CURRICULUM VITAE

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EDUCATION

February 1976	**B.S.** in Mathematics, **M**assachusetts **I**nstitute of **T**echnology, Cambridge, MA, USA
December 1977	**M.A.** in Mathematics, University of California, **Berkeley**, CA, USA
December 1981	**Ph.D.** in Mathematics, University of California, **Berkeley**, CA, USA

PROFESSIONAL RECORD

1/88 – present	Department of Mathematics, Oregon State University, Corvallis, OR, USA. *Assistant Professor 1/88 – 8/90; Associate Professor 9/90 – 8/97; Professor 9/97 – present*
8/02 – 12/02	Grinnell College, Grinnell, IA, USA. *Robert N. Noyce '49 Visiting Professor in the Physical Sciences, Math, and Computer Science*
9/01 – 6/02	Department of Mathematics and Statistics, Mount Holyoke College, South Hadley, MA, USA. *Hutchcroft Visiting Professor of Mathematics*
2/95 – 8/95	Department of Physics and Mathematical Physics, University of Adelaide, Adelaide, AUSTRALIA. *Fulbright Senior Scholar*
8/94 – 1/95	School of Physics and Chemistry, Lancaster University, Lancaster, ENGLAND. *Visiting Research Fellow*
1/91 – 6/91	Mathematical Sciences Research Institute (MSRI), Berkeley, CA, USA. *Senior Member*
10/87 – 12/87	Theoretical Astrophysics Group, Tata Institute of Fundamental Research (TIFR), Bombay, INDIA. *Visiting Professor*
7/87 – 9/87	Institute of Mathematical Sciences, Madras, INDIA. *Visiting Scientist*
1/86 – 6/87	Department of Mathematics, University of York, York, ENGLAND. *Postdoctoral Research Fellow*
1/84 – 9/84 & 4/85 – 12/85	Instituut voor Theoretische Fysica, Rijksuniversiteit Utrecht, Utrecht, THE NETHERLANDS. *Wetenschappelijk Medewerker*
9/84 – 4/85	School of Mathematics, Institute for Advanced Study, Princeton, NJ, USA. *Member*
10/81 – 12/83	Institut für Theorie der Elementarteilchen, Freie Universität Berlin, Berlin, WEST GERMANY. *Tutor*

SHORT-TERM VISITS

7/07 – 8/07	Department of Mathematics and Physics, DigiPen Institute of Technology, Redmond, WA, USA.
12/04	Perimeter Institute for Theoretical Physics (PI), Waterloo, CANADA.
7/99	Scuola Internazionale Superiore di Studi Avanzati (SISSA), Trieste, ITALY.
6/97 & 8/98	Department of Physics, Reed College, Portland, OR, USA.
7/90 & 8/90	School of Mathematical Sciences, Queen Mary College, London, ENGLAND.
7/90 – 8/90	Physics Department, University of Crete, Iraklion, GREECE.
8/88	Tata Institute of Fundamental Research (TIFR), Bombay, INDIA.
7/88	Raman Research Institute, Bangalore, INDIA.
8/86	School of Mathematical Sciences, Queen Mary College, London, ENGLAND.
12/85	School of Natural Sciences, Institute for Advanced Study, Princeton, NJ, USA.

GRANTS

9/08 – 8/10	FQXi (PI), *Using Octonionic Cayley Spinors to Describe Fundamental Particles*
9/07 – 6/08	L. L. Stewart Faculty Development Award (OSU), *Teaching Calculus Coherently*
8/07 – 12/07	Hewlett Foundation mini-grant (OSU), *Teaching Calculus Coherently*
9/06 – 8/09	NSF/DUE–0618877 (co-PI), *Paradigms in Physics: Multiple Entry Points*
8/04 – 7/09	OMLI Disciplinary Content Team (funded by NSF/EHR–0412553)
2/04 – 9/08	ODE/Oregon ESEA Title II-B MSP 4076, (co-PI), *Central Oregon Consortium*
4/03 – 3/07	NSF/DUE–0231032 (PI), *Bridging the Vector Calculus Gap: Episode II*
1/01 – 7/03	NSF/DUE–0088901 (PI), *Bridging the Vector Calculus Gap*
6/00 – 6/01	OCEPT Faculty Fellow (funded by NSF/DUE–9996543)
1/00 – 6/01	L. L. Stewart Faculty Development Award (OSU), *Vector Calculus*
6/97 – 11/02	NSF/DUE–9653250 (senior personnel), *Paradigms in Physics*
9/96 – 6/97	L. L. Stewart Faculty Development Award (OSU), *Vector Calculus*
9/92 – 8/95	NSF/PHY–9208494 (co-PI), *The Wave Equation Isn't As Simple As You Thought*
8/94 – 6/95	OSU Research Council Award, *Algebraic Computing*
12/88 – 5/91	NSF/PHY–8813126 (PI), *Algebraic Computing in General Relativity*
11/89 – 5/90	OSU Research Council Award, *Algebraic Computing*

FELLOWSHIPS

2/95 – 8/95	Fulbright Senior Scholar (*Adelaide*)
7–12/87; 7–8/88	Indo-American Fellow (*Madras, Bombay, & Bangalore*)
1/86 – 4/87	SERC Postdoctoral Research Fellow (*York*)
10/82 – 9/83	NATO Postdoctoral Fellow (*Berlin*)
8/78 – 12/79	DAAD Stipendiat (*München*)

HONORS & AWARDS

1999 Named a "**Top Prof**" by the Mortar Board Senior Honor Society, Oregon State University.

2004 **Frederick Horne Award** for Sustained Excellence in Teaching Science, College of Science, Oregon State University.

