David K. Strickland

Associate Research Scientist
Department of Physics & Astronomy
The Johns Hopkins University
3400 North Charles Street
Baltimore, MD 21218 USA

British Citizen, US Legal Permanent Resident
Tel: 410.516.2881
Fax: 410.516.5096
E-mail: dks@pha.jhu.edu
Website: http://proteus.pha.jhu.edu/∼dks

Research Interests in Brief

- ⋆ I am a world leader in the study of outflows and winds from star-forming galaxies and the effect thereof on galaxy evolution and the properties of the intergalactic medium.
- ⋆ Theoretical modeling of the ISM including mechanical feedback from stellar winds and supernovae, with an emphasis on physically accurate observational predictions and diagnostics.
- ⋆ Observational constraints on the thermodynamics and structure of the hot ISM ($10^5 \lesssim T$ (K) $\lesssim 10^8$), specifically stellar wind-blown bubbles, superbubbles, galactic fountains, clouds in moving media and in the halo of the Milky Way, the galaxy disk/halo interface and galactic-scale superwinds.

Employment

2009 January – Present	Research Scientist, Johns Hopkins University
2001 September – 2008 December	Associate Research Scientist, Johns Hopkins University
2000 September – 2003 August	*Chandra* Fellow, Department of Physics & Astronomy, JHU
1998 September – 2000 August	Postdoctoral Research Fellow, Department of Physics & Astronomy, JHU
1994 September – 1998 July	Postgraduate Teaching Assistant, University of Birmingham

Education

Ph.D. (Physics) 1998/12/18: University of Birmingham, UK (Supervisor: Dr Ian R. Stevens).

B.Sc. (Physics with Astrophysics) 1994/7/18: First class honors, University of Birmingham, UK

Award and Prizes

Chandra Postdoctoral Fellowship (NASA/Smithsonian Astrophysical Observatory)	2000 – 2003
Michael Penston Prize; runner up (Royal Astronomical Society; best UK astrophysics thesis)	1998

Teaching Experience

Four years of teaching undergraduates as a Postgraduate Teaching Assistant at the University of Birmingham, to which I devoted 120 contact hours per year. I led general physics problem-solving classes, was a personal tutor to second-year astrophysics students and helped supervise final year astrophysics student projects.

Professional Activities

Chandra X-ray Observatory time allocation committee (2000, 2002, 2005, 2007)
NSF Astrophysics Theory peer review panel (2001)
XMM-Newton time allocation committee (2005)
NASA Astrophysics Theory Program peer review panel (2005, 2009)
Constellation-X Science Panel member (Interstellar Medium: 2005 — 2007)
Constellation-X/International X-ray Observatory Science Panel chair (Supernova/Stellar Feedback: 2008)

Grants Obtained as Principal Investigator

Grant and Proposal Title	Agency	Total Funding	Duration
Chandra AO10 (*Wide, Deep and Sharp: A Comprehensive Observation of M82, the Exemplar of Starburst Activity*)	SAO/NASA	$172,861	2009-2010
HST Cycle 17 (*Toward Understanding the Fundamental Structure of Superwinds*)	STScI	$70,835	2008-2010
Suzaku AO3 (*NGC 3079's 40-kpc Scale Outflow: AGN or Starburst-Driven?*)	NASA	$23,993	2008-2010
NSF Astronomy Division (*Understanding the Nature of Clouds in Galactic Winds*)	NSF	$177,726	2008–2010
Chandra AO8 (*Supernova Feedback Efficiency and the Hot Wind from NGC 3125*)	SAO/NASA	$38,885	2007–2008
Chandra AO8 (*X-Ray Emission in the Halos & Disks of of Disk Galaxies*)	SAO/NASA	$33,310	2007–2008
NASA Astrophysics Theory Program (*Hot Gas in Superbubbles and Superwinds*)	NASA	$346,000	2005–2008
XMM AO4 (*The Origin and Properties of Hot Gas in the Halos of Milky Way-Like Spiral Galaxies*)	NASA	$61,500	2006–2007
XMM AO3 (*A Deep Search for Hot Gas in the Halos of Normal Spiral Galaxies*)	NASA	$52,000	2004–2006
XMM AO3 (*Chemical and Spectral Properties of Hot Gas in the Halos of Starburst Galaxies*)	NASA	$42,300	2004–2006
Chandra AO5 (*Searching for Hot Gas in the Halos of Normal Spiral Galaxies*)	SAO/NASA	$64,153	2004–2006
XMM AO2 (*Quantifying the Energetics of Starburst-Driven Superwinds*)	NASA	$41,883	2003–2004
Chandra AO3 (*Resolving the Origin of X-Ray Emission in a Complete Sample of Local Starburst-Driven Superwinds*)	SAO/NASA	$47,964	2002–2003
Chandra AO2 (*Starburst-Nucleus Outflow Cones*)	SAO/NASA	$16,000	2001–2002
Chandra Fellowship (*Understanding the Origin and Physics of Hot Gas in Starburst-Driven Superwinds*)	SAO/NASA	$200,445	2000–2003

