

**ANTHONY ARTHUR CHAN**  
**Professor of Physics and Astronomy**

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## Education

**Princeton University, Princeton, New Jersey, 7/84–12/89.**

Ph.D. in Astrophysical Sciences, Program in Plasma Physics, 6/91.

Thesis: *Interaction of Energetic Ring Current Protons with Magnetospheric Hydromagnetic Waves.*

Advisors: Liu Chen and Roscoe White.

M.A. in Astrophysical Sciences, Program in Plasma Physics, 5/86.

**University of Auckland, Auckland, New Zealand, 2/78–12/83.**

M.Sc. (First Class Honours) in Physics, 2/84.

M.Sc. Thesis: *Monte Carlo Calculations for an In Vivo Neutron Activation Analysis System.*

Advisors: Alun Beddoe and Ross Garrett.

Seiichi Waki Prize (Best M.Sc. Thesis in Physics Department), 1983.

B.Sc. in Physics, 2/82. Senior Prize in Physics, 1981. Senior Prize in Pure Mathematics, 1981.

## Professional Experience

Rice University, Department of Physics and Astronomy, Professor, 7/07–present.

Rice University, Department of Physics and Astronomy, Associate Professor, 7/00–6/07.

Sabbatical visit to LASP, University of Colorado in Boulder, 1/02–7/02.

Rice University, Department of Space Physics and Astronomy, Associate Professor, 7/99–6/00.

Rice University, Department of Space Physics and Astronomy, Assistant Professor, 4/93–6/99.

Dartmouth College, Department of Physics and Astronomy, Research Associate, 1/90–3/93.

Visitor to STAR Lab, Stanford University, 1/90–6/90.

Princeton University, Plasma Physics Laboratory, Theory Group, Research Assistant, 8/85–12/89.

Princeton University, Plasma Physics Laboratory, TFTR Group, Research Assistant, 7/84–7/85.

University of Auckland Medical School, Department of Surgery, Research Officer, 1/84–6/84.

## Teaching

***Rice University:***

NSCI 111: *Science Today I: Physics and Astronomy* (1996)

ASTR 202: *Exploration of the Solar System* (2001)

PHYS 302: *Intermediate Electrodynamics* (2003, 2004, 2005, 2006)

SPAC 480: *Introduction to Plasma Physics* (1994, 1999, 2000, 2007)

SPAC 500: *Graduate Seminar* (1997, 2000)

SPAC 506: *Plasma Physics III* (1993)

PHYS 519/SPAC 521: *Plasma Kinetic Theory* (1995, 1998, 2000, 2002, 2004, 2006, 2008)

PHYS 532: *Classical Electrodynamics* (1995, 1997, 2008)

PHYS 516/SPAC 602: *Mathematical Methods of Physics* (1998, 2003, 2005)

SPAC 604: *Regular and Chaotic Dynamics* (1994)

***Princeton University:*** Teaching assistant for advanced graduate courses in plasma physics, 1986 to 1987. Lectures on the theory of plasma waves for Professor Thomas Stix, Fall 1987.

