Research specialties: Millimeter and submillimeter receivers for radioastronomy. Contact: PGrimes@cfa.harvard.edu

GURWELL, Mark Andrew, Astrophysicist. Sc.B. (1990) University of Washington; Sc.M. (1992), Ph.D. (1996) California Institute of Technology. Research specialties: Milimeter/submillimeter-wave spectroscopy of planets and planetary atmospheres; planetary atmospheric evolution; KBO temperature and size measurements; interferometry; mm/submm observing techniques and absolute flux calibration; detection of high-z galaxies ('submm galaxies'); long-term quasar monitoring. Contact: MGurwell@cfa.harvard.edu

JOHNSON, Michael D., Astrophysicist. B.A. (2007) University of Southern California; M.A. (2010), Ph.D. (2013) University of California, Santa Barbara. Research specialties: Black holes, the Event Horizon Telescope, radio interferometry, pulsars, interstellar propagation and scintillation. Contact: MJohnson@cfa.harvard.edu

KEATING, Garrett K., Physicist. B.A. (2008), M.A. (2012), Ph.D. (2016) University of California, Berkeley. Research specialties: Radio astronomy and interferometry; galaxies in the early Universe; molecular gas; cosmological measurements with intensity mapping; realtime/automated processing and calibration of interferometric data. Contact: GKeating@cfa.harvard.edu

LADA, Charles J., Senior Astrophysicist. B.A. (1971) Boston University; Ph.D. (1975) Harvard University. Research specialties: Star formation in galaxies; dense molecular clouds; bipolar molecular outflows; protoplanetary disks, extremely young star clusters; interstellar medium; infrared and millimeter-wave observational astronomy. Contact: CLada@cfa.harvard.edu

MORAN, James M., Senior Radio Astronomer; Professor of Astronomy, Harvard University. B.S. (1963) University of Notre Dame; S.M. (1965), Ph.D. (1968) Massachusetts Institute of Technology. Research specialties: Radio astronomy; very long-baseline interferometry; cosmic masers; star-formation studies; active galactic nuclei, black holes (especially the one in the center of the Milky Way). Contact: JMoran@cfa.harvard.edu

MYERS, Philip C., Senior Astrophysicist. A.B. (1966) Columbia University; Ph.D. (1972) Massachusetts Institute of Technology. Research specialties: Radio astronomy; physical processes in molecular clouds and star formation; interstellar molecules; molecular spectroscopy; protostars; gravitational infall and condensation; magnetic fields and turbulence; formation of groups and clusters. Contact: PMyers@cfa.harvard.edu

PAINE, Scott N., Astrophysicist. B.S. (1984) California Institute of Technology; Ph.D. (1992) Massachusetts Institute of Technology. Research specialties: Atmospheric radiometry, spectroscopy, and radiative transfer modeling; radio meteorology and climatology of astronomical observing sites; millimeter- and submillimeter-wave instrumentation. Contact: SPaine@cfa.harvard.edu

PATEL, Nimesh A., Radio Astronomer and General Engineer. M.Sc. (1984) Bombay University; Ph.D. (1990) Indian Institute of Science, Bangalore. Research specialties: Evolved stars; Molecular spectroscopy; Star formation; Astrophysical masers; Radio interferometry; Antenna pointing and metrology; instrumentation and software. Contact: NPatel@cfa.harvard.edu

PEARLMAN, Michael R., Physicist. S.B. (1963) Massachusetts Institute of Technology; Ph.D. (1968) Tufts University; S.M. (1980) MIT Sloan School of Management. Research specialties: Laser ranging to satellites; application of space techniques to precision geodesy for Earth Science. Contact: MPearlman@cfa.harvard.edu

PETITPAS, Glen R., Computer Engineer. B.Sc. (1995) St. Mary's, NS; M.Sc. (1997), Ph.D. (2001) McMaster University, ON. Research specialties: Submillimeter Interferometry. Contact: GPetitpas@cfa.harvard.edu

QI, Chunhua, Astrophysicist. B.S. (1995) Beijing University; Ph.D. (2001) California Institute of Technology. Research specialties: Protoplanetary disks; comets; interferometer software. Contact: CQi@cfa.harvard.edu

REID, Mark J., Senior Radio Astronomer. B.A. (1971) University of California, San Diego; Ph.D. (1975) California Institute of Technology. Research specialties: Radio astronomy, including spectral-line very long-baseline interferometry; star formation; cosmic masers; active galactic nuclei and quasars; galactic structure and evolved stars. Contact: MReid@cfa.harvard.edu