Letters of Recommendation

1. Prof. Timothy M. Heckman
   heckman@pha.jhu.edu
   Department of Physics & Astronomy
   The Johns Hopkins University
   3400 North Charles Street
   Baltimore, MD 21218 USA
   Tel: 410.516.7369
   Fax: 410.516.5096
2. Dr. Ian R. Stevens
   irs@star.sr.bham.ac.uk
   School of Physics & Astronomy
   University of Birmingham
   Edgbaston
   Birmingham, B15 2TT, UK
   Tel: +44.121.414.6450
   Fax: +44.121.414.3722
3. Prof. Colin A. Norman
   norman@stsci.edu
   Department of Physics & Astronomy
   The Johns Hopkins University
   3400 North Charles Street
   Baltimore, MD 21218 USA
   Tel: 410.516.7329
   Fax: 410.516.5096

Publications

A full list of all of my publications along with links to electronic versions of each manuscript is available at
http://proteus.pha.jhu.edu/∼dks/dks_published.html

Invited Conference Talks and Reviews

"*Theory and Simulation of Starburst-Driven Galactic Winds*" at "The Chemical Enrichment of the Intergalactic Medium," Leiden, Netherlands, May 2009.

"*Hot Metals and Galactic Winds*" at "The 4th UC Irvine Center for Cosmology Workshop," Irvine, USA, April 2008.

"*X-Ray Imaging and Spectroscopy of Nearby Disk Galaxies*," at the "Warm-Hot Gas in and Around Galaxies," topical session at the 206^{th} meeting of the AAS, Calgary, Canada, June 2006.

"*Massive Star Feedback and the Violent ISM in Dwarfs*" at "Dwarf Galaxies as Astrophysical and Cosmological Probes," Ringberg Castle, Germany, March 2006.

"*Collective Feedback from Massive Stars: The Status of Observational Data and Theoretical Models*" at "Galactic Flows: The Galaxy/IGM Ecosystem," Baltimore, USA, March 2005.

"*The Origin and Properties of X-Ray-Emitting Gas in the Halos of Both Starburst and Normal Spiral Galaxies*" at "Extra-Planar Gas," Dwingeloo, Netherlands, June 2004.

"*Winds from Nuclear Starbursts*" at the IAU Symposium 222 "The Interplay Among Black Holes, Stars and ISM in Galactic Nuclei," Gramado, Brazil, March 2004.

"*The Current State of X-Ray Spectroscopy of Diffuse Emission In and Around Starburst Galaxies*" at the "Constellation-X Spectroscopy Workshop," New York, USA, May 2003.

"*Galactic Fountains and Winds: The Link Between Metals in Galaxies and the IGM*" at the American Physical Society April meeting, Philadelphia, USA, April 2003.

"*The Connection Between Outflows from Massive Star Feedback and the Halos of Star-Forming Galaxies*" at "The Outer Edges of Dwarf Irregular Galaxies: Stars and Gas," 2002 Lowell Observatory Workshop, Flagstaff, USA, October 2002.

"*Recent Progress in Understanding the Hot and Warm Gas Phases in the Halos of Star-Forming Galaxies*" at "A Massive Star Odyssey, from Main Sequence to Supernova," IAU Symposium 212, Lanzarote, Spain, June 2002.

"*X-Ray, UV and Optical Constraints on the Physics of Galactic Outflows*" at "The Bologna Galactic Winds Workshop," Bologna, Italy, January 2002.

"*The Latest Results from Chandra on X-Ray Emission from Starburst-Driven Superwinds*" at "The Cosmological Impact of Galactic Winds," AAS Special Session, Pasadena, USA, June 2001.

"*Starburst-Driven Galactic Superwinds*" at "Chemical Enrichment of Intracluster and Intergalactic Medium," Vulcano, Italy, May 2001.

