Curriculum Vitae

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Name:

Robert G. Brown

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Personal:

Born March 29, 1955 in Raleigh, North Carolina. Married in 1979 to Susan Foster Isbey, MD. Three sons, Patrick O'Dowd Brown, b. 1987; William Brinkman Brown, b. 1990; and Samuel Gibbins Brown, b. 1995. Lives in Durham, N.C.

Education:

- B.S. from Duke University, 1977; Magna Cum Laude, four years on the Dean's list with class honors. Majors were Physics and Philosophy, with a minor interest (eight course credits, four at the graduate level) in Mathematics.
- PhD. from Duke University, 1982 in Theoretical and Mathematical Physics (see dissertation title below).

Employment:

- Undergraduate Research Assistant for Triangle Universities Nuclear Laboratory (TUNL), 1977.
- Teaching Assistant, Duke University, 1977–1979.
- Instructor/Research Associate, Duke University, 1982–1988.
- Visiting Assistant Professor, Duke University, 1989–2001
- Visiting Professor, Duke University, 2001-present
- Senior Systems Programmer, Duke University, 1987-present.

Teaching Experience:

1982-present: undergraduate introductory physics, undergraduate quantum theory, graduate classical electrodynamics, and graduate mathematical methods of physics. In addition Brown has taught independent study courses in computer science, programming, genetic algorithms, quantum mechanics, information theory, and neural networks.

Brown has been a pre-major advisor for the Trinity School of Arts and Sciences since 1995.

Publications and Conferences:

1. "Multiple scattering and non–muffin–tin band theory", presented at the Southeastern Sectional meeting of the American Physical Society, November, 1980.
2. "The position space Green's function and its application to a non–muffin–tin band theory". Ph.D. dissertation; June 1982.
3. "Generalized non–muffin–tin band theory," R. G. Brown and M. Ciftan, *Phys. Rev.* **B27**, 4564 (1983).
4. "Stress activated Raman scattering and microcrack detection", M. Ciftan, R. G. Brown, and E. Saibel, *Int J. Eng. Sci* **21**, 128 (1983).
5. "A numerical application of a generalized non–muffin–tin band theory", Poster presented at Sanibel Quantum Chemistry Symposium, March, 1984.

6. "A generalized non–muffin–tin theory of band structure", R. G. Brown and M. Ciftan, *Int. J. Quan. Chem.: QCS* **18** ed. P. O. Lowdin, J. R. Sabin, M. C. Zerner. Wiley and Sons, New York, 1984.

7. "A generalized theory of band structure", R. G. Brown and M. Ciftan, *Phys. Rev.* **B32**, 1339 (1985).

8. "Numerical tests of high–precision multiple–scattering band theory", R. G. Brown and M. Ciftan, *Phys. Rev.* **B33**, 7937 (1986).

9. "Convergence properties of an exact band theory", R. G. Brown and M. Ciftan, *Condensed Matter Theories* **1**, ed. F. B. Malik, Plenum, New York, 1986.

10. "Pseudospin–ordered optical bistability for two–level atoms", presented at the meeting of the Southeastern Section of the American Physical Society in Williamsburg, VA, November 1986.

11. "Local dynamics, correlation, and phase transitions: N–body versus nonlinear quantum optics", R. G. Brown and M. Ciftan *Condensed Matter Theories* **3**, ed. J. S. Arponen, R. F. Bishop and M. Manninen, Plenum, New York, 1988.

12. "Generalized non–muffin–tin multiple scattering theory", R. G. Brown, *J. Phys.* **B21** (letter), L309 (1988).

13. "Multipolar integral equation theory and generalized multiple scattering theory", , R. G. Brown and M. Ciftan *Condensed Matter Theories* **4**, ed. J. H. Keller, Plenum, New York, 1989.

14. "Multipolar expansions in the empty lattice problem", R. G. Brown and M. Ciftan, *Phys. Rev.* **B39**, 3543 (1989).

15. Comment on "Energy band equations for a general periodic potential", R. G. Brown and M. Ciftan, *Phys. Rev.* **B39**, 10415 (1989).