## Publications

1. X. Tao, A. A. Chan, J. M. Albert, and J. A. Miller. Stochastic modeling of multidimensional diffusion in the radiation belts. *J. Geophys. Res.*, 113:A07212, 2008. doi:10.1029/2007JA012985.
2. M. W. Liemohn and A. A. Chan. Unraveling the causes of radiation belt enhancements. *EoS, Trans. AGU*, 88:425, 2007.
3. Xin Tao, A. A. Chan, and A. J. Brizard. Hamiltonian theory of adiabatic motion of relativistic charged particles. *Phys. Plasmas*, 14:092107, 2007.
4. Y. Fei, A. A. Chan, S. R. Elkington, and M. J. Wiltberger. Radial diffusion and MHD particle simulations of relativistic electron transport by ULF waves in the September 1998 storm. *J. Geophys. Res.*, 111:12209, December 2006. doi: 10.1029/2005JA011211.
5. T. M. Loto'aniu, I. R. Mann, L. G. Ozeke, A. A. Chan, Z. C. Dent, and D. K. Milling. Radial diffusion of relativistic electrons into the radiation belt slot region during the 2003 Halloween geomagnetic storms. *J. Geophys. Res.*, 111:A04218, 2006. doi:10.1029/2005JA011355.
6. P. G. Loubser and A. A. Chan. Prediction of the effect of acute normovolemic hemodilution on the hematological constituents of sequestered autologous whole blood. *Anesthesia and Analgesia*, 102(4):991–997, 2006.
7. G. Toth, I. V. Sokolov, T. I. Gombosi, D. R. Chesney, C. R. Clauer, D. L. De Zeeuw, K. C. Hansen, K. J. Kane, W. B. Manchester, R. C. Oehmke, K. G. Powell, A. J. Ridley, I. I. Roussev, Q. F. Stout, O. Volberg, R. A. Wolf, S. Sazykin, A. A. Chan, Yu B, and J. Kota. Space Weather Modeling Framework: A new tool for the space science community. *J. Geophys. Res.*, 110:A12226, 2005. doi:10.1029/2005JA011126.
8. A. J. Brizard and A. A. Chan. Relativistic quasilinear diffusion in axisymmetric magnetic geometry for arbitrary-frequency electromagnetic fluctuations. *Phys. Plasmas*, 11(9):4220–4229, 2004.
9. T. G. Onsager, A. A. Chan, Y. Fei, S. R. Elkington, J. C. Green, and H. J. Singer. The radial gradient of relativistic electron phase-space density at geosynchronous orbit. *J. Geophys. Res.*, 109(A05221):doi:10.1029/2003JA010368, 2004.
10. S. R. Elkington, M. J. Wiltberger, A. A. Chan, and D. N. Baker. The Center for Integrated Space-weather Modeling (CISM) and physical models of the geospace radiation environment. *J. Atmos. Solar Terres. Phys.*, 66:1371–1388, 2004.
11. S. R. Elkington, M. K. Hudson, and A. A. Chan. Resonant acceleration and diffusion of outer zone electrons in an asymmetric geomagnetic field. *J. Geophys. Res.*, 108(A3):1116, 2003.
12. A. J. Brizard and A. A. Chan. Relativistic bounce-averaged quasilinear diffusion equation for low-frequency electromagnetic fluctuations. *Phys. Plasmas*, 8(11):4762–4771, 2001.
13. H.-J. Kim, A. A. Chan, R. A. Wolf, and J. Birn. Injection of outer-belt relativistic electrons by substorms. In *Proceedings of the Fifth International Conference on Substorms, Saint Petersburg, Russia*. European Space Agency, ESA SP-443, 2000.
14. H.-J. Kim, A. A. Chan, R. A. Wolf, and J. Birn. Can substorms produce relativistic outer-belt electrons? *J. Geophys. Res.*, 105:7721, 2000.
15. A. J. Brizard and A. A. Chan. Nonlinear relativistic gyrokinetic Vlasov-Maxwell equations. *Phys. Plasmas*, 6:4548–4558, 1999.