Refereed Publications

Strickland D.K. and Heckman T.M., 2009, ApJ, 697, 2030. "*Supernova Feedback Efficiency and Mass Loading in the Starburst and Galactic Superwind Exemplar M82.*"

Grimes J.P., Heckman T., Aloisi, A., Calzetti, D., Leitherer, C., Martin, C.L., Meurer, G., Sembach, K., **Strickland D.**, 2009, ApJS, 181, 272. "*Observations of Starburst Galaxies With Far-Ultraviolet Spectrographic Explorer: Galactic Feedback in the Local Universe.*"

Grimes J.P., Heckman T., **Strickland D.**, Dixon W.V., Sembach K., Overzier R., Hoopes C., Aloisi A. and Ptak A., 2007, ApJ, 668, 891. "*Feedback in the Local LBG Analog Haro 11 as Probed by Far-UV and X-Ray Observations.*"

Strickland D.K., 2007, MNRAS, 376, 523. "*A New Superwind Galaxy: XMM-Newton Observations of NGC 6810.*"

Strickland D.K. and Heckman T.M., 2007, ApJ, 658, 258. "*Iron Line and Diffuse Hard X-Ray Emission from the Starburst Galaxy M82.*"

Grimes J.P., Heckman T., Hoopes C., **Strickland D.**, Aloisi A., Meurer G. and Ptak A., 2006, ApJ, 648, 310. "*Far-*

Ultraviolet and X-Ray Observations of VV 114: Feedback in a Local Analog to Lyman Break Galaxies."

Marcolini, A., **Strickland, D.K.**, D'Ercole, A., Heckman, T.M. and Hoopes, C.G., 2005, MNRAS, 362, 626. "*The Dynamics and High-Energy Emission of Conductive Gas Clouds in Supernova-Driven Galactic Superwinds.*"

Grimes, J.P., Heckman, T.M., **Strickland, D.K.** and Ptak, A., 2005, ApJ, 628, 187. "*A Chandra X-Ray Investigation of the Violent Interstellar Medium: From Dwarf Starbursts to Ultraluminous Infrared Galaxies.*"

Colbert, E.J.M, **Strickland, D.K.**, Veilleux, S. and Weaver, K.A., 2005, ApJ, 628, 113. "*Extranuclear X-Ray Emission in the Edge-On Seyfert Galaxy NGC 2992.*"

Hoopes, C.G., Heckman, T.M., **Strickland, D.K.**, Seibert, M., Madore, B.F., Rich, R.M., Bianchi, L., Gil de Paz, A., Burgarella, D., Thilker D.A., Friedman, P.G., Barlow, T.A., Byun, Y.-I., Donas, J., Forster, K., Jelinsky, P.N., Lee, Y.-W., Malina, R.F., Martin, D.C., Milliard, B., Morrissey, P.F., Neff, S.G., Schiminovich, D., Siegmund, O.H.W., Small, T., Szalay, A.S., Welsh, B.Y. and Wyder, T.K., 2005, ApJL, 619, 99. "*GALEX Observations of the Ultraviolet Halos of NGC 253 and M82.*"

Summers, L.K., Stevens, I.R., **Strickland, D.K.** and Heckman, T.M., 2004, MNRAS, 351, 1. "*Chandra and XMM-Newton Observations of NGC 5253: Analysis of the X-Ray Emission from a Dwarf Starburst Galaxy.*"

Strickland, D. K., Heckman, T. M., Colbert, E. J. M., Hoopes, C. G. and Weaver, K.A., 2004, ApJ, 606, 829. "*A High Spatial Resolution X-Ray and Hα Study of Hot Gas in the Halos of Star-Forming Disk Galaxies. II. Quantifying Supernova Feedback.*"

Strickland, D. K., Heckman, T. M., Colbert, E. J. M., Hoopes, C. G. and Weaver, K.A., 2004, ApJS, 151, 193. "*A High Spatial Resolution X-Ray and Hα Study of Hot Gas in the Halos of Star-Forming Disk Galaxies. I. Spatial and Spectral Properties.*"

Hartwell, J.M., Stevens, I.R., **Strickland, D.K.**, Heckman, T.M. and Summers, L.K., 2004, MNRAS, 348, 406 "*Chandra and XMM-Newton Observations of NGC 4214: The Hot Interstellar Medium and the Luminosity Function of Dwarf Starbursts.*"

Colbert, E.J.M., Heckman, T.M., Ptak, A. and **Strickland, D.K.**, 2004, ApJ, 602, 231. "*Old and Young X-Ray Point Source Populations in Nearby Galaxies.*"

Hoopes, C.G., Heckman, T.M., **Strickland, D.K.** and Howk, J.C., 2003, ApJL, 596, 175. "*Cooling in Coronal Gas in the M82 Starburst Superwind.*"