16. "The N–atom optical Bloch equations: A microscopic theory of quantum optics", R. G. Brown and M. Ciftan, *Phys. Rev.* **A40**, 3080 (1989).

17. "An elementary integral of Bessel functions", A. Kenan Ciftci, R. G. Brown and M. Ciftan, *Phys. Rev.* **B41**, 3242 (1990).

18. "Quantum Statistical Microdynamics and critical phenomena", R. G. Brown and M. Ciftan, *Condensed Matter Theories* **6**, ed. S. Fontoni and S. Rosati, Plenum, New York, 1991.
19. "Ferromagnetism in two dimensions", presented at the 1991 Southeastern Sectional meeting of the American Physical Society in Durham, NC.
20. "Multipolar Expansions for Multiple Scattering Theory", presented at the 1991 Materials Research Society Fall Symposium (session V) in Boston, MA; published in the symposium proceedings.
21. "The 2d/3D classical Heisenberg ferromagnet", presented at the March, 1992 Simulation Methods Workshop at the Center for Simulational Studies in Athens, GA; published in the workshop proceedings. (Springer-Verlag).
22. "The Dynamic Critical Exponents of the 3d, $\mathcal{O}(3)$ Classical Heisenberg Model", R. G. Brown and M. Ciftan, *Condensed Matter Theories* **10**, ed. Artur Polls, Nova Science Publishers, (1996).
23. "A high-precision evaluation of the static exponents of the classical Heisenberg ferromagnet", R. G. Brown and M. Ciftan, *Phys. Rev. Lett.* **76** 1352 (1996).
24. "The critical exponents of the classical Heisenberg ferromagnet", talk presented by R. G. Brown at the 1996 APS meeting, St. Louis, Missouri.
25. "Critical exponents of the classical Heisenberg model: Comment and Reply", R. G. Brown and M. Ciftan, *Phys. Rev. Lett.* **78** 2265 (1997)
26. "Critical scaling of the dynamic critical exponents of the classical Heisenberg ferromagnet", R. G. Brown and M. Ciftan, *Phys. Rev. B* **54** 15860 (1996).
27. "Critical Exponents of the Classical Heisenberg Model", R. G. Brown and M. Ciftan, p. 345 of *Condensed Matter Theories* **12**, ed. John. W. Clark and P. V. Panat, Nova Science Publishers, New York, 1997.
28. "Monte Carlo study of the helicity modulus of the classical Heisenberg ferromagnet", R. G. Brown and M. Ciftan, in *Condensed*

Matter Theories **13** (1998, part I) and *Condensed Matter Theories* **14** (1999, part II).

29. "A study of the critical exponent of the helicity modulus of the O(3) Heisenberg model" in *Condensed Matter Theories*, **15** 77-85 (2000).

30. "Critical behavior of the helicity modulus for the classical Heisenberg model", R. G. Brown and M. Ciftan, *Physical Review B* **74** 224413 (2006).

Magazine Articles and Columns:

1. "Beowulf Infrastructure", R. G. Brown, article in *Linux Magazine*, June 2003. This article is available online at:
   http://www.linux-mag.com/id/4125.

2. Monthly column in *Cluster World Magazine*, December 2003 to current. A list of column titles and topics follows. The column itself was initially called "Cluster Kickstart", which explains the focus on topics for the beginner. In January, 2005 the column's name was changed to "Cluster Edge" and topics are more free-ranging.

   Many of these columns have been republished and are available online at:
   http://www.clustermonkey.net/content/category/5/14/32/

   December 2003 *Building Your First Cluster*
   The beauty of cluster computing is that it requires little more than a generic workstation LAN to do it. We begin to explore cluster computing with just that: a "Network of Workstations" (NOW) that you may well already have!

   January 2004 *Doing Work in Parallel*
   Last month we started out by learning how to use pretty much an arbitrary linux LAN as the simplest sort of parallel compute cluster. This month we continue our hands-on approach to learning about clusters and play with our archetypical parallel task on our starter cluster to learn when it runs efficiently and just as important, when it runs *in*efficiently.

