

Min-Kai Lin

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EMPLOYMENT

Academia Sinica Institute of Astronomy and Astrophysics

Associate Research Fellow

2021—

Assistant Research Fellow

2016—2021

University of Arizona

Steward Theory Fellow

2014—2016

Canadian Institute for Theoretical Astrophysics

Postdoctoral Fellow

2011—2014

AFFILIATIONS

National Center for Theoretical Sciences

Center Scientist and Coordinator, Theoretical and Computational Astrophysics

2021—

EDUCATION

University of Cambridge

PhD, Theoretical Astrophysics

2011

BA and MSci, Natural Sciences: Astrophysics (First Class honors)

2008

RESEARCH

Topics: theoretical astrophysics, astrophysical fluid dynamics, accretion disks, planet formation and evolution, numerical simulations

Computing languages: Fortran, C, IDL, Mathematica, Python

Codes: ATHENA, DEDALUS, FARGO, FARGO3D, PLUTO, ZEUS-MP

AWARDS

- Young Theoretical Scholar Award, National Center for Theoretical Sciences 2021
- Outstanding Young Physicist, The Physical Society of Taiwan 2020
- Academic Sinica Career Development Award 2020
- Academic Sinica Initial Employment Academic Research Award 2016
- Steward Observatory Prize Fellowship in Theoretical and Computational Astrophysics 2014
- CITA Postdoctoral Fellowship 2011
- Smith Rayleigh Knight Prize 2010
- Fellow of the Cambridge Overseas Society 2008
- St. John's College Benefactors' Scholarship 2008
- Isaac Newton Studentship 2008
- Overseas Research Scholarship 2008
- Institute of Astronomy Prize (top of class) 2008
- JS Wilson Prize for Natural Sciences 2006, 2007, 2008
- College Awarded Bursary 2007

- o Skerne Scholarship 2005, 2006, 2007, 2008
- o College Book Prize for Academic Distinction 2005, 2006, 2007, 2008

GRANTS (AS PI)

- MOST** **Regular Research Project**
- o *Finding hidden planets in empty gaps and big data (1/3)* (USD 48K) 2021—2022
110-2112-M-001-034-
- Academia Sinica** **Career Development Award**
- o *How are planets made in windy, turbulent disks?* (USD 620K) 2021—2025
AS-CDA-110-M06
- MOST** **Research Project for Newly-recruited Personnel**
- o *From dust and gas to planet formation and evolution* (USD 154K) 2018—2022
107-2112-M-001-043-MY3
- NASA** **Astrophysics Theory Program**
- o *Hydrodynamic processes in planet-forming accretion disks* (USD 300K) 2017—2020
NNX17AK59G

PROFESSIONAL MEMBERSHIP

- o International Astronomical Union, [URL here](#) 2018—
- o The Astronomical Society of the Republic of China (Taiwan) 2018—
- o The Physical Society of Taiwan 2020—

ACADEMIC SERVICES

Referee for: Nature Astronomy, The Astrophysical Journal, Astronomy & Astrophysics, Monthly Notices of the Royal Astronomical Society, Icarus, Astrophysics and Space Science, Geophysical & Astrophysical Fluid Dynamics, Research in Astronomy and Astrophysics

MOST proposal reviewer 2018—
Panelist, NASA proposal review panel 2015, 2016

ASIAA Colloquium Committee 2016—2021 (2017—2018 as chair)
ASIAA Summer Student Program Committee 2020— (2021— as chair)
ASIAA Theory Group HPC Committee (chair) 2018/19—

Chair, NCTS-ASIAA Joint Workshop: Star and Planet Formosa I Aug. 2022
LOC/SOC, NCTS Annual Theory Meeting Dec. 2021

LOC, TIARA Summer School on Origins of the Solar System Jul. 2018
LOC, Taiwanese Theoretical Astrophysics Workshop Sep. 2018
LOC, EANAM 8 Oct. 2018
LOC, TIARA/CHARMS Mini-Workshop on Disks in the Protoplanetary Systems Jul. 2017

SUPERVISION AND TEACHING

ASIAA

Postdocs

- o M. Hammer, *Windy disk-planet interactions* 2021—
- o M. Lehmann, *Dust dynamics in 3D protoplanetary disks* 2020—
- o S. Auddy (→ Iowa State U., postdoc), *Machine learning and disk-planet interaction* 2018—2020

Graduate students

- o S. Bandopadhyay, *Development of the Antares MHD code* (co-supervised with S. Shang) 2017—