Ptak, A., Heckman, T.M., Levenson, N.A., Weaver, K.A. and **Strickland, D.K.**, 2003, ApJ, 592, 782. "*A Chandra Survey of the Nearest ULIRGs: Obscured AGN or Super-Starbursts?*"

Summers, L.K., Stevens, I.R., **Strickland, D.K.** and Heckman, T.M., 2003, MNRAS, 342, 690. "*Chandra Observation of NGC4449. Analysis of the X-Ray Emission from a Dwarf Starburst Galaxy.*"

Dahlem, M., Ehle, M., Jansen, F., Heckman, T.M., Weaver, K.A. and **Strickland, D.K.**, 2003, A&A, 403, 547. "*The Quest for Hot Gas in the Halo of NGC 1511.*"

Heckman, T.M., Norman, C.A., **Strickland, D.K.** and Sembach, K.R., 2002, ApJ, 577, 691. "*On the Physical Origin of O*VI *Absorption-Line Systems.*"

Weaver, K. A., Heckman, T. M., **Strickland, D. K.** and Dahlem, M., 2002, ApJ, 576, L19. "*Chandra Observations of the Evolving Core of the Starburst Galaxy NGC 253.*"

Strickland, D. K., Heckman, T. M., Weaver, K. A., Hoopes, C. G. and Dahlem, M., 2002, ApJ, 568, 689. "*Chandra Observations of NGC 253. II: On the Origin of X-Ray Emission in the Halos of Starburst Galaxies.*"

Strickland, D.K., Colbert, E.J.M., Heckman, T.M., Weaver, K.A., Dahlem, M. and Stevens, I.R., 2001, ApJ, 560, 707. "*Another Intermediate Mass Black Hole in a Starburst Galaxy?: The Luminous X-Ray Source in NGC 3628 Reappears.*"

Heckman, T.M., Sembach, K.R., Meurer, G.R., **Strickland, D.K.**, Martin, C.L., Calzetti, D. and Leitherer, C., 2001, ApJ, 554, 1021. "*FUSE Observations of Outflowing OVI in the Dwarf Starburst Galaxy NGC 1705.*"

Summers, L.K., Stevens, I.R. and **Strickland, D.K.**, 2001, MNRAS, 327, 385. "*The Energetics and Mass-Loss of the Dwarf Starburst Markarian 33.*"

Strickland, D.K., Heckman, T. M., Weaver, K. A., and Dahlem, M., 2000, AJ, 120, 2965. "*Chandra Observations of NGC 253: New Insights into the Nature of Starburst-Driven Superwinds.*"

Heckman, T. M., Lehnert, M. D., **Strickland, D.K.** and Armus, L., 2000, ApJS, 129, 1514. "*Absorption-Line Probes of Gas and Dust in Galactic Superwinds.*"

Strickland, D.K. and Stevens, I. R., 2000, MNRAS, 314, 511. "*Starburst-Driven Galactic Winds: I. Energetics and Intrinsic X-Ray Emission.*"

Stevens, I. R., **Strickland, D.K.** and Wills, K. A., 1999, MNRAS, 308, L23. "*X-Ray-Luminous Radio Supernovae in the Center of M82.*"

Strickland, D.K. and Stevens, I. R., 1999, MNRAS, 306, 43. "*Multiple Superbubbles in the Starburst Nucleus of NGC 5253? Implications for Mass Loss from Dwarf Galaxies.*"

Stevens, I. R. and **Strickland, D.K.**, 1998b, MNRAS, 301, 215. "*A ROSAT Survey of Wolf-Rayet Galaxies - II. The Extended Sample.*"

Strickland, D.K. and Stevens, I. R., 1998, MNRAS, 297, 747. "*Predicting X-Ray Emission from Wind-Blown Bubbles - Limitations of Fits to ROSAT Spectra.*"

Stevens, I. R. and **Strickland, D.K.**, 1998a, MNRAS, 294, 523. "*A ROSAT Survey of Wolf-Rayet Galaxies.*"

Strickland, D.K., Ponman, T. J. and Stevens, I. R., 1997, A&A, 320, 378. "*ROSAT Observations of the Galactic Wind in M82.*"

Read, A. M., Ponman, T. J. and **Strickland, D.K.**, 1997, MNRAS, 286, 626. "*ROSAT PSPC Observations of Nearby Spiral Galaxies. 1. The Data.*"

Published Conference Proceedings as First Author

Strickland, D.K., 2005, in "Extra-planar Gas," ASP Conference Proceedings Vol 331, Ed. R. Braun (San Francisco: ASP), 345. "*The Origin and Properties of X-Ray-emitting Gas in the Halos of both Starburst and Normal Spiral Galaxies.*"