   February 2004 *Amdahl's Law*
   Clustering seems almost too good to be true. If you have work that needs to be done in a hurry, buy ten systems and get done in a tenth of the time. If only it worked with kids and the dishes. Alas, kids and dishes or cluster nodes and tasks, linear speedup on a divvied up task *is* too good to be true, according to *Amdahl's Law*, which strictly limits the speedup your cluster can hope to achieve.

   March 2004 *Serious Parallel Computing: PVM*
   The idea of a homemade parallel supercomputer predates the actual Beowulf project by years if not decades. In this column

(and the next), we explore "the" message passing library that began it all and learn some important lessons that extend our knowledge of parallelism and scaling.

April 2004 *PVM, Part II*
In this column we continue our exploration of PVM, the parallel computing subroutine library that more or less enabled the current explosion of high-performance parallel compute clusters to happen.

May 2004 *PVM, Part III*
In this column we write and run a very simple PVM application to "get started" with PVM.

June 2004 *Cluster Infrastructure*
Location, location, location. Clusters need space, power, cooling, and network access.

July 2004 *Cluster Design Prototyping*
We discuss some very basic principles for how to go about picking the best hardware for your cluster.

August 2004 *Cluster Infrastructure: The Network*
From inexpensive 100 Base T Ethernet to expensive custom networks, the network is the glue that makes a cluster.

September 2004 *Packets 'n' Protocols*
Wrap your data in TCP, pop it into an IP datagram, and insert it into an ethernet envelope...

September 2004 Head Node: A True Clu-story
Top 500 or Gordon Bell? Cost-benefit, not raw performance, is what cluster computing is all about.

October 2004 *Packets 'n' Protocols II*
Wrap your data in TCP, pop it into an IP datagram, and insert it into an ethernet envelope...continued and with UDP thrown in for good measure.

November 2004 *Measuring Network Performance*
The critical component of a beowulf cluster is the network. How can we compare network performance across a dazzling array of choices?

December 2004 *Cluster Design Revisited*
Now that we understand a bit about networking, we return

to cluster design.

January 2005 *A New Year, a New Column...*
Random thoughts about clusters, column names, and Linux versus Windows in my home cluster/LAN.

February 2005 *Cluster Ranking and the Top 500*
When the only work being ranked is driving nails, the only tool that is valued is the hammer. Too bad if your work involves driving screws...

March 2005 *Benchmarking and Benchmarketing*
Competition is good, but a single measure of performance in one dimension is not terribly useful for optimizing in a multidimensional space. We can do better.

April 2005 *Newbie Cluster Tasks*
So you've built that new cluster, for fun or eventual profit, but had no specific task in mind. You want to test it out. But how?

May 2005 *A Modest Proposal*
What if we made a benchmark daemon a built-in component of standard Linux? Tools with a library interface could *optimize* in many useful ways, and automagic resource aware cluster schedulers would finally become possible...

3. "The Future of Linux Clusters", R. G. Brown, article in *Linux Magazine*, August, 2005. This article is available online at:
   http://www.linux-mag.com/id/2147
4. "Live Random or Dieharder", R. G. Brown, article in *Linux Magazine*, September, 2007. This article is available online at:
   http://www.linux-mag.com/id/4125.

Web Publications:

The following are selected web-only publications by Robert G. Brown on the website:
http://www.phy.duke.edu/∼rgb

This website gets over 6 million hits a year from users downloading 66 gigabytes of online content authored by Brown ranging from free physics lecture notes and online textbooks to computing information and poetry.