16. S. R. Elkington, M. K. Hudson, and A. A. Chan. Acceleration of relativistic electrons via drift-resonant interaction with toroidal-mode Pc-5 ULF oscillations. *Geophys. Res. Lett.*, 26:3273, 1999.
17. A. A. Chan. Noncanonical Hamiltonian methods for particle motion in magnetospheric hydromagnetic waves. *J. Geophys. Res.*, 103(9):20501–20513, 1998.
18. J. W. Freeman, T. P. O’Brien, A. A. Chan, and R. A. Wolf. Energetic electrons at geostationary orbit during the November 3-4, 1993 storm: Spatial/temporal morphology, characterization by a power-law spectrum and representation by an artificial neural network. *J. Geophys. Res.*, 103:26251, 1998. doi: 10.1029/97JA03268.
19. H.-J. Kim and A. A. Chan. Fully-adiabatic changes in storm-time relativistic electron fluxes. *J. Geophys. Res.*, 102:22107–22116, 1997.
20. E. V. Belova, R. E. Denton, and A. A. Chan. Hybrid simulations of the effects of energetic particles on low-frequency MHD waves. *J. Comput. Phys.*, 136:324–336, 1997.
21. A. A. Chan. Hamiltonian chaos in the interaction of ring current ions with magnetospheric hydromagnetic waves. In T. Chang and J. R. Jasperse, editors, *Physics of Space Plasmas (1993). Proceedings of the 1993 Cambridge Workshop in Geoplasma Physics and 1993 Symposium on the Physics of Space Plasmas "Chaos, Stochasticity, and Strong Turbulence"*, number 13, pages 31–41, Cambridge, Massachusetts, 1995. MIT Center for Theoretical Geo/Cosmo Plasma Physics.
22. A. A. Chan, M. Xia, and Liu Chen. Anisotropic Alfvén-ballooning modes in Earth’s magnetosphere. *J. Geophys. Res.*, 99:17,351–17,366, 1994.
23. Xinlin Li, M. K. Hudson, A. A. Chan, and I. Roth. Loss of ring current  $O^+$  ions due to interaction with Pc 5 waves. *J. Geophys. Res.*, 98:215–231, 1993.
24. Xinlin Li, A. A. Chan, and M. K. Hudson. Ring current ion interactions with micropulsations during the recovery phase of geomagnetic storms. In *Magnetospheric Substorms (AGU Monograph 64)*, page 469. Editors J. R. Kan, T. A. Potemra, S. Kokobun and T. Iijima. American Geophysical Union, 1991.
25. M. K. Hudson, A. A. Chan, X. Li, and I. Roth. Ring current ion interaction with Pc 5 micropulsations. In *Physics of Space Plasmas (1990): Magnetic Fluctuations, Diffusion and Transport in Geoplasmas*, pages 263–276. Editor T. S. Chang. Scientific Publishers, Inc., 1991.
26. A. A. Chan, A. Brizard, and Liu Chen. Hamiltonian test particle dynamics in a perturbed magnetic dipole field. In *Nonlinear and Relativistic Effects in Plasmas*, pages 526–535. Edited by V. Stefan. American Institute of Physics, College Park, Md., 1991.
27. A. A. Chan. *Interaction of Energetic Ring Current Protons with Magnetospheric Hydromagnetic Waves*. PhD thesis, Princeton University, Princeton, N.J., 1991.
28. A. A. Chan, Liu Chen, and R. B. White. Nonlinear interaction of energetic ring current protons with magnetospheric hydromagnetic waves. *Geophys. Res. Lett.*, 16(10):1133–1136, 1989.
29. J. D. Strachan and A. A. Chan. Helium transport in TFTR. *Nucl. Fusion*, 27:1025, 1987.
30. R. Kaita, W. W. Heidbrink, G. W. Hammett, A. A. Chan, A. C. England, H. W. Hendel, S. S. Medley, E. Nieschmidt, A. L. Roquemore, S. D. Scott, J. D. Strachan, G. D. Tait, G. Taylor,

C. E. Thomas, , and K. L. Wong. Charge exchange and fusion reaction measurements during compression experiments with neutral beam heating in the tokamak fusion test reactor. *Nucl. Fusion*, 26:863, 1986.

31. K. L. Wong, M. Bitter, G. W. Hammett, W. Heidbrink, H. Hendel, R. Kaita, S. Scott, J. D. Strachan, G. Tait, M. G. Bell, R. Budny, C. Bush, A. A. Chan, J. Coonrod, P. C. Efthimion, A. C. England, H. P. Eubank, E. Fredricson, H. P. Furth, R. J. Goldston, B. Grek, L. Grisham, R. J. Hawryluk, K. W. Hill, D. Johnson, J. Kamperschroer, H. Kugel, C. Ma, D. Mansfield, D. Manos, D. C. McCune, K. McGuire, S. S. Medley, D. Mueller, E. Nieschmidt, D. K. Owens, V. K. Paré, H. Park, A. Ramsey, D. Rasmussen, A. L. Roquemore, J. Schivell, S. Sesnic, G. Taylor, M. D. Williams, and M. C. Zarnstorff. Acceleration of beam ions during major-radius compression in the tokamak fusion test reactor. *Phys. Rev. Lett.*, 55:2587, 1985.
32. J. D. Strachan, A. A. Chan, W. W. Heidbrink, J. Lovberg, T. J. Murphy, E. Nieschmidt, and S. J. Zweben. Confinement of fusion products in tokamaks. In *Basic Physical Processes of Toroidal Fusion Plasmas*, volume 2, pages 699–712. Euratom, 1985.
33. A. A. Chan. Monte Carlo calculations for an *in vivo* neutron activation analysis system. Master's thesis, University of Auckland, Auckland, New Zealand, 1984.
34. A. A. Chan and A. H. Beddoe. Application of the Monte Carlo technique to the study of radiation transport in a prompt-gamma *in vivo* neutron activation system. *Australasian Physical and Engineering Sciences in Medicine*, 8:22, 1985.