SHAPIRO, Irwin I., Senior Scientist, Smithsonian Institution; Timken University Professor, Harvard University. A.B. (1950) Cornell University; A.M. (1951), Ph.D. (1955) Harvard University. Research specialties: Radio and radar techniques: applications to astrometry, astrophysics, geophysics, planetary physics, and tests of theories of gravitation; precollege and college science education: curriculum development and teacher training. Contact: IShapiro@cfa.harvard.edu

STARK, Antony A., Senior Astronomer. B.S. (1975) California Institute of Technology; M.A. (1977), Ph.D. (1979) Princeton University. Research specialties: Antarctic astronomy; radio astronomical instrumentation; interstellar medium; galactic structure; cosmic background radiation; Sunyaev-Zel'dovich effect observations; telescope control and data acquisition. Measurement of cosmological parameters and neutrino properties via observations of galaxy clusters discovered by the South Pole Telescope. Contact: AStark@cfa.harvard.edu

TIRUPATI, Sridharan K, Astronomer/Engineer. E.B. (1985) Madras University; Ph.D. (1993) Indian Institute of Science. Research specialties: Molecular clouds; star formations; radio holography. Contact: TKSridharan@cfa.harvard.edu

TONG, Edward C., Engineer. B.Sc. (1983) University of Hong Kong; Ph.D. (1988) University of Joseph Fourier, Grenoble. Research specialties: Instrumentation for millimeter- and submillimeter-wave astronomy. Contact: ETong@cfa.harvard.edu

WEINTROUB, Jonathan, Electrical Engineer. B.Sc.(Eng) (1983), M.Sc.(Eng) (1986) University of Cape Town; Ph.D. (1998) Harvard University. Research specialties: Astronomy digital signal processing (DSP); Radioastronomy correlators and phased arrays for Submillimeter Array and ALMA; Astronomical masers; Instrumentation for the Event Horizon Telescope (EHT). Contact: JWeintroub@cfa.harvard.edu

WILNER, David James, Associate Director, Radio and Geoastronomy Division, Harvard Smithsonian Center for Astrophysics. A.B. (1987) Princeton University; Ph.D. (1993) University of California, Berkeley. Research specialties: Star and planet formation; protoplanetary disks and debris disks; aperture synthesis observations and interferometry techniques. Contact: DWilner@cfa.harvard.edu

WILSON, Robert Woodrow, Senior Scientist, part time. B.A. (1957) Rice University; Ph.D. (1962) California Institute of Technology. Research specialties: Radio astronomy; cosmic background; millimeter and submillimeter spectroscopy; telescope system design; submillimeter synthesis; radio communication. Contact: RWilson@cfa.harvard.edu

ZENG, Lingzhen, Physicist. B.A. (2005) University of Science and Technology, China; Ph.D. (2012) Johns Hopkins University. Research Specialties: Millimeter and submillimeter instrumentation and the interstellar medium. Contact: Lingzhen.Zeng@cfa.harvard.edu

ZHANG, Qizhou, Senior Astrophysicist. M.S. (1993), Ph.D. (1996) Harvard University. Research Specialties: Molecular clouds and star formation; study of infall motions, disks, outflows, fragmentation and magnetic fields in star-forming regions. Contact: QZhang@cfa.harvard.edu

ZHAO, Jun-Hui, Astrophysicist. B.S. (1982), M.S. (1985) Peking University; Ph.D. (1990) University of New Mexico. Research specialties: The Galactic center, dynamics of circum-nuclear disks, black holes, star formation, starbursts, AGNs, imaging techniques and interferometer software. Contact: JZhao@cfa.harvard.edu

AFFILIATED RESEARCH STAFF

GOODMAN, Alyssa A., Research Associate of SAO; Professor of Astronomy, Harvard University; Founding Director of the Harvard Initiative in Innovative Computing. Sc.B. (1984) Massachusetts Institute of Technology; A.M. (1986), Ph.D. (1989) Harvard University. Research specialties: Radio through optical observations of the interstellar medium and star formation; special interests in velocity structure, magnetic fields, polarimetry; Scientific Data Visualization. Contact: AGoodman@cfa.harvard.edu