Research assistants

- C.-Y. Hsu, *Dust-gas interaction in magnetized disks* 2020—

Undergraduate summer student program

- Lecture: *Accretion disks* Aug. 2017
- J.-W. Chen, *Dusty disk-planet simulations* 2017
- K. Chen, *Streaming instability in turbulent disks* 2017
- S. Tong, *Axisymmetric dusty disk-planet simulations* 2019
- J. Bi, *Three-dimensional dusty disk-planet simulations* 2019

National Taiwan University

Computational Astrophysics

- Protoplanetary disks: theory and simulations 2019

University of Arizona

Graduate research

- M. Hammer, *Numerical simulations of disk-planet interactions* (supervisor: Prof. K. Kratter) 2015—2021

ASTR 296: Topics in Astronomical Research

- 'Signposts of planet formation' Apr. 2015

CITA, University of Toronto

Undergraduate summer student program

- R. Les, *Gap formation and stability in non-isothermal protoplanetary discs* 2014
- R. Cloutier, *Orbital migration of giant planets induced by gravitationally unstable gaps* 2012

University of Cambridge

Undergraduate supervision

- Part II NST Astrophysical Fluid Dynamics 2011
- Part IA NST Mathematics 2008—2011

PUBLICATIONS

†directly supervised student

Submitted:

1. *Revealing the drag instability in the one-fluid non-ideal MHD simulations of a 1D isothermal C-shock*
Gu, P.-G., Chen, C.-C., Shen, E., Yen, C.-C., **Lin, M.-K.**, ApJ 2022
2. *Using Bayesian Deep Learning to infer planet mass from gaps in protoplanetary disks*
Auddy, S., Dey, R., **Lin, M.-K.**, Carrera, D., Simon, J.B., ApJ 2022
3. *Hydro-, magnetohydro-, and dust-gas dynamics of protoplanetary disks*
Lesur, G., Ercolano, B., Flock, M., **Lin, M.-K.**, Yang, C.-C., Barranco, J. A., Benitez-Llambay, P., Goodman, J., Johansen, A., Klahr, H., Laibe, G., Lyra, W., Marcus, P., Nelson, R.P., Squire, J., Simon, J.B., Turner, N., Umurhan, O.M., Youdin, A.N., Protostars and Planets VII 2022

Refereed:

36. *Impact of local pressure enhancements on dust concentration in turbulent protoplanetary discs*
Lehmann, M., **Lin, M.-K.**, A&A, 658, A156 2022
35. *Streaming instabilities in accreting and magnetized laminar protoplanetary disks*
Lin, M.-K., Hsu, C.-Y., ApJ, 926, 14 2022
34. *DPNNet-2.0 Part I: Finding hidden planets from simulated images of protoplanetary disk gaps*
Auddy, S., Dey, R., **Lin, M.-K.**, Hall, C., ApJ, 920, 3 2021
33. *On the vertical shear instability in magnetized protoplanetary disks*
Cui, C., **Lin, M.-K.**, MNRAS, 505, 2983 2021

32. *Which planets trigger longer-lived vortices: low-mass or high-mass?*
Hammer, M., **Lin, M.-K.**, Kratter, K.M., Pinilla, P., MNRAS, 504 3963 2021
31. *Puffed up edges of planet-opened gaps in protoplanetary disks I. Hydrodynamic simulations*
†Bi, J., **Lin, M.-K.**, Dong, R., ApJ, 912, 107 2021
30. *Stratified and vertically shearing streaming instabilities in protoplanetary disks*
Lin, M.-K., ApJ, 907, 64 2021
29. *A Machine Learning model to infer planet masses from gaps observed in protoplanetary disks*
Auddy, S., **Lin, M.-K.**, ApJ, 900, 62 2020
28. *Migrating low-mass planets in inviscid dusty protoplanetary discs*
Hsieh, H.-F., **Lin, M.-K.**, MNRAS, 497, 2425 2020
27. *How efficient is the streaming instability in viscous protoplanetary disks?*
†Chen, K., **Lin, M.-K.**, ApJ, 891, 132 2020
26. *Vortex instabilities triggered by low-mass planets in pebble-rich, inviscid protoplanetary discs*
Pierens, A., **Lin, M.-K.**, Raymond, S., MNRAS, 488, 645 2019
25. *Dust settling against hydrodynamic turbulence in protoplanetary discs*
Lin, M.-K., MNRAS, 485, 5221 2019
24. *Observational diagnostics of elongated planet-induced vortices with realistic planet formation timescales*
Hammer, M., Pinilla, P., Kratter, K., **Lin, M.-K.**, MNRAS, 482, 3609 2019
23. *On the evolution of vortices in massive protoplanetary discs*
Pierens, A., **Lin, M.-K.**, MNRAS, 479, 4878 2018
22. *Dusty disc-planet interaction with dust-free simulations*
†Chen, J.-W., **Lin, M.-K.**, MNRAS, 478, 2737 2018
21. *Vortex survival in 3D self-gravitating accretion discs*
Lin, M.-K., Pierens, A., MNRAS, 478, 575 2018
20. *A thermodynamic view of dusty protoplanetary disks*
Lin, M.-K., Youdin, A.N., ApJ, 849, 129 2017
19. *Slowly-growing gap-opening planets trigger weaker vortices*
Hammer, M., Kratter, K.M., **Lin, M.-K.**, MNRAS, 466, 3 2017
18. *On the gravitational stability of gravito-turbulent accretion disks*
Lin, M.-K., Kratter, K.M., ApJ, 824, 91 2016
17. *Cooling requirements for the vertical shear instability in protoplanetary disks*
Lin, M.-K., Youdin, A.N., ApJ, 811, 17 2015
16. *Gap formation and stability in non-isothermal protoplanetary discs*
†Les, R., **Lin, M.-K.**, MNRAS, 450, 1503 2015
15. *One-armed spirals in locally isothermal, radially structured self-gravitating discs*
Lin, M.-K., MNRAS, 448, 3806 2015
14. *Linear stability of magnetized massive protoplanetary disks*
Lin, M.-K., ApJ, 790, 13 2014
13. *Testing large-scale vortex formation against viscous layers in three-dimensional discs*
Lin, M.-K., MNRAS, 437, 575 2014