## Refereed Medical Abstracts

Please note: Extended abstracts that are submitted to medical meetings and that are refereed before acceptance are listed by medical researchers as publications. However, since that is not common practice for physicists, these are listed these separately from the main publication list.

P. G. Loubser, J. A. Daribi, and A. A. Chan. Prediction of hemoglobin concentration in sequestered whole blood during acute normovolemic hemodilution. *Anesthesia and Analgesia*, 92:S105, 2001.

A. A. Chan and P. G. Loubser. Acute normovolemic hemodilution: Limits on allowable surgical blood loss and on hemoglobin concentration. *Anesthesia and Analgesia*, 86:S58, 1998. This paper was one of ten papers (from over five hundred presented at the 1998 International Anesthesia Research Society (IARS) Meeting) which was selected by the Editorial Board of the Medical Education Network, an international medical information service, for re-publication in *Scientific Conference and Abstract News*, Spring, 1998.

## Professional Service

Member of National Academy Committee on Solar and Space Physics (CSSP), June 2003 to June 2006. Contributed to the following National Academy reports:

- *Plasma Physics of the Local Cosmos*. Committee on Solar and Space Physics, National Academies Press, 2004.
- *Exploration of the Outer Heliosphere and the Local Interstellar Medium*. Committee on Solar and Space Physics, National Academies Press, 2004.
- *Solar and Space Physics and its Role in Space Exploration*. Committee on the Assessment of the Role of Solar and Space Physics in NASA's Space Exploration Initiative, National Academies Press, 2005.
- *Distributed Arrays of Small Instruments for Research and Solar-Terrestrial Research: Report of a Workshop*. Ad Hoc Committee on Distributed Arrays of Small Instruments for Research

and Monitoring in Solar-Terrestrial Physics, National Academies Press, 2006.

Associate Editor of Geophysical Research Letters, December 2000 to December 2003.

Lead Convener of the Inner Magnetosphere/Storms Campaign, NSF Geospace Environment Modeling (GEM) Program, 1999 to 2003. (Lead organizer of a workshop each summer and a mini-workshop each winter, on physics of the inner magnetosphere and magnetic storms.)

Member of the GGCM Steering Committee, June 1998 to June 2001. The GGCM (Geospace General Circulation Model) is being developed by the Geospace Environment Modeling program of the NSF as a comprehensive global physical model of the geospace environment.

Member of the AGU Scarf Award Committee, 2000-2001. The Scarf Award is given at most annually for the best PhD thesis in Space Physics, Planetary Physics and Aeronomy. The committee also makes awards for the best student papers presented at the AGU Fall and Spring meetings.

Co-Organiser: *Rarotonga Energetic Particle Workshop (REPW)*, Rarotonga, Cook Islands, August 2007. (Lead Organiser: Dr. Craig Rodger, University of Otago, New Zealand)

Lead Convener: *Wave and Particle Dynamics in the Ring Current and Radiation Belts*. IUGG XXIV 2007, Perugia, Italy, July 2007.

Deputy Organiser: *Meeting of the Panel on Radiation Belt Environment Models* 36th COSPAR Scientific Assembly, Beijing, People's Republic of China, July 2006.

Co-Convener: Special Session *Nonlinear and Kinetic Physics of ULF and VLF Waves*. Fall AGU Meeting, San Francisco, December 2005.

Co-Convener: *Session 3.1: The Magnetospheric Particle Accelerator*. IAGA, Toulouse, France, July 2005.