1. http://www.phy.duke.edu/∼rgb/Class/Class.php
   Contains online lecture note-style textbooks on introductory physics in association with learning support materials, as well as an online textbook on Classical Electrodynamics. (3216854 hits over 12 months.)
2. http://www.phy.duke.edu/∼rgb/Beowulf/beowulf.php
   Contains an online book as well as numerous papers, tutorials, and support documents associated with high performance cluster computing. (1171947 hits over 12 months.)
3. http://www.phy.duke.edu/∼rgb/General/general.php
   Contains a number of Gnu Public Licensed (GPL) software packages authored by Brown as well as project templates, tool documentation, and other objects that are useful to the general internet community. The GPL packages are futher enumerated below. (808300 hits over 12 months.)
4. http://www.phy.duke.edu/∼rgb/Philosophy/philosophy.php
   Contains *Axioms*, an early draft of a book being written by Brown on metaphysical philosophy that has become extremely popular. (370733 hits over 12 months.)

GPL Software: The following are Linux-based GPL programs written by R. G. Brown and made available on the web:

Dieharder *Dieharder* is a fully GPL random number generator tester, under development by Brown. It currently incorporates all of the tests from George Marsaglia's *Diehard* tester, several tests from the NIST *Statistical Test Suite* (with more on the way), and a number of tests devised by Brown.

Dieharder is in active use by an increasing number of research groups because it subjects random number generators to far more strenuous tests (with user-adjustable parameters that permit the user to determine the power of the test) than previous generators. A community is developing that is contributing ideas and code and helping to debug the tool. *Dieharder* is available in a linkable library and has been incorporated directly into the *R* statistical suite by Dirk Eddelbeutel. By virtue of its power, *Dieharder* is serving as a test of its own code – possible weaknesses in two *Diehard* routines have been revealed by it.

Dieharder is available from:
http://www.phy.duke.edu/ rgb/General/dieharder.php

Wulfware Wulfware is a collection of several tools (xmlsysd, libwulf, wulfstat, wulflogger) designed to support the monitoring of clusters and grids. xmlsysd is a lightweight daemon that provides xml-wrapped system statistics and other information extracted from /proc and various systems calls. wulfstat and wulflogger are ncurses and straight ascii (respectively) tools for connecting to the xmlsysd daemons running on an entire cluster and either presenting it with a user-selectable refresh delay in a tty (xterm) window or printing it in a simple column format to standard out where it can easily be fed to a log file for eventual plotting or to other tools (e.g. a builder of a web view of the data). This is of obvious and immediate use for monitoring cluster status, tracking particular jobs, determining resource utilization for gridware schedulers or policy engines.

Wulfware is available from:
http://www.phy.duke.edu/ rgb/General/wulfware.php

Benchmaster benchmaster is a microbenchmark program designed to time and test system performance at a low level. It will eventually be added to the wulfware suite as a component of *xmlbenchd*, a new project that provides a daemon interface to xml-wrapped drop-in benchmark programs so that applications can be built that can automatically tune their algorithms to the particular hardware they are running on and so that grid tools can be built that can dynamically determine the resources available on an anonymous grid node.

Benchmaster is available from:
http://www.phy.duke.edu/ rgb/General/benchmaster.php

Flashcard flashcard is a program for presenting simple flashcards to students in a standard terminal (e.g. xterm) window. Special features include an xml encoding of flashcard problems and the ability to present auditory cues (e.g. spelling words out loud) from compressed sound files.

Flashcard is available from:
http://www.phy.duke.edu/ rgb/General/flashcard.php

Books:

1. *The Book of Lilith*, a mythopoeic work of fiction by Robert G. Brown, ISBN: 1430322454. Lulu Press, Morrisville, NC, 2007. This book has a website of its own located here:
   http://www.phy.duke.edu/∼rgb/Lilith/Lilith.php
2. *Engineering a Beowulf-Style Compute Cluster* by Robert G. Brown. Available online for free here:
   http://www.phy.duke.edu/∼rgb/Beowulf/beowulf_book.php
   or in printed form here:
   http://www.lulu.com/content/1203568
3. *Classical Electrodynamics* by Robert G. Brown. Available online for free here:
   http://www.phy.duke.edu/∼rgb/Class/Electrodynamics.php
   or in printed form here:
   http://www.lulu.com/content/1144184
4. *Who Shall Sing, When Man is Gone* original poetry by Robert G. Brown. Available online for free here:
   http://www.phy.duke.edu/∼rgb/Poetry/who.php
   or in printed form here:
   http://www.lulu.com/content/671809
5. *Hot Tea!* original poetry by Robert G. Brown. Available online for free here:
   http://www.phy.duke.edu/∼rgb/Poetry/hot_tea.php
   or in printed form here:
   http://www.lulu.com/content/736821