12. *Steady state of dust distributions in disk vortices: observational predictions and applications to transitional disks*
Lyra, W., **Lin, M.-K.**, ApJ, 775, 17 2013
11. *Orbital migration of giant planets induced by gravitationally unstable gaps: the effect of planet mass*
†Cloutier, R., **Lin, M.-K.**, MNRAS, 434, 621 2013
10. *Non-barotropic linear Rossby wave instability in three-dimensional disks*
Lin, M.-K., ApJ, 765, 84 2013
9. *Effects of upper disc boundary conditions on the linear Rossby wave instability*
Lin, M.-K., MNRAS, 428, 19 2013
8. *Vortex and spiral instabilities at gap edges in three-dimensional self-gravitating disc-satellite simulations*
Lin, M.-K., MNRAS, 426, 3211 2012
7. *Rossby wave instability in locally isothermal and polytropic disks: three-dimensional linear calculations*
Lin, M.-K., ApJ, 754, 21 2012
6. *Outward migration of a giant planet with a gravitationally unstable gap edge*
Lin, M.-K., Papaloizou, J.C.B., MNRAS, 421, 780 2012
5. *Spin-down of protostars through gravitational torques*
Lin, M.-K., Krumholz, M. R., Kratter, K. M., MNRAS, 416, 580 2011
4. *Edge modes in self-gravitating disc-planet interactions*
Lin, M.-K., Papaloizou, J.C.B, MNRAS, 415, 1445 2011
3. *The effect of self-gravity on vortex instabilities in disc-planet interactions*
Lin, M.-K., Papaloizou, J.C.B, MNRAS, 415, 1426 2011
2. *Type III migration in a low viscosity disc*
Lin M.-K., Papaloizou, J.C.B, MNRAS, 405, 1473 2010
1. *Three-layer magnetoconvection*
Lin, M.-K., Silvers, L. J., Proctor, M.R.E., Physics Letters A, 373, 69 2008

Conference proceedings and abstracts:

5. *Insights into the Streaming Instability in Protoplanetary Disks*
Youdin, A.N., **Lin, M.-K.**, Li, R., AAS -DPS meeting 49, #500.06 2017
4. *Vertical shear instability in the solar nebula*
Lin, M.-K., Youdin, A.N., IAUS 314 proceedings 2016
3. *Gravitational instability of planetary gaps and its effect on orbital migration*
Lin, M.-K., *Cloutier, R., IAUS 299 proceedings 2014
2. *Instabilities at planetary gap edges in 3D self-gravitating disks*
Lin, M.-K., Instabilities and Structures in Proto-Planetary Disks, Marseille, France, EPJ Web of Conferences, 46, id.07001 2013
1. *Evolution of bar-driven disks under the influence of the interaction between two inner Lindblad resonances*
Yuan, C., Yen, D. C. C., **Lin, M.-K.**, AAS meeting 207, #188.04 2005

Outreach:

2. *Exoplanet science: a new era of astronomy (in Chinese)*
Lin, M.-K., Physics Bimonthly, [URL here](#) 2020

