

CHI-KWAN CHAN

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Research Interests

High-energy astrophysics, computational physics, data-driven science, and virtual reality for scientific data visualization and education

Employment

2013 – Research Associate, Steward Observatory
2010 – 12 NORDITA Fellow, Nordic Institute for Theoretical Physics
2010 Teaching Fellow, Harvard University
2007 – 10 ITC Fellow, Harvard-Smithsonian Center for Astrophysics
2005 – 07 Summer Internship in Theory Division, Los Alamos National Laboratory
2003 – 07 Research Assistant in Astrophysics, University of Arizona
2002 – 03, 06 Teaching Assistant in Physics and Computational Physics, University of Arizona
2001 Teaching and Research Assistant in Mathematics, University of Arizona
2000 Software Developer in Computational Physics, Texas A&M University

Education

2007 Ph.D. in Physics, University of Arizona
2002 B.S. in Physics and Mathematics (Cum Laude), University of Arizona

Professional and Academic Service

2015 – Founder and contributor of the `mockservation` project
2015 – Co-founder of the AstroCardboard project and developer of the `RosettaTour` app
2009 – Peer reviewer for ApJ, MNRAS, PASJ, AA, and SIGGRAPH
2012 Co-organizer of the “Astrophysics Code Comparison Workshop” at NORDITA
2010 Guest lecturer in numerical analysis class on topics of GPU computation
2009 Co-organizer of the “Plasma Astrophysics Meetings” at ITC
2008 – 09 Member of the CfA Postdoc Council
2008 Member of the local organizing committee of the “Saturation and Transport Properties of MRI-driven Turbulence” conference at IAS
2007 – 08 Organizer of the “Astrophysical Turbulence Meetings” at ITC

Grants and Awards

- 2016–2017 “X-ray Variability of Sgr A* as a Probe of Plasma Physics in Accretion Flows”, Co-I (PI: Feryal Özel), Chandra X-ray Observatory Cycle 17 (Theory)
- 2013–2016 “Multi-Scale Plasma Flows Around Black Holes”, named collaborator (PI: Jonathan McKinney), NASA/NSF Theoretical and Computational Astrophysics Network
- 2010–2012 NORDITA Fellowship
- 2007–2010 Harvard ITC Fellowship
- 2007–2008 “Understanding the Flares of Sgr A* through 3D Radiative Magnetohydrodynamic Simulations”, Co-I (PI: Dimitrios Psaltis), Chandra X-ray Observatory Cycle 9 (Theory)

Student Mentorship (together with Dimitrios Psaltis and Feryal Özel)

- 2015– Ph.D. student David Ball on general relativistic radiative transfer
- 2015– Ph.D. student Lia Medeiros on “Time Variability and Interferometric Images in GRMHD Models of Sgr A*”
- 2011–2012 Graduate student Phillip Jenks on “Growth of Massive Black Holes by Super-Eddington Accretion”
- 2005–2006 Undergraduate student Robert Marcus on senior thesis

Selected Software Projects

- `lux` A versatile, scalable, extendable framework to simulate astrophysical systems, fully open sourced once completed
- `mockservation` A python package for managing and manipulating mock observations for the Event Horizon Telescope (<http://github.com/chanchikwan/mockservation>)
- `RosettaTour` A virtual reality mobile app compatible with Google Cardboard for touring the Rosetta mission (<http://github.com/AstroCardboard/RosettaTour>)
- `insight` An OpenGL-based interactive virtual reality data visualizer for Oculus Rift (<http://github.com/chanchikwan/insight>)
- `gray` A massive parallel ODE integrator for performing general relativistic radiative transfer using ray tracing (<http://github.com/chanchikwan/gray>)
- `orbits` A collection of symplectic integrators that are ideal for solving celestial mechanic problems (<http://github.com/chanchikwan/orbits>)
- `fg2` A 2D grid-based partial differential equation solver written in CUDA C and runs on nVidia GPUs (<http://github.com/chanchikwan/fg2>)
- `sg2` A 2D spectral Galerkin code written in CUDA C and runs on nVidia GPUs (<http://github.com/chanchikwan/sg2>)