Solar, Stellar, and Planetary Sciences

Research in the SSP Division is directed toward understanding star and planet formation and the physical processes in the Sun, stars, and stellar systems. Division research on the Sun addresses its basic stellar properties, its atmosphere and corona, and its effects on the Earth. Studies of other stars seek to measure the age and chemical composition and to understand the structure of surrounding disks, magnetic fields, and winds. Searches for objects in our own solar system and for extra-solar planets inform theoretical investigations of star and planet formation and evolution. Observational data are obtained from ground-based observatories (such as the MMT Observatory, Magellan, and the Whipple Observatory) and from satellites including the Solar and Heliospheric Observatory, the Transition Region and Coronal Explorer, the Far Ultraviolet Spectrographic Explorer, the Hubble Space Telescope, the Chandra X-ray Observatory, and the Spitzer Space Telescope.

RESEARCH STAFF

AVRETT, Eugene H., Senior Physicist. B.S. (1957) Georgia Institute of Technology; Ph.D. (1962) Harvard University. Research specialties: Theory of stellar atmospheres and spectra; models of solar and stellar atmospheres; computer simulation of solar, stellar, and nebular spectra. Contact: EAvrett@cfa.harvard.edu

CRANMER, Steven R., Astrophysicist. B.S. (1990) Drexel University; M.S. (1991) Ohio State University; Ph.D. (1996) University of Delaware. Research specialties: Heating of the solar corona and acceleration of the solar wind; Plasma physics and kinetic theory of waves and turbulence; Rotating hot stars (O, B, Wolf-Rayet) and circumstellar fluid dynamics; Radiative transfer and spectroscopy.

DUPREE, Andrea K., Senior Astrophysicist. B.A. (1960) Wellesley College; Ph.D. (1968) Harvard University. Research specialties: Astronomical s>pectroscopy; theory of solar and stellar atmospheres and spectra; stellar chromospheres and coronae; mass loss and stellar winds. Contact: ADupree@cfa.harvard.edu

GINGERICH, Owen, Senior Astronomer Emeritus; Professor of Astronomy and the History of Science Emeritus, Harvard University. B.A. (1951) Goshen College; M.A. (1953), Ph.D. (1962) Harvard University. Research specialties: History of astronomy, especially the sixteenth to twentieth centuries.

IRWIN, Jonathan M., Astronomer. B.A., M.Sci. (2004); M.A., Ph.D. (2007) University of Cambridge. Research specialties: Robotic telescope operations; very low-mass eclipsing binaries; rotational evolution of low-mass stars. Contact: JIrwin@cfa.harvard.edu

KALKOFEN, Wolfgang, Astrophysicist. Vordiplom (1956) Goethe University, Germany; M.A. (1961), Ph.D. (1963) Harvard University. Research specialties: Radiative transfer in continua and in spectral lines through static and moving media; radiative gas dynamics; propagation and dissipation of shock waves in stellar atmospheres.

KENYON, Scott J., Senior Astrophysicist. B.S. (1978) Arizona State University; M.S. (1979), Ph.D. (1983) University of Illinois. Research specialties: Numerical calculations of planet formation; structure of debris disks; the formation and evolution of single and multiple stars; accretion disks. Contact: SKenyon@cfa.harvard.edu

KORZENNIK, Sylvain G., Physicist. Degree of Engineering (1977) Free University of Brussels; Ph.D. (1990) University of California, Los Angeles. Research specialties: Astronomy; solar physics; helioseismology; astroseismology; extrasolar planets. Contact: SKorzennik@cfa.harvard.edu

LATHAM, David W., S.B. Massachusetts Institute of Technology (1961), Ph.D. Harvard University (1970); The search for and characterization of exoplanets, binary and multiple star characteristics of various stellar populations in the Galaxy, the chemical and kinematical history of the Galaxy, telescopes and instrumentation, NASA's Kepler mission, NASA's Transiting Exoplanet Survey Satellite. Contact: DLatham@cfa.harvard.edu

LOPEZ-MORALES, M. Mercedes, Staff Astrophysicist. B.S. (1996) Universidad de La Laguna, Spain; M.S. (2001), Ph.D. (2004) University of North Carolina at Chapel Hill. Research specialties: Exoplanet detection and characterization; exoplanet atmospheres; extrasolar bio-signatures; low-mass stars. Contact: MLopez-Morales@cfa.harvard.edu