2006 **Renie Award** for best deposit of 2006, National Curve Bank.

MEMBERSHIPS

International Society on General Relativity and Gravitation, Bern, SWITZERLAND

American Mathematical Society, Providence, RI, USA

London Mathematical Society, London, ENGLAND

Indian Association for General Relativity and Gravitation, Pune, INDIA

Oregon Academy of Sciences, Portland, OR, USA

Australasian Society for General Relativity and Gravitation, Canberra, AUSTRALIA

Southern African Relativity Society, Cape Town, SOUTH AFRICA

Mathematical Association of America, Washington, DC, USA

American Physical Society, College Park, MD, USA

Mathematicians and Education Reform Forum, Chicago, IL, USA

Oregon Mathematical Association of Two-Year Colleges, Pendleton, OR, USA

PUBLICATIONS

I have published more than 50 articles on mathematical physics in refereed journals; this total does not include conference proceedings, refereed or otherwise, nor numerous book reviews. I have also published a dozen articles in refereed journals on science education, focusing on the teaching of vector calculus, and have designed materials for such a course which are intended for national dissemination.

A complete list can be found at `http://oregonstate.edu/~drayt/cv/pubs.html`.

In addition, I am working on the drafts of two books, one on special relativity, the other on vector calculus, and have outlines for at least two more.

INVITED TALKS

I have given invited talks in 18 countries on 6 continents, including colloquia in 3 departments (Mathematics, Physics, and Computer Science) here at OSU.

A complete list can be found at `http://oregonstate.edu/~drayt/cv/talks.html`.

CONFERENCES

I have co-organized two conferences, and special sessions at two further conferences; one of the latter was at a major international conference. I have also attended numerous conferences the world over, as invited speaker, session chair, and/or presenter of a contributed talk.

A complete list can be found at `http://oregonstate.edu/~drayt/cv/conferences.html`.

STUDENTS SUPERVISED

Stuart Boersma	Major Professor (Ph.D. 1994)	(`http://www.cwu.edu/~boersmas`)
Jim Fischer	Major Professor (Ph.D. 1998)	(`http://snoopy.oit.edu/~fischerj`)
Al Agnew	Major Professor (M.S. 1996 & Ph.D. 1999)	(`http://math.fullerton.edu/aagnew`)
Aaron Wangberg	Major Professor (Ph.D. 2007)	
Sam Cook	Major Professor (Ph.D. 2009)	
Don Hickethier	Major Professor (Ph.D. in progress)	(`http://mail.fvcc.cc.mt.us/~dhicketh`)
Kevin Thompson	Major Professor (M.S. 1997)	(`http://www.alpacacriations.com/Nivek`)
Henry Gillow-Wiles	Major Professor (M.S. 2008)	
Jeff Hazboun	Major Professor (M.S. 2008)	*(Physics)*
Jonathan Wong	Major Professor (M.S. 2009)	
Pat Averbeck	Minor Professor (M.S. 1993)	
Jörg Schray	Minor Professor (M.S. 1991 & Ph.D. 1994)	*(Physics)*
Aparna Guntupalli	Minor Professor (M.S. 2005)	*(Physics)*

I have been a member of the Graduate Faculty in both the Department of Mathematics and the Department of Physics since 1988, a member of the University Honors College Faculty since 2000, and have been listed as Courtesy Faculty in the Department of Physics since 1993.

Much of this CV can be found online at `http://oregonstate.edu/~drayt/cv`*, including an up-to-date list of publications with links to copies of most of my recent work.*

RESEARCH RESULTS

Much of my early work involved *classical general relativity*. For instance, my dissertation confirmed the existence of solutions of Einstein's equations containing gravitational radiation and satisfying known "physical" boundary conditions — formulated in terms of a conformal structure on spacetime.

I also published a paper on a rotating version of the famous *twin paradox*, illustrating at an elementary pedagogical level the subtleties involved in working with rotating observers.

I then became interested in *algebraic computing in relativity*, in which computer algebra is used to classify exact solutions of Einstein's equations. I have always been intrigued by this use of computers to derive equations which are then solved by hand, not vice versa.

I have also done purely mathematical work in *differential geometry*. For instance, together with my student, Stuart Boersma, I introduced the concept of *parametric manifolds*, a generalization of the idea of surfaces. This geometric structure is well-suited to the study of rotation, and should have applications to quantum field theory as described by rotating observers.