Selected Talks

10. “GRay2: Improving General Relativistic Ray Tracing and Beyond”
TCAN Collaboration Meeting, Oct 2016
9. “Fast Variabilities in GRMHD Models of Sgr A* and Their Implications for EHT Observations”
International Astronomical Union Symposium 322, Jul 2016
8. “On MHD Turbulence and Angular Momentum Transport in Accretion Disk Boundary Layers”
International Astronomical Union Symposium 294, Aug 2012
7. “Condensates in Two Dimensional Turbulence”
FrischFest: the Solar Course, the Chemic Force, and the Speeding Change of Water, Oct 2011
6. “Local Anisotropy in MHD Turbulence”
RädlerFest: α Effect and Beyond, Feb 2011
5. “High Order Numerical Methods on GPUs”
Computational Physics with GPUs Conference at Lund Observatory, Nov 2010
4. “Lessons from Radiative and MHD Simulations for Supermassive Black Hole Growth”
Aspen Winter Conference on Formation and Evolution of Black Holes, Feb 2010
3. “What do Spectra Mean in MHD Turbulence?”
Institute for Advanced Study Thursday Seminar, May 2009
2. “Generalized Shearing Boxes for Multi-Scale Studies of MHD Turbulence”
Saturation and Transport Properties of MRI-driven Turbulence Conference at IAS, Jun 2008
1. “Toward Realistic Accretion Disk Simulations”
Los Alamos National Laboratory Theory Seminar, Jul 2007

Publications

26. “Variability in GRMHD Simulations of Sgr A*: Implications for EHT Closure Phase Observations”
Medeiros, L., **Chan, C.K.**, Özel, F., Psaltis, D., Kim, J., Marrone, D.P., & Sądowski, A. 2017 ApJ, 844, 35
25. “GRay2: A General Purpose Geodesic Integrator for Kerr Spacetimes”
Chan, C.K., Medeiros, L., Özel, F., & Psaltis, D. 2017 (arXiv:1706.07062)
24. “The Properties of Reconnection Current Sheets in GRMHD Simulations of Radiatively Inefficient Accretion Flows”
Ball, D., Özel, F., Psaltis, D., **Chan, C.K.**, Sironi, L. 2017 (arXiv:1705.06293)
23. “Bayesian Techniques for Comparing Time-Dependent GRMHD Simulations to Variable Event Horizon Telescope Observations”
Kim, J., Marrone, D.P., **Chan, C.K.**, Medeiros, L., Özel, F., Psaltis, D. 2016 ApJ, 832, 156
22. “Particle Acceleration and the Origin of X-ray Flares in GRMHD Simulations of Sgr A*”
Ball, D., Özel, F., Psaltis, D., & **Chan, C.K.** 2016 ApJ, 826, 77
21. “Persistent Asymmetric Structure of Sagittarius A* on Event Horizon Scales”
Fish, V.L., Johnson, M.D., Doeleman, S.S., ..., **Chan, C.K.**, et al. 2016 ApJ, 820, 90
20. “GRMHD Simulations of Visibility Amplitude Variability for EHT Images of Sgr A*”

- Medeiros, L., **Chan, C.K.**, Özel, F., Psaltis, D., Kim, J., Marrone, D.P., & Sądowski, A. 2016 submitted to ApJ (arXiv:1601.06799)
19. “A General Relativistic Null Hypothesis Test with Event Horizon Telescope Observations of the Black Hole Shadow in Sgr A*”
Psaltis, D., Özel, F., **Chan, C.K.**, & Marrone, D.P. 2015 ApJ, 814, 115
 18. “Fast Variability and mm/IR flares in GRMHD Models of Sgr A* from Strong-Field Gravitational Lensing”
Chan, C.K., Psaltis, D., Özel, F., Medeiros, L., Marrone, D.P., Sądowski, A., & Narayan, R. 2015 ApJ, 812, 103
 17. “The Power of Imaging: Constraining the Plasma Properties of GRMHD Simulations using EHT Observations of Sgr A*”
Chan, C.K., Psaltis, D., Özel, F., Narayan, R., & Sądowski, A. 2015 ApJ, 799, 1
 16. “GRay: A Massively Parallel GPU-based Code for Ray Tracing in Relativistic Spacetimes”
Chan, C.K., Psaltis, D., & Özel, F. 2013 ApJ, 777, 13
 15. “On Magnetohydrodynamic Turbulence and Angular Momentum Transport in Accretion Disk Boundary Layers”
Chan, C.K. & Pessah, M.E. 2013 IAU Symposium, 294, 349
 14. “Angular Momentum Transport in Accretion Disk Boundary Layers Around Weakly Magnetized Stars”
Pessah, M.E. & **Chan, C.K.** 2013 EPJ Web of Conferences, 46, 04004
 13. “On Hydromagnetic Stresses in Accretion Disk Boundary Layers”
Pessah, M.E. & **Chan, C.K.** 2012 ApJ, 751, 48
 12. “Dynamics of Saturated Energy Condensation in Two-Dimensional Turbulence”
Chan, C.K., Mitra, D., & Brandenburg, A. 2012 PhRvE, 85, 036315
 11. “A Class of Physically Motivated Closures for Radiation Hydrodynamics”
Chan, C.K. 2011 ApJ, 727, 67
 10. “Oscillations of the Inner Regions of Viscous Accretion Disks”
Chan, C.K. 2009 ApJ, 704, 68
 9. “MHD Simulations of Sgr A*: Quiescent Fluctuations, Outbursts, and Quasi-Periodicity”
Chan, C.K., Lui, S., Fryer, C.L., Psaltis, D., Özel, F., Rockefeller, G., & Melia, F. 2009 ApJ, 701, 521
 8. “Spectral Methods for Time-Dependent Studies of Accretion Flows. III. Three-Dimensional, Self-Gravitating, Magnetohydrodynamic Disks”
Chan, C.K., Psaltis, D., & Özel, F. 2009 ApJ, 700, 741
 7. “Viscous, Resistive Magnetorotational Modes”
Pessah, M.E. & **Chan, C.K.** 2008 ApJ, 684, 498
 6. “The fundamental difference between shear α -viscosity and turbulent magnetorotational stresses”
Pessah, M.E., **Chan, C.K.**, & Psaltis, D. 2008 MNRAS, 383, 683
 5. “Angular Momentum Transport in Accretion Disks: Scaling Laws in MRI-driven Turbulence”
Pessah, M.E., **Chan, C.K.**, & Psaltis, D. 2007 ApJ, 668, 51
 4. “A Local Model for Angular Momentum Transport in Accretion Disks Driven by the Magnetorotational Instability”

- Pessah, M.E., **Chan, C.K.**, & Psaltis, D. 2006 PRL, 97, 1103
3. “The Signature of the Magnetorotational Instability in the Reynolds and Maxwell Stress Tensors in Accretion Discs”
Pessah, M.E., **Chan, C.K.**, & Psaltis, D. 2006 MNRAS, 372, 183
 2. “Spectral Methods for Time-Dependent Studies of Accretion Flows. II. Two-Dimensional Hydrodynamic Disks with Self-Gravity”
Chan, C.K., Psaltis, D., & Özel, F. 2006 ApJ, 645, 506
 1. “Spectral Methods for Time-Dependent Studies of Accretion Flows. I. Two-dimensional, Viscous, Hydrodynamic Disks”
Chan, C.K., Psaltis, D., & Özel, F. 2005 ApJ, 628, 353