MEIBOM, SØren, Astronomer. M.S. (1999) University of Copenhagen; Ph.D. (2005) University of Wisconsin. Research specialties: Observational studies of the rotation of stars as a function of mass and age with a special focus on members of open clusters with known ages; searches for transiting planets in open clusters; surveys of open clusters to determine membership and binarity. SMeibom@cfa.harvard.edu

MIRALLES, Mari Paz, Astrophysicist. M.Sc. (1989), Ph.D. (1993) Complutense University of Madrid. Research specialties: Solar physics: solar corona, ultraviolet spectroscopy of solar-wind source regions; star formation: radio astronomy, molecular clouds, OB stars, ultracompact H II regions, infrared imaging and spectroscopy. Contact: MMiralles@cfa.harvard.edu

NOYES, Robert W., Astrophysicist; Professor of Astronomy, Harvard University. B.A. (1957) Haverford College; Ph.D. (1963) California Institute of Technology. Research specialties: Solar and stellar physics; solar structure and dynamics; detection and characterization of planets around other stars; origin and evolution of planetary systems. Contact: Rnoyes@cfa.harvard.edu

PANASYUK, Alexander V., Computer Scientist. M.S. (1988) Moscow Physical Technical Institute; Ph.D. (1992) Acoustics Institute of the Russian Academy of Sciences, Moscow. Research specialties: Propagation of acoustical waves in nonlinear media; numerical analysis and simulation; software development for data acquisition and control systems.

PETAEV, Michail, Senior Geologist. M.A. (1979) Moscow State University; Ph.D. (1985) Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow. Research specialties: Experimental and theoretical cosmochemistry; petrologic and chemical studies of the meteoritic record of events and processes in the primordial solar nebula; thermodynamic and kinetic modeling of nebular condensation and igneous and aqueous processes on asteroids. Contact: MPetaev@cfa.harvard.edu

RAYMOND, John C., Astrophysicist. B.A. (1970), Ph.D. (1976) University of Wisconsin, Madison. Research specialties: Supernova remnants; solar physics; cataclysmic variables. Contact: JRaymond@cfa.harvard.edu

SOON, Willie, Astrophysicist. B.Sc. (1985), M.Sc. (1987), Ph.D. (1991)[with distinction] University of Southern California. Research specialties: Observational analysis and physical modeling of phenomena relevant to the Sun, Sun-like stars, and the Earth. Contact: WSoon@cfa.harvard.edu

SPAHR, Timothy, Astronomer. B.S. (1993) University of Arizona; Ph.D. (1998) University of Florida. Research specialties: Distribution of asteroids; sky surveys for near-Earth objects; determination of orbits.

SZENTGYORGYI, Andrew H., Associate Director, B.S. (1979) S.U.N.Y. at Stony Brook, M.S. (1983), Ph.D. (1986) University of Wisconsin, Madison. Research specialties: exoplanets, stellar astronomy, precision radial velocity surveys; high dispersion spectroscopy; instrumentation. Contact: ASzentgyorgyi@cfa.harvard.edu

VAN BALLEGOOIJEN, Adriaan, Astrophysicist. Ph.D. (1982) State University of Utrecht. Research specialties: Solar magnetic fields; magnetohydrodynamics; nonthermal heating of the solar atmosphere; solar prominences.

AFFILIATED RESEARCH STAFF

BUCHHAVE, Lars A., Research Associate, Harvard University. Ph.D. (2010) University of Copenhagen. Research specialties: Detection and characterization of exoplanets and spectroscopic characterization of exoplanet hosts stars.

CHARBONNEAU, David B., Thomas D. Cabot Associate Professor of Astronomy, Harvard University. Hons B.Sc. (1996) University of Toronto; A.M (1999), Ph.D. (2001) Harvard University. Research specialties: Detection and characterization of planets orbiting nearby stars; design and implementation of automated telescopes for photometric monitoring. Contact: DCharbonneau@cfa.harvard.edu

FRANKLIN, Fred A., Astronomer and Physicist. B.A. (1954) Harvard College; M.A. (1956), Ph.D. (1962) Harvard University. Research specialties: Planetary photometry; stability problems; investigations of concentration and scattering properties of small particles in the solar system; techniques and instrumentation to measure the Earth's albedo.