Co-Convener: *The Radiation Belts*. Asia-Oceania Geophysical Society (AOGS) Annual Meeting, Singapore, July 5–9, 2004.

Co-Convener: Special Session *Relativistic Electron Dynamics: Focus on Losses* at the Western Pacific Geophysics Meeting, Wellington, New Zealand, July 9-12, 2002.

Head of the Scientific Committee and Lead Organizer: *International Space Environment Conference (ISEC): Radiation Belt Science and Technology*, Queenstown, New Zealand, July 2001.

Co-Convener: Symposium 9, *Energetic Particle Dynamics in the Inner Magnetosphere*. S-RAMP: STEP – Results, Applications and Modeling Phase. Sapporo, Japan, October 2000.

Co-Convener: Special Session *New Perspectives in Dynamics and Coupling in Inner Magnetospheric Physics*. AGU Spring Meeting. Boston, Massachusetts, May 1999.

Lead Convener: Symposium 3.07: *Generation and Propagation of ULF Waves*. IAGA Meeting. Uppsala, Sweden, July 1997.

**Referee for Journal Articles:** Journal of Geophysical Research, Geophysical Research Letters, Physics of Plasmas, Physics of Fluids.

**Referee and Review Panelist for Research Proposals:** NSF, NASA.

## Rice University Service and Activities

Faculty Associate at Martel College, Rice University, since 2001.

Award for Outstanding Faculty Associate, Martel College, Rice University: 2005–2006.

Award for Distinguished Faculty Associate, Martel College, Rice University: 2003–2004, 2004–2005, 2006–2007, 2007–2008.

Faculty Associate at Sid Richardson College, Rice University, 1995–2001.

Fellow of Scientia, 1994–1996, 2002-present. Scientia is an institute of Rice University faculty founded in 1981 to promote scholarly discussion across disciplinary boundaries.

## Student Advising

### Current Ph.D. Student:

Xin Tao. Hamiltonian theory and stochastic simulation methods for radiation belt dynamics. Since May 2005. Winner of the William and Elva Gordon Prize, 2008.

### Previous Graduate Students:

Bin Yu, Ph.D., May 2007. *Simulation of Dynamics of Radiation Belt Electrons During Geomagnetic Storms Driven by High Speed Solar Wind Streams.*

Yue Fei. Ph.D., May 2007. *Simulation of Radiation Belt Electron Diffusion.*

Timothy Glover, Ph.D., 2002. *Measurement of Plasma Parameters in the Exhaust of a Magnetoplasma Rocket by Gridded Energy Analyzer and Emissive Langmuir Probe.* Winner of the William and Elva Gordon Prize, 2002.

Hee-Jeong Kim, Ph.D., 1999. *Dynamics of Relativistic Electrons in Earth's Magnetosphere.*

Karsten E. Braaten, M.S., 1997. *A Model of Bounce-Averaged Relativistic Protons with Emphasis on the March 1991 Magnetospheric Compression.*

Karen M. Klamczynski, M.S., 1997. *Bounce-Resonant Ion Interaction with Hydromagnetic Waves.*

### Thesis Committees:

Deirdre Wendel, Ph.D., expected 2008. Antoun Daou, Ph.D., 2008. Liang Wu, M.S., 2008. Brooke Olson, Ph.D., 2007. Yining Li, M.S., 2005. Kaan Ozturk, Ph.D., 2005. Shuo Ji, M.S., 2001. Brent Buckalew, M.S., 2000. David Geller, Ph.D., 1999. Seth Orloff, Ph.D., 1998. Shan Xue, Ph.D., 1997. Michikazu Hojo, M.S., 1997. Mauricio Reyes-Ruiz, Ph.D., 1996. Adam Usadi, Ph.D., 1995. Tracy Totten, Ph.D., 1994. Chuxin Chen, Ph.D., 1994.

**Undergraduate Senior Theses:** Shawn Brooks, '96. Jeff Williams, '96. Justin Ruths, '04. Yoav Kallus, '06.

## Membership in Professional Organizations

American Physical Society, 1983 to present.

American Geophysical Union, 1986 to present.

International Association of Geomagnetism and Aeronomy, ULF Working Group, 1990 to present.

International Anesthesia Research Society, 1998-2000.