I have been fortunate over the years to have collaborated with a number of world-class scientists. Foremost among these is Professor Gerard 't Hooft, recipient of the 1999 Nobel Prize in Physics and one of the most often cited physicists ever, with whom I was a postdoc for two years. Our first paper, describing the only known *2-body solution* in general relativity, has been cited more than 100 times.

I have also had the chance to work with Professor Paul Davies, recipient of the 1995 Templeton Prize and prolific author of popular science books, on *quantum field theory in curved space*, the attempt to generalize quantum theory to relativity. Together with Corinne Manogue, we resolved the apparent paradox that rotating particle detectors see particles in "the" vacuum; the analogous problem for linearly accelerating detectors is well-understood, and is related to the *Hawking effect*, in which quantum black holes create particles with a thermal spectrum.

In the early 1990s, I was part of a collaboration which proposed considering *signature-changing spacetimes*, which contain Euclidean regions. This idea was proposed simultaneously, in the context of early-universe cosmology, by a group led by Professor George Ellis, the recipient of the 2004 Templeton Prize. The Euclidean region is a possible model for the Big Bang, and a comparison of our approaches led to a long and fruitful collaboration between the two groups.

More recently, again together with Corinne Manogue, I have been studying the *octonions* with a view to describing the physics of fundamental particles. Intriguing results have been obtained regarding the eigenvalues of 3×3 Hermitian octonionic matrices, notably that they admit 6, rather than 3, real eigenvalues. Work on this topic is continuing in collaboration with Professor Susumu Okubo. Furthermore, using division algebras to do Clifford algebra manipulations in suitable dimensions provides an elegant mathematical framework which, among other things, shows why superstring theory only works in certain dimensions. This approach has already led us to new insights in particle physics, based on our eigenvalue results. Notable among these is a dimensional reduction scheme which suggests that the octonionic Dirac equation may lead to 3 generations of leptons with single-helicity neutrinos, observed properties of nature which remain unexplained by current theories.

TEACHING STATEMENT

I have always loved to teach.

I have primarily taught geometry classes, ranging from graduate courses in differential geometry to service courses in vector calculus. I have also taught precalculus, and most of the calculus sequence. But I most enjoy, and am best at, teaching undergraduates at the upper-division level. I have developed a variety of *advanced undergraduate courses*, some of which are described in more detail below.

I have been a member of the Graduate Faculty in both the Mathematics and Physics Departments since 1988, a member of the University Honors College Faculty since 2000, and have been listed as Courtesy Faculty in the Department of Physics since 1993.

My student evaluations are consistently among the best in my department. I was a finalist for the Carter Award for Undergraduate Teaching in 1990, 2006, and 2008, and received the 2004 Frederick Horne Award for Sustained Excellence in Teaching Science, both from the College of Science at OSU. In 1999 I was honored as a "Top Prof" by the Mortar Board Senior Honor Society.

I designed a *course in general relativity* intended for math majors; this course has been in high demand (when it is offered), and is taken by both undergraduate and graduate students in math, physics, and occasionally other disciplines. This course has twice been audited by senior faculty in unrelated departments.

I also developed a *course in non-Euclidean geometry*, taken by prospective secondary school teachers as well as traditional math majors. This course involves not only heavy use of *Mathematica*, but also a term paper; this is unquestionably the most challenging, as well as the most rewarding, course I have ever taught.

In addition, I have been closely involved in the NSF-funded effort to redesign the physics major here at OSU. In this *Paradigms in Physics* project, the junior year courses were replaced by intensive, cross-disciplinary *paradigms*, which are followed in the senior year by more traditional, discipline-specific *capstones*. At the invitation of the physics department, I designed and taught the last paradigm, on *reference frames* (special relativity and Coriolis forces); I am the only non-physics faculty member to teach a paradigm. I am actively working on developing the course notes from this course into a form suitable for publication.

My current curricular focus is an NSF-funded project entitled *Bridging the Vector Calculus Gap*, whose goal is to better incorporate the way vector calculus is actually used by physicists and engineers into the teaching of this material by mathematicians. We have developed supplemental small group activities which emphasize geometric visualization, as well as a student Study Guide and an Instructor's Guide. We have been invited to give numerous workshops on the use of our materials, including several at major national meetings.

In addition, I have recently become involved with two projects aimed at increasing the mathematics content knowledge of K–12 teachers in rural Oregon, namely the *High Desert Mathematics Partnership*, and the *Oregon Mathematics Leadership Institute*.

Along the way, I have tried a variety of innovations in the classroom. The vector calculus recitations have been turned into extended labs involving small group activities, somewhat along the lines of the *MathExcel* project. In the same class, I am experimenting with "flash cards" along the lines of the *ConcepTests* originally developed for other disciplines, and which are intended to break up the tedium of a large lecture. I have used computer demonstrations in classes large and small, and several classes have involved student work in computer labs. But my favorite teaching aid remains the one I started with: colored chalk!