JOHNSON, John A., Professor of Astronomy, Harvard University. B.S. (2000) Physics Missouri University of Science and Technology, M.A. (2002) Astronomy UC Berkeley, Ph.D. (2007) Astronomy UC Berkeley. Research specialties: detection and characterization of planets orbiting nearby stars; stellar astrophysics; design and implementation of robotic telescopes for highly precise radial velocity monitoring of bright stars.

KURUCZ, Robert L., Research Associate. A.B. (1966) Harvard College; Ph.D. (1973) Harvard University. Research specialties: Radiative transfer; stellar atmospheres; solar physics; atomic and molecular spectroscopy. Contact: RKurucz@cfa.harvard.edu

ÖBERG, Karin I., Assistant Professor of Astronomy, Harvard University. B.Sc. (2005) California Institute of Technology, Ph.D. (2009) Leiden University. Research specialties: Astrochemistry; laboratory astrophysics; molecular processes during star and planet formation. Contact: KOberg@cfa.harvard.edu

SASSELOV, Dimitar, Professor, Harvard University. M.Sc. (1986), Ph.D. (1988) University of Sofia; Ph.D. (1990) University of Toronto. Research specialties: Stellar pulsation; radiation hydrodynamics; stellar spectroscopy; extrasolar planets.

STRACHAN, Leonard, Research Associate. S.B. (1982) Massachusetts Institute of Technology; A.M. (1987), Ph.D. (1990) Harvard University. Research specialties: Solar physics; ultraviolet spectroscopy; development of space-based instruments. Contact: StrachanL22@si.edu

Science Education Department

The SAO/CfA Science Education Department (SED) conducts fundamental research and creates products and programs designed to improve the teaching and learning of science, technology, engineering and mathematics (STEM), in precollege classroom environments as well as museum and out-of-school learning settings. SED staff includes scientists and science educators, educational researchers, research methodologists, and education technology developers. Ongoing and recent major projects include: the research, development, and validation of misconception-based assessment instruments; research into identifying measurable factors that predict levels of achievement by students in both K-12 science and introductory college STEM courses, including massive open online courses (MOOCs); examination of professional development programs and their impact on teacher participants; research into identifying variables that predict persistence of students within the STEM pipeline, particularly for females and underrepresented minorities, and the development of science identity. SAO's science education innovations have included: programs that integrate the CfA's robotic telescopes and authentic inquiry into classroom, museum, and out-of-school learning environments; the development and evaluation of museum exhibitions and programs; and the creation of innovative curriculum and technology-based tools for STEM learning.

RESEARCH STAFF

DUSSAULT, Mary E., Instructional Systems Specialist, SAO. B.A. (1981) Wellesley College; M.L.A. (1993) Harvard University Extension School. Research specialties: Science education; robotic telescopes; STEM teaching and learning in informal environments; professional development for out-of-school time and pre-college educators. Contact: mdussault@cfa.harvard.edu

GOULD, Roy R., Education Analyst, SAO Education Forum. A.B. (1968) Cornell University; Ph.D. (1974) Harvard University. Research specialties: Science education; technology-based tools for science and math education; integration of contemporary science into school curricula; public understanding of science. Contact: rgould@cfa.harvard.edu

SADLER, Philip M., Frances W. Wright Senior Lecturer on Celestial Navigation, Harvard University; Director, Science Education Department, Harvard-Smithsonian Center for Astrophysics. B.S. (1973) Massachusetts Institute of Technology; Ed.M. (1974), Ed.D. (1992) Harvard University. Research specialties: Science education; children's scientific misconceptions; remote telescopes; curriculum development; simulation software; celestial navigation; sundials; assessment; technology education; history of science;. high school to college transition, calculus, computer science education, pedagogy, pre-college STEM education, MOOCs. Contact: psadler@cfa.harvard.edu

SUNBURY, Susan E., Instructional Systems Specialist, SAO. B.A. (1986), Ed.D. (1994) Boston University; M. Ed., (1990) Lesley University. Research specialties: Museum exhibit and program research and evaluation; curriculum development; high school students' scientific misconceptions; professional development for pre-college educators. Contact: ssunbury@cfa.harvard.edu

AFFILIATED RESEARCH STAFF

SONNERT, Gerhard, Research Associate in the Harvard College Observatory. M.A. (1982), Dr. phil. (1986) University of Erlangen-Nürnberg, Germany; M.P.A. (1988) Harvard University. Research specialties: Sociology of science, of gender, and of education; history of science; science education.
Contact: gsonnert@cfa.harvard.edu