

# Jonathan C. McKinney

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## Contact Info

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## Education

2004      **Ph.D.** in Physics, University of Illinois at Urbana-Champaign (UIUC)  
Thesis: Black Hole Accretion Systems (Prof. Gammie, advisor)  
1999      **M.S.** in Physics, UIUC  
1997      **B.Sc.** in Physics (Summa Cum Laude), Texas A&M Univ., College Station

## Research Interests

High-energy astrophysics, non-relativistic and relativistic jets, black hole and neutron star accretion, general relativistic perturbation theory and numerical relativity, plasma physics, plasma and MHD instabilities, pulsar emission, non-thermal emission, gamma-ray bursts, galaxy/galaxy cluster evolution, AGN feedback, stellar and planetary internal magnetic fields and magnetospheres

## Post-Graduate Research Experience

2007-      **Einstein (Chandra) Fellow**, Stanford Physics  
2007-      **KIPAC Fellow**, 5yr Fellow/Senior Research Scientist  
2004-2007      **Institute for Theory & Computation Fellow**, CfA

## Graduate Research Experience

2001-2004      **NASA GSRP Fellow**, UIUC  
*Computational General Relativistic Astrophysics*  
1999-2000      **Research Assistant**, UIUC  
*Computational and theoretical study of black hole accretion disks*  
Advisor: Prof. Charles Gammie  
Molecular Clouds, Galactic Dynamics, Accretion Disks  
1998      **Research Assistant**, UIUC  
*General relativistic hydrodynamic processes involving shocks as applied to cosmological sheets*  
Advisor: Prof. Mike Norman, Sr. Res. Scientist, NCSA (now UCSD)  
Numerical methods to model astrophysical fluid dynamical systems  
1996Sum      **Research Assistant (REU)**, UIUC  
*Symmetry breaking and chaos in electron transport in semiconductor superlattices*  
Advisor: Prof. David K. Campbell (now Dean, Boston University)  
Nonlinear Dynamics of Electrons in Mesoscopic Nanostructures

## **Fellowships, Awards, Honors, Scholarships**

- 2008 **Scholarship:** Beatrice M. Tinsley Research Scholarship from Univ. of Texas
- 2007 **Fellowship:** 3yr Einstein (Chandra) Fellowship
- 2007 **Fellowship:** Stanford Physics 5yr KIPAC Fellow/Senior Research Scientist
- 2007 **Honor:** IAS 5yr Long Term Member (declined)
- 2007 **Honor:** CITA 5yr Senior Research Associate (declined)
- 2007 **Fellowship:** Harvard CfA 4yr Clay Fellowship (declined)
- 2007 **Fellowship:** Princeton Univ. 3yr Council on Sci. & Tech. Teaching Fellowship (declined)
- 2007 **Fellowship:** Princeton Astro. 3yr Lyman Spitzer, Jr. Fellowship (declined)
- 2007 **Fellowship:** Princeton Society of Fellows (declined)
- 2006 **Fellowship:** NYU 5yr James Arthur Fellow – Senior Res. Sci. (declined)
- 2004-2007 **Fellowship:** Institute for Theory and Computation (ITC) Fellow, CfA
- 2001-2004 **Fellowship:** NASA GSRP Fellow, S01-GSRP-044, sole author
- 1998, 2000 **Fellowship:** General Electric Fellow (for scholastic excellence as graduate at UIUC), Amount: twice received \$7,000 stipend + \$500 expenses
- 1996-1997 **Award:** Faculty Achievement Award (for leadership in the College of Science at Texas A&M as recognized by physics faculty)
- 1996 **Fellowship:** Summer Research Fellowship, UIUC  
<http://www.physics.uiuc.edu/education/undergrad/reu/>
- 1994 **Award:** Golden Key National Honor Award, National Honor Society (\$1,000 scholarship award) <http://goldenkey.org>

## **Computing Time Awarded**

- 2009 **Computing Award:** Sole author, Co-PI for Teragrid, 8,000,000 hours on Lonestar/Abe clusters, PI: Roger Blandford (2009-2010)
- 2009 **Computing Award:** Co-I for Teragrid, 2,000,000 hours on Abe/QueenBee clusters, PI: Ramesh Narayan (2009)
- 2008 **Computing Award:** Co-I/Co-Author for Teragrid, 500,000 hours on Abe/QueenBee clusters, PI: Ramesh Narayan (2008-2009)
- 2008 **Computing Award:** Sole author, Co-PI, Teragrid, 1,000,000 hours on TACC's Lonestar/Ranger, AST080029, PI: Roger Blandford (2008-2009)
- 2008 **Computing Award:** Sole author and PI for Teragrid, 30,000 development hours on Abe cluster, AST080015, PI: Jonathan McKinney (2008-2009)
- 2006 **Computing Award:** Granted unique access to Harvard's Bluegene/L, 3,000,000 hours used over 2 years, PI: Ramesh Narayan (2006-)
- 2003 **Computing Award:** Co-I/Co-Author for NCSA NRAC, 300,000 hours on Tungsten (2900 CPU Xeon cluster), PI: Charles F. Gammie (2003-2006)
- 2002 **Computing Award:** Co-I/Co-Author for NCSA NRAC, 100,000 hours on Platinum (512 CPU Pentium3 cluster), PI: Charles F. Gammie (2002-2003)
- 2001 **Computing Award:** Co-I/Co-Author for NCSA NRAC, 50,000 hours on Posic (Intel linux cluster), project oiq, PI: Charles F. Gammie (2001-2002)

## **Research Grants**

- 2007 **Research Award:** Co-I NASA NNH07ZDA001N-ATFP, two years graduate student. *Measuring Black Hole Spin: Physics of the Inner Region of an Accretion Disk*. PI: Ramesh Narayan. Amount: \$200,000 (2008-2010)
- 2002 **Research Award:** Co-I NSF-ITR0205155, *MHD Simulations in Full General Relativity*. PI: Charles Gammie. Amount: \$2,250,000 (2002-2007)
- 2001 **Research Award:** Co-I NSF0093091, *Black Hole Accretion Flow Theory*. PI: Charles F. Gammie. Amount: \$570,429 (2001-2007)

## Teaching Experience

2008,2009	<b>Guest Lecturer</b> , Stanford, Undergrad. level, <i>Black Holes</i> , Prof. Tom Abel
2001	<b>Teaching Assistant</b> , 1/2 year, UIUC, Graduate level, <i>The Physics of Compact Objects</i> , Prof. Stuart L. Shapiro
2001	<b>Teaching Assistant</b> , 1/2 year, UIUC, ENGR. level, Stat. Mech.
2000	<b>Teaching Assistant</b> , 1/2 year, UIUC, ENGR. level, Mechanics
1999	<b>Teaching Assistant</b> , 1 year, UIUC, ENGR. level, E&M
1997-1998	<b>Teaching Assistant</b> , 1 year, UIUC, ENGR. level, Quantum Mechanics
1996-1997	<b>Teaching Assistant</b> , 1 year, Texas A&M, Graduate level, Stat. Mech.

## Student Mentoring (Under supervision by Ramesh Narayan @ CfA)

2005-2006	<b>Undergraduate student</b> : Manuel A. Aguilar: Senior thesis (1 <sup>st</sup> year '02)
2004-2010	<b>Ph.D. student</b> : Alexander Tchekhovskoi: Research advisor (1 <sup>st</sup> year '04)
2007-2009	<b>Ph.D. student</b> : Rebecca Shafee: Research advisor (1 <sup>st</sup> year '04)

## Professional Memberships/Services and Other Services

2007-	Review Panel: ATFP2007, ATP2009
2002-	Refereed Papers: ApJ, ApJ Letters, MNRAS, MNRAS Letters, PRL, Computer Physics Communications, A&A
2008-	Refereed Proposals: DOE Applied Math
2006	CfA organizer and leader: Weekly 2 hour group meeting of postdocs and graduate students where an individual discusses a paper on astro-ph in detail or discusses their own research in detail.
1999-	Member: AAS, APS

## Publications in Preparation

- 1) **McKinney, J.C.** *Simulating Black Hole Accretion Flows and Jets*, Physics Reports Invited Review [planned completion around May 2010]
- 2) **McKinney, J.C.** & Blandford, R.D., *Observed Relativistic Jet Variability as a Pattern Effect Induced by Unstable Jet Modes*
- 3) **McKinney, J.C.** , Tchekhovskoi, A.D., & Narayan, R., *CPC-HARM: Conservative-Primitive-Consistent high-accuracy General Relativistic Magnetohydrodynamics code*
- 4) Penna, R., Narayan, R., Tchekhovskoi A., **McKinney, J.C.** *Effects of Disk Thickness and Magnetic Field Geometry within the Plunging Region of Rotating Black Holes*
- 5) Dexter, J. Agol, E., **McKinney, J.C.** *Comparison of General Relativistic Simulations of Jets with Observations of M87*

## Refereed Publications

- 28) **McKinney, J.C.** & Uzdensky, D.A., *A Reconnection Switch to Trigger Gamma-Ray Burst Jet Dissipation*, MNRAS, submitted
- 27) **McKinney, J.C.** & Kohri, K., *Code and Tables for Nuclear Equations of State and Neutrino Opacities for General Relativistic Magnetohydrodynamical Simulations of Gamma-Ray Bursts*, MNRAS, submitted
- 26) Tchekhovskoy, Alexander; Narayan, Ramesh; **McKinney, J.C.**, *Black Hole Spin and the Radio Loud/Quiet Dichotomy of Active Galactic Nuclei*, ApJ, 2009, submitted
- 25) Tchekhovskoy, Alexander; Narayan, Ramesh; **McKinney, J.C.**, *Magnetohydrodynamic Simulations of Gamma-Ray Burst Jets: Beyond the Progenitor Star*, ApJL, 2009, accepted
- 24) Zhu, Zhaohuan; Hartmann, Lee; Gammie, Charles; **McKinney, J.C.** *2-D simulations of FU Orionis disk outbursts*, ApJ, 2009, 701, 620

- 23) Tchekhovskoy, Alexander; **McKinney, J.C.**; Narayan, Ramesh, *Efficiency of Magnetic to Kinetic Energy Conversion in a Monopole Magnetosphere*, ApJ, 2009, **699**, 1789
- 22) **McKinney, J.C.** & Blandford, R.D. *Stability of Relativistic Jets from Rotating, Accreting Black Holes via Fully Three-Dimensional Magnetohydrodynamic Simulations*, MNRAS Letters, 2009, **394**, L126
- 21) Shafee, R., **McKinney, J.C.**, Narayan, R., Tchekhovskoy, A., Gammie, C. F., & McClintock, J. E., *Three-Dimensional Simulations of Magnetized Thin Accretion Disks around Black Holes: Stress in the Plunging Region*, ApJ Letters, 2008, **687**, L25
- 20) Tchekhovskoi, A.D., **McKinney, J.C.**, & Narayan, R., *Simulations of Ultrarelativistic Magnetodynamic Jets from Gamma-ray Burst Engines*, 2008, MNRAS, **388**, 551
- 19) Komissarov, S.S. & **McKinney, J.C.**, “Meissner effect” and Blandford-Znajek mechanism in conductive black hole magnetospheres, 2007, MNRAS Letters, **377**, L49
- 18) Mignone, A. & **McKinney, J.C.**, *On the Equation of State in Relativistic Magnetohydrodynamics*, 2007, MNRAS, **378**, 1118
- 17) Tchekhovskoi, A.D., **McKinney, J.C.**, & Narayan, R., *WHAM: WENO-based general relativistic scheme I: hydrodynamics*, 2007, MNRAS, **379**, 469
- 16) Narayan, R. **McKinney, J.C.**, & Farmer, A.J., *Self-Similar Force-Free Wind from an Accretion Disk*, 2007, MNRAS, **375**, 548
- 15) **McKinney, J.C.** & Narayan, R., *Disk-Jet Coupling in Black Hole Accretion Systems I: General Relativistic Magnetohydrodynamical Models*, 2007, MNRAS, **375**, 513
- 14) **McKinney, J.C.** & Narayan, R., *Disk-Jet Coupling in Black Hole Accretion Systems II: General Relativistic Force-Free Models*, 2007, MNRAS, **375**, 531
- 13) Noble, S. C., Gammie, C. F., **McKinney, J.C.**, & Del Zanna, L., *Primitive Variable Solvers for Conservative General Relativistic Magnetohydrodynamics*, 2006, ApJ, **641**, 626
- 12) **McKinney, J.C.**, *Relativistic Force-Free Electrodynamics Simulations of Neutron Star Magnetospheres*, 2006, MNRAS Letters, **368**, L30
- 11) **McKinney, J.C.**, *General Relativistic Magnetohydrodynamic Simulations of Jet Formation and Large Scale Propagation from Black Hole Accretion Systems*, 2006, MNRAS Main Journal, **368**, 1561
- 10) **McKinney, J.C.**, *General Relativistic Force-Free Electrodynamics: A New Code and Applications to Black Hole Magnetospheres*, 2006, MNRAS Main Journal, **367**, 1797
- 9) **McKinney, J.C.**, *Total and Jet Blandford-Znajek Power in the Presence of an Accretion Disk*, 2005, ApJ Letters, **630**, L5-L8
- 8) **McKinney, J.C.** & Gammie, C.F., *A measurement of the hydromagnetic luminosity of a Kerr black hole*, 2004, ApJ, **611**, 977M
- 7) Watson, W. D., Wiebe, D. S., **McKinney, J. C.**, & Gammie, C. F., *Anisotropy of magnetohydrodynamic turbulence and the polarized spectra of OH masers*, 2004, ApJ, **604**, 707W
- 6) Gammie, C.F., Shapiro, S.L., & **McKinney, J.C.**, *Black hole spin evolution*, 2004, ApJ, **602**, 312G
- 5) Gammie, C.F., **McKinney, J.C.**, & Tóth, G., *HARM: A numerical scheme for general relativistic magnetohydrodynamics*, 2003, ApJ, **589**, 444G
- 4) **McKinney, J. C.** & Gammie, C. F., *Numerical models of viscous accretion flows near black holes*, 2002, ApJ, **573**, 728M
- 3) Anninos, P. & **McKinney, J.** *Relativistic hydrodynamics of cosmological sheets*, 1999, Phys. Rev. D **60**, 064011
- 2) Alekseev, K. N., Cannon, E. H., **McKinney, J. C.**, Kusmartsev, F. V., & Campbell, D. K. *Symmetry-breaking and chaos in electron transport in semiconductor superlattices*, 1998, Physica D. **113**, 129-133

- 1) Alekseev, K. N., Cannon, E. H., **McKinney, J. C.**, Kusmartsev, F. V., & Campbell, D. K. *Spontaneous dc current generation in a resistively shunted semiconductor superlattice driven by a terahertz field*, 1998, Phys. Rev. Lett. **80**, 2669-2672

## **Post-Graduate Invited Talks**

- Oct09 *Disk-Jet Connection*, HEPROII, Argentina  
<http://hepro2.iar-conicet.gov.ar/>
- Sept09 *Measuring Black Hole Spin*, IoA  
<http://www.ast.cam.ac.uk/meetings/disc09/>
- June09 *Simulating Black Holes, Disks, and Jets*, AAS Plenary Talk/Session102  
<http://aas.org/meetings/aas214/schedule/scientific.php>
- May09 *Stability of Relativistic Jets & Measuring Black Hole Spin*, APS  
<http://meetings.aps.org/Meeting/APR09/APS/Invited>
- April09 *SLAC Public Lecture Series: Black Holes: Brightest Objects in the Universe*  
[http://www2.slac.stanford.edu/lectures/info/2009/2009\\_04\\_28.htm](http://www2.slac.stanford.edu/lectures/info/2009/2009_04_28.htm)
- Mar09 *Stability of Relativistic Jets*, NSGRB2009  
[http://www.cfa.harvard.edu/events/2009/ns\\_grb/](http://www.cfa.harvard.edu/events/2009/ns_grb/)
- Mar09 *Relativistic Compact Objects and their Environs*, Caltech (Job Talk)
- Feb09 *Relativistic Compact Objects and their Environs*, MIT (Job Talk)
- Dec08 *General Relativistic Simulations of Black Hole Accretion Disks and Jets*, Northwestern (Job Talk)
- Aug08 *Simulations of Accreting Black Holes*, CA Astronomy Postdoc. Symposium  
<http://www.ucolick.org/~jkalirai/CaliPostdocSymposium/postdoc.html>
- Aug08 *Black Holes*, SLAC Summer Institute general pedagogical lecture  
<http://www-conf.slac.stanford.edu/ssi/>
- Apr08 *Ultrarelativistic Jet Solutions*, KIPAC SciDAC Meeting
- Dec07 *How to form Ultrarelativistic Jets*, Stanford ACKS
- Oct07 *How to form Ultrarelativistic Jets*, Berkeley TAC
- Apr07 *Relativistic Jets*, Univ. of Alabama, Tuscaloosa, AL
- Apr07 *Relativistic Jets*, NSSTC, Huntsville, AL
- Dec06 *Review Talk on AGN Jets*, 5th Stromlo Symposium, Texas in Australia  
<http://www.mso.anu.edu.au/5SS>
- Oct06 *Disk-Jet Coupling in Accreting X-ray Binary Systems*, MIT Workshop on Magnetized Accretion Disks. [http://xte.mit.edu/~rr/magdisk\\_workshop.ls](http://xte.mit.edu/~rr/magdisk_workshop.ls)
- Sep06 *Black Hole Accretion*, IAS  
<http://www.sns.ias.edu/~seminar/wed/seminars/fall06.html>
- Sep06 *Adventures in Relativistic MHD as Applied to Compact Objects*, CITA  
<http://www.cita.utoronto.ca/index.php/events/calendar/archive>
- Jul06 *Relativistic MHD Models of Accretion Disks*, Marcell Grossmann 11, CM2  
<http://www.icra.it/MG/mg11/>
- Jun06 *GRMHD Simulations of Jet Formation and Large-Scale Propagation from Black Hole Accretion Systems*, IAM, Sicily  
<http://www.mporzio.astro.it/cefalu2006/>
- May06 *Jet Formation and Propagation in Black Hole Accretion Systems*, BU
- May06 *Formation of Jets in MHD Simulations*, Sackler, Cfa  
<http://www.cfa.harvard.edu/bh2006/>
- Mar06 *Pulsar Spin-down*, NYU  
<http://www.physics.nyu.edu/cgi-bin/astro>
- Oct05 *Black Hole Jet Formation: Teaching forum for audience of graduate students*, Cfa, [http://cfa160.cfa.harvard.edu/~r\\_forum/](http://cfa160.cfa.harvard.edu/~r_forum/)
- Apr05 *Jet Formation in Black Hole Accretion Systems*, Cfa/TA
- Jan05 *GRMHD Models of Black Hole Accretion*, Black Hole Astrophysics, Kyoto  
<http://www2.yukawa.kyoto-u.ac.jp/~ykato/BHworkshop2004/program.html>
- Feb05 *The Blandford-Znajek effect and Spin Equilibrium*, Tapir, Caltech  
[http://www.tapir.caltech.edu/tapir\\_seminars.html](http://www.tapir.caltech.edu/tapir_seminars.html)

## **Computational Projects and Skills**

- Digital Demo Room:** Helped create an educational web portal for astrophysical simulations: <http://ddr.astro.uiuc.edu>
- Beowulf Cluster:** Was principle designer, builder, and manager of a 32 CPU Linux gigabit & Myrinet cluster for testing, development, and up to medium scale simulations:  
<http://rainman.astro.uiuc.edu/cluster/>
- Supercomputers:** Broad experience and knowledge including shared memory systems with OpenMP and clusters with MPI
- Programming:** C, FORTRAN77 & 90, C++, Visual C++, Bash, Tcl, Supermongo, Matlab, Vis5D+, Mathematica

## **References**

**Prof. Charles F. Gammie**  
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**Prof. Roger D. Blandford**  
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**Prof. Ramesh Narayan**  
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**Prof. Stuart L. Shapiro**  
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**Prof. William D. Watson**  
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