Strickland, D.K., 2004, in "The Interplay among Black Holes, Stars and ISM in Galactic Nuclei," proceedings of IAU symposium 222, Eds. Th. Storchi Bergmann, L.C. Ho and H.R. Schmitt. "*Winds from Nuclear Starbursts: Old Truths and Recent Progress on Superwinds.*"

Strickland, D. K., Heckman, T. M., Colbert, E. J. M., Hoopes, C. G. and Weaver, K. A., 2003, in "A Massive Star Odyssey, from Main Sequence to Supernova," proceedings of IAU symposium 212, Eds. K.A. van der Hucht, A. Herrero and C. Esteban, (San Francisco: ASP), 612. "*Recent Progress in Understanding the Hot and Warm Gas Phases in the Halos of Star-Forming Galaxies.*"

Strickland, D.K., 2002, in "Chemical Enrichment of Intracluster and Intergalactic Medium," ASP Conference Series 253, Eds. R. Fusco-Femiano and F. Matteucci (San Francisco: ASP), p387. "*Starburst-Driven Galactic Superwinds.*"

Strickland, D.K. and Stevens, I. R., 1998, in "The Central Regions of the Galaxy and Galaxies," Proc. IAU Symp.184, Ed. Y. Sofue, (Dordrecht: Kluwer Academic), 127. "*ROSAT HRI Observations of the Young Starburst NGC 5253.*"

Strickland, D.K., Stevens, I. R. and Ponman, T. J., 1998, in "The Hot Universe," Proc. IAU Symp.188, Eds. K. Koyama, S. Kitamoto and M. Itoh, (Dordrecht: Kluwer Academic), 287. "*Simulated X-Ray Emission from Starburst Driven Winds.*"

Strickland, D.K., Ponman, T. J. and Stevens, I. R., 1996, in "X-Ray imaging and spectroscopy of cosmic hot plasmas," Proceedings of an International Symposium on X-ray Astronomy (ASCA Third Anniversary), Eds. F. Makino and K. Mitsuda, 197. "*A ROSAT Analysis of the Wind in M82.*"

David K. Strickland: Research Statement

1. Gastrophyics: Gas, Astration and Physics — a Problem Whose Time Has Come

It is a tribute to the power of the human intellect that modern "precision" cosmology has largely achieved its goals: tightly constraining Ω, Λ, H_0 and predicting the purely gravitational growth of Universal large-scale structure. However, at the smaller and more personal scales of galaxies themselves, hydrodynamical processes become important, in particular, the feedback loops between massive star formation and AGN growth and the interstellar medium (ISM), and consequently between galaxy formation (and evolution) and the intergalactic medium (IGM). In this realm of baryonic physics, many astrophysical questions remain to be answered if we are to truly understand the nature and history of galaxies.

Collectively stellar (and AGN) activity can drive complex multi-phase gaseous flows with large radii of effect, and it is understanding the astrophysics of these processes that is the ongoing goal of my research career. Much of the observational diagnostic power lies at "difficult" wavelengths, in particular the X-ray and UV bands which most closely track the energy feedback and kinematics of these flows. This observational data, and even that taken at other wavelengths, is hard to interpret unambiguously without hands-on familiarity with the theory of the multi-phase ISM and numerical hydrodynamics. These factors have influenced the choices I have made regarding the direction of my research, resulting in what I believe to be a unique balance and range of skills in this field.

2. Summary of Research Interests

⋆ I am a world leader in both the theoretical and observational study of outflows and winds from star-forming galaxies and the effect thereof on galaxy evolution and the properties of the intergalactic medium.

⋆ Theoretical modeling of the ISM including mechanical feedback from stellar winds and supernovae, with an emphasis on physically accurate observational predictions and diagnostics.

⋆ Observational studies of the thermodynamics and structure of the hot ISM ($10^5 \lesssim T\,(\mathrm{K}) \lesssim 10^8$), specifically stellar wind-blown bubbles, superbubbles, galactic fountains, clouds in moving media and in the halo of the Milky Way, the galaxy disk/halo interface and galactic-scale superwinds.

3. Current and Future Research Directions

My current focus is largely on theoretical topics. I am currently working on a new generation of fully three-dimensional hydrodynamical simulations of superwinds, as well as improved analytical theory of the dynamics of warm neutral and ionized gas clouds driven by mechanical and/or radiative feedback from massive stars or AGN.