PRESENTATIONS

- *Hopes and challenges in modern planet formation*
Colloquium, NCU, Taiwan Apr. 2022
Colloquium, ASIES, Taiwan Apr. 2022
Invited talk, NCTS Forum, TPS Annual Meeting, NTNU, Taiwan Jan. 2022
- *Vertically shearing streaming instabilities in protoplanetary disks*
TPS Annual Meeting, NTNU, Taiwan Jan. 2022

- *Hopes and challenges in modern planet formation*
NCTS Annual Theory Meeting, NTU, Taiwan Dec. 2021
- *Vortex survival in 3D self-gravitating protoplanetary disks*
Distorted Astrophysical Discs (online), University of Cambridge, UK May 2021
- *Making planets from small grains and big data*
Colloquium, Beijing Normal University, China Oct. 2021
Colloquium, NTHU, Taiwan Mar. 2021
- *Vertically shearing streaming instabilities in protoplanetary disks*
Laboratory Fluid Dynamics for Disks and Planets (online), Ringberg, Germany Sep. 2021
Invited talk, Cores to Codes, ASIAA, Taiwan Mar. 2021

- *Stratified and vertically-shearing streaming instabilities in protoplanetary disks*
Planetsimal formation meeting (remote), Lund University, Sweden Nov. 2020
- *Making planets from small grains and big data*
StarPlan seminar (remote), University of Copenhagen, Denmark May 2020
Seminar (remote), University of Warwick, UK Oct. 2020
Exoplanet seminar (remote), University of Cambridge, UK Nov. 2020
DAMTP seminar (remote), University of Cambridge, UK Nov. 2020
GIAP seminar, National Chengchi University, Taiwan Dec. 2020
- *Planetesimal formation in turbulent protoplanetary disks*
Annual Meeting of the Physical Society of Taiwan, NPTU Feb. 2020

- *Dust dynamics in (3D) protoplanetary disks*
2nd Workshop for Protoplanetary Disks and Exoplanets, ASIAA Dec. 2019
- *Hydrodynamic activity in planet-forming disks*
Invited review, Planet Formation Workshop, NAOJ, Japan Nov. 2019
- *The thickness of dusty protoplanetary disks depends on metallicity*
Extreme Solar Systems IV, Reykjaik, Iceland Aug. 2019
- *A rocky road from dust to planets*
Seminar, Herzberg Astronomy and Astrophysics Research Centre, Victoria, Canada May 2019
Invited colloquium, Tsinghua University, Beijing, China May 2019
- *Dust settling in turbulent protoplanetary disks*
Annual Meeting of the Physical Society of Taiwan, NCTU, Taiwan Jan. 2019
New Horizons in Planetary Systems, Victoria, Canada May 2019
CCA Planet Formation Workshop, Flatiron Institute, New York, USA May 2019
Great Barriers in Planet Formation, Palm Cove, Australia Jul. 2019
Theory Group Workshop, ASIAA, Taiwan Jul. 2019

- *Astrophysical fluid dynamics: accretion disks*
Mini-school on Computational Astrophysics, ASIAA, Taiwan Oct. 2018
- *Dust settling in turbulent protoplanetary disks*
Taiwanese Theoretical Astrophysics Workshop, ASIAA, Taiwan Sep. 2018

- 8th East Asian Numerical Astrophysics Meeting, NCKU, Taiwan Oct. 2018
- *Linear hydrodynamics of protoplanetary discs: a crash course*
TIARA Summer School on Origins of the Solar System, ASIAA, Taiwan Jul. 2018
- *Dust-free modelling of dusty protoplanetary discs*
Exoplanets II, Cambridge, UK Jul. 2018
Planets, Stars and Discs: A Golden Age for Particle and Gas Dynamics, Oxford, UK Jul. 2018
- *Footprints of planet formation*
Colloquium, National Taiwan Normal University, Taiwan May 2018
- *Dust dynamics in protoplanetary disks*
Seminar, Imperial College London, UK Mar. 2018
Seminar, University of Bristol, UK Mar. 2018
Seminar, Queen Mary University of London, UK Mar. 2018
Seminar, University of Exeter, UK Mar. 2018
Seminar, University of Leicester, UK Mar. 2018
Colloquium, ASIAA, Taiwan Nov. 2018
Colloquium, NTHU, Taiwan Nov. 2018
- *Lifting dust particles by the vertical shear instability*
ALMA North American-Taiwan Joint Workshop Feb. 2018
ASROC Annual Meeting, Kinmen May 2018
- *Footprints of planet formation*
Invited colloquium, National Central University