Manuscripts being prepared:

1. *Axioms*
   This is a draft book on the fundamental basis of all human knowledge. It covers the assumptions and problems of knowledge from the Greeks through Hume and the Enlightenment, noting that most attempts to determine knowledge were ill-founded from a strictly logical and mathematical point of view, foundering on the

lack of a sound basis for inference. However, it points out that work by Physicists Richard Cox and E. T. Jaynes as well as Claude Shannon provide an axiomatic basis for the algebra of inference and therefore put empirically supported human knowledge on the soundest basis that it can have. It also examines the spoken and unspoken axiomatic assumptions underlying most of the world's great philosophies and religions, exposing the numerous fallacies therein.

2. *Diehardder*
   This tool has been developed to the point where it is raising some very hard questions about random number generators and/or some of the tests that have been developed to verify the randomness of the sequences they produce. A draft manuscript is being prepared that is targeted at the *Journal of Computational and Graphical Statistics* both to announced *dieharder's* existence to the broader statistics community and to bring to the attention of that community the need for a "gold standard" random number generator to enable the tests to be tested.

Other Accomplishments:

1. Systems engineer who designed (circa 1995) and has subsequently been building, upgrading, and redesigning the beowulf-class distributed parallel supercomputer cluster *Brahma* in the Duke University physics department. Parts of this system have been funded by the University, by the Army Research Office, by the Department of Energy, by the National Science Foundation, and by an Intel equipment grant, and R. G. Brown gratefully acknowledges this support. Details of the system can be obtained from:
   http://www.phy.duke.edu/brahma/
2. Linux-smp and beowulf contributor. As a natural extension of the work on distributed parallel systems, R. G. Brown has actively participated in the development and debugging of the network and adaptec (scsi disk) drivers in the linux kernel distributions. In addition, brahma provides a home for mirrors of the linux-smp FAQ and the beowulf website. In various linux mailing list groups, he has helped countless persons get over various humps in developing their own resources and hence has contributed to international

productivity in science and industry. This help has extended to remotely managing honors projects and topical dissertations for students all over the world.

R. G. Brown, together with Dave Rahul of the University of Pennsylvania, organized the Extreme Linux section of the 1999 Linux Expo, which focused considerable attention on the beowulf effort and the possibilities of COTS parallel supercomputing. R. G. Brown was selected to be on the organizing committee of the "IEEE International Symposium on Cluster Computing and the Grid" (CCGrid'2000), held in Brisbane, Australia in May, 2001, and was on the program committee of "The 2005 International Conference on Parallel Processing (ICPP-05)", held at the University of Oslo, Norway June 14-17, 2005.

3. Primary author of *Discover*, a neural network engine that can be used to do predictive modeling in both scientific and business contexts. This engine incorporates a number of proprietary improvements to standard neural algorithms to achieve high predictivity with minimal training times. This tool is currently being adapted by independent study students to attempt to solve the many-electron problem in quantum theory using unsupervised learning (variational) methodology. If successful, this will represent one of the only truly *new* methods for solving the Schrödinger equation developed over last sixty years. In addition to its sheer novelty, this approach has particular promise, because neural networks are in principle capable of precisely representing the so-called "correlation hole" in multielectron wavefunctions.
4. Chairperson and primary volunteer of the technology commitee of Immaculata Catholic School in Durham, NC. Headed a project that basically wired the school and installed a proper client server network. Brown continues to serve as a technical advisor to the school.
5. Advisory Board member for Wake Technical College's High Performance Computing initiative.
6. Board member of Copperfield's Books, a small independent California bookstore. Currently guiding Copperfields through a difficult transition from "homemade" IT to a proper client/server network spanning multiple stores.