I am PI of the gnoM82es (Great NASA Observatories M82 Extended Survey) team, a Large Chandra project awarded time to survey the archetypal starburst galaxy M82 with ten times the observation length of the previous longest observations. The aims of this project are advance our knowledge of the soft X-ray emitting plasma in the extended superwind, the very hot metal enriched plasma tracing feedback in the starburst region and X-ray point source population that traces star formation in the starburst and post-starburst galactic disk. We will tie these high energy phenomena to the large surveys of this important galaxy with *HST* and *Spitzer* that we have access to.

In the future my intention is to concentrate on further developing the theory of feedback at galactic and trans-galactic scales, in particular, focusing on the relationship between the observable tracers of wind activity and the true contents and impact of wind-related feedback. There are a variety of reasons to do so:

⇒ The quantity and quality of (non-X-ray) multi-wavelength observational data on starbursts and superwinds, in

both the local and high redshift universe, has increased dramatically over the last decade (eg. Keck, HST *STIS* and *FUSE* absorption line spectroscopy, HST *ACS* and *Spitzer* imaging) and is likely to continue to increase (eg. HST *COS*, ALMA, other 10 m-class telescopes). Such data is the only means of probing winds at high redshift, as the X-ray emission from the hot gas that actually drives these winds is too faint to detect beyond the closest starbursts. However the analysis of what this data actually means has been hampered by the lack of theoretical work on the cooler ($T < 10^6$ K) entrained material in winds — we are still using the Strel'nitskii & Sunyaev (1973) / Chevalier & Clegg (1985) model of a simple indestructible cloud in a spherical wind and/or the Weaver et al. (1977) wind-blown bubble model. To truly exploit and understand the kinematic information available in existing and future absorption and emission line data of starburst galaxies, I am developing and will test more realistic models of the multi-phase material within superwinds using both analytical and numerical techniques. Furthermore much of this work can also be applied to developing the predictions of and assessing the validity of alternatives to the standard pressure-driven wind model, such as radiation or cosmic ray-driven wind models (eg. Murray et al. 2005; Socrates et al. 2006).

⇒ Spectroscopic measurement of the velocity of the soft and hard X-ray emitting phases of superwinds would be a more direct and unambiguous way of tracking the majority of the energy and metals carried in superwinds. However, this requires non-dispersive high spectral resolution X-ray detectors of the type envisaged for . Progress in this area is dependent on continued instrument development, in particular of X-ray calorimeters such as those to be used on *ASTRO-H* (launch 2013) and the *International X-ray Observatory*. In the intermediate term my goals are to improve predictions of the high energy signatures of supernova feedback. Initial work along these lines was submitted to the NAS Astro2010 Decadal Survey (Strickland et al. 2009). In the shorter term I believe that the more indirect, and currently poorly understood, tracers of wind energetics such as optical and UV absorption lines deserve renewed investigation as methods to study galactic winds.

⇒ Feedback from massive stars and galactic outflows have now been recognized as important ingredients in galaxy formation and evolution, but their implementation in current theoretical models of galaxy formation and evolution is overly simplistic and is often in contradiction to well-established properties of local starburst galaxies. One of my main priorities for the future is to bridge the divide between the physically-detailed multi-phase models of feedback such as starbursts-driven outflows, and the implementation of such phenomena in cosmological treatments of galaxy formation and evolution. I will do this first by providing simple, yet accurate, prescriptions that will work in current N-body/SPH and semi-analytical models (for example see Strickland & Heckman 2009), and later by implementing directly true multi-phase winds in cosmological codes.

4. Research History

My research career began as a graduate student doing a mixture of both observational studies of starbursting dwarf and normal spiral galaxies with X-ray telescopes (Strickland, Ponman, & Stevens 1997; Read, Ponman, & Strickland 1997; Stevens & Strickland 1998a,b; Strickland & Stevens 1999), and detailed theoretical modeling (primarily using numerical hydrodynamics) of stellar wind blown bubbles, superbubbles and galactic winds (Strickland & Stevens 1998, 1999, 2000).

As a postdoctoral fellow (and later as a *Chandra* Fellow) working with Professor Tim Heckman I focused primarily on using the unique capabilities of the *Chandra* and *XMM-Newton* X-ray observatories (launched in 1999) to answer some of the longstanding questions regarding X-ray emission from star-forming galaxies. I and my collaborators made use of the greater sensitivity and superior spatial and spectral resolution of *Chandra* and *XMM-Newton* to significantly advance our empirical understanding of both diffuse thermal X-ray-emitting plasmas and point-like X-ray sources (including the so-called Ultraluminous X-ray sources) from a wide range of normal and starbursting galaxies (Strickland et al. 2000, 2001; Summers et al. 2001; Strickland et al. 2002; Ptak et al. 2003; Summers et al. 2003, 2004; Hartwell et al. 2004; Colbert et al. 2004; Strickland et al. 2004a,b; Grimes et al. 2005; Strickland & Heckman 2007).

Other observational work has investigated the nature of the starburst/AGN connection and the (still ambiguous) possibility of AGN-driven galactic winds (Weaver et al. 2002; Colbert et al. 2005; Strickland 2007), as well as UV spectroscopy of galactic winds (Grimes et al. 2006, 2007, 2009).

Significant results from this period include: (1) Observationally resolving the two-decade-long argument regarding the physical origin of the soft X-ray-emitting gas in superwinds — our *Chandra* observations prove it arises in low volume filling factor regions of interaction between denser ambient gas and the true hot wind fluid (Strickland et al. 2000, 2002, 2004a), which validated the theoretical predictions (Strickland & Stevens 2000). (2) Confirming and repeating the detection of genuinely-diffuse hard X-ray emission from the starburst region of M82 (Griffiths et al. 2000; Strickland & Heckman 2007), the presence of which is a cornerstone of the supernova-driven theory of galactic winds. A detailed comparison of analytical and numerical predictions of updated superwind theoretical models with this observational data directly constrains the energy efficiency and degree of mass loading of the wind from a starburst region for the first time (Strickland & Heckman 2009).

Other theoretical work on feedback and winds has continued over this period includes numerical modeling that I performed with aim of understanding the nature of the warm neutral, warm ionized and coronal phase material found in superwinds can be found in Heckman et al. (2000, 2001, 2002) and Marcolini et al. (2005). An off-shoot of this work led by Andrea Marcolini on line diagnostics of simulated high velocity clouds (HVCs) is in preparation.

References

Chevalier, R. A. & Clegg, A. W. 1985, Nature, 317, 44
Colbert, E. J. M., Heckman, T. M., Ptak, A. F., Strickland, D. K., & Weaver, K. A. 2004, ApJ, 602, 231
Colbert, E. J. M., Strickland, D. K., Veilleux, S., & Weaver, K. A. 2005, ApJ, 628, 113
Griffiths, R. E. et al. 2000, Science, 290, 1325
Grimes, J. P., Heckman, T., Aloisi, A., Calzetti, D., Leitherer, C., Martin, C. L., Meurer, G., Sembach, K., & Strickland, D. 2009, ApJS, 181, 272
Grimes, J. P., Heckman, T., Hoopes, C., Strickland, D., Aloisi, A., Meurer, G., & Ptak, A. 2006, ApJ, 648, 310
Grimes, J. P., Heckman, T., Strickland, D., Dixon, W. V., Sembach, K., Overzier, R., Hoopes, C., Aloisi, A., & Ptak, A. 2007, ApJ, 668, 891
Grimes, J. P., Heckman, T., Strickland, D., & Ptak, A. 2005, ApJ, 628, 187
Hartwell, J. M., Stevens, I. R., Strickland, D. K., Heckman, T. M., & Summers, L. K. 2004, MNRAS, 348, 406
Heckman, T. M., Lehnert, M. D., Strickland, D. K., & Armus, L. 2000, ApJS, 129, 493
Heckman, T. M., Norman, C. A., Strickland, D. K., & Sembach, K. R. 2002, ApJ, 577, 691
Heckman, T. M., Sembach, K. R., Meurer, G. R., Strickland, D. K., Martin, C. L., Calzetti, D., & Leitherer, C. 2001, ApJ, 554, 1021
Marcolini, A., Strickland, D. K., D'Ercole, A., Heckman, T. M., & Hoopes, C. G. 2005, MNRAS, 362, 626
Murray, N., Quataert, E., & Thompson, T. A. 2005, ApJ, 618, 569
Ptak, A., Heckman, T., Levenson, N. A., Weaver, K., & Strickland, D. 2003, ApJ, 592, 782
Read, A. M., Ponman, T. J., & Strickland, D. K. 1997, MNRAS, 286, 626
Socrates, A., Davis, S. W., & Ramirez-Ruiz, E. 2006, ArXiv Astrophysics e-prints
Stevens, I. R. & Strickland, D. K. 1998a, MNRAS, 294, 523
—. 1998b, MNRAS, 301, 215
Strel'nitskii, V. S. & Sunyaev, R. A. 1973, Soviet Astronomy, 16, 579
Strickland, D. K. 2007, MNRAS, 376, 523
Strickland, D. K., Colbert, E. J. M., Heckman, T. M., Weaver, K. A., Dahlem, M., & Stevens, I. R. 2001, ApJ, 560, 707
Strickland, D. K. & Heckman, T. M. 2007, ApJ, 658, 258
—. 2009, ApJ, 697, 2030
Strickland, D. K., Heckman, T. M., Colbert, E. J. M., Hoopes, C. G., & Weaver, K. A. 2004a, ApJS, 151, 193
—. 2004b, ApJ, 606, 829
Strickland, D. K., Heckman, T. M., Weaver, K. A., & Dahlem, M. 2000, AJ, 120, 2965
Strickland, D. K., Heckman, T. M., Weaver, K. A., Hoopes, C. G., & Dahlem, M. 2002, ApJ, 568, 689
Strickland, D. K., Hornschemeier, A., Ptak, A., Schlegel, E., Tremonti, C., Tsuru, T., Tüllmann, R., & Zezas, A. 2009, NAS Astrophysics Decadal Survey White Paper, 289
Strickland, D. K., Ponman, T. J., & Stevens, I. R. 1997, A&A, 320, 378
Strickland, D. K. & Stevens, I. R. 1998, MNRAS, 297, 747
—. 1999, MNRAS, 306, 43
—. 2000, MNRAS, 314, 511
Summers, L. K., Stevens, I. R., & Strickland, D. K. 2001, MNRAS, 327, 385
Summers, L. K., Stevens, I. R., Strickland, D. K., & Heckman, T. M. 2003, MNRAS, 342, 690
—. 2004, MNRAS, 351, 1
Weaver, K. A., Heckman, T. M., Strickland, D. K., & Dahlem, M. 2002, ApJ, 576, L19
Weaver, R., McCray, R., Castor, J., Shapiro, P., & Moore, R. 1977, ApJ, 218, 377

David K. Strickland: Statement of Teaching Interests

I view teaching as an intellectual challenge on par with research and consider it to be an integral part of academic endeavor. I believe the failure of the current funding environment to support, encourage or reward teaching activity by postdoctoral fellows and research scientists in Physics and Astronomy departments to be a deeply regrettable flaw of the system within the United States. I provide details of my teaching experience, philosophy and interests below:

1. Teaching Experience

I was a Postgraduate Teaching Assistant for four years at the University of Birmingham in the United Kingdom, responsible for 120 hours per year of direct contact time with students.

I was a Personal Tutor to a group of typically eight second year Physics with Astronomy BSc/MSc students per year, meeting in groups of about four for at least one hour every week. In the British tutorial system, the tutor is the first port of call for students with questions on either *any* of their lecture courses or personal problems. Most often tutorials consisted of helping students with the harder lecture problem sheet questions or general discussion regarding physical concepts, but would occasionally (upon student request) cover other issue such as career choice or exam and revision strategy.

I also led a two-hour general problem-solving class for ~ 20 second year students that met once per week. Here the physical problems posed were not based on any lecture course the students attended, but were more often "real-world" applications of physics with the aim of building physical intuition and problem-solving skills. As with tutorials the emphasis was on engaging the students to solve the problems themselves and aid whichever student was at the blackboard at the time.

My final teaching responsibility was as a supervisor of fourth year MSc Physics with Astronomy student final projects. Here the students involved were academically superior, but this was their first exposure to an individual (rather than group) and open-ended research project and my role as supervisor dealt often with teaching research and project management skills.

2. Teaching Philosophy

I believe the role of the University is more than teaching a specific subject, it is about enabling individuals to be able to learn and enact rational decision making without outside instruction. In an age where the accuracy of outside information can often not be relied upon, such skills are as vital in everyday life as they are in academia.

Based on my experience teaching small groups ($\lesssim 20$ students) I quickly learned that the combination of the Socratic method and student involvement are critical to building long-term learning success. Careful questioning of the students, rather than telling them, draws upon what they already know and builds both their understanding and confidence. I also quickly learned that engaging the other students to help each other when stuck built not only camaraderie but further aided understanding at all skill levels, as not only were the explanations of students to their peers more understandable than those of the instructor, but also the process of explaining it to another student often clarified or corrected their own understanding of the subject.

My aim as a tutor and instructor was to also to tie the apparently disparate strands of knowledge provided in the separate courses my tutees attended into single widely-applicable concepts and techniques, and I actively encouraged my students to seek out such a synthesis themselves.

3. Teaching Interests

I am prepared to teach what ever undergraduate and graduate level courses are required of me. With my experience of both observational and theoretical astronomy I am confident in teaching courses on galaxies, high energy astrophysics, computational physics and/or scientific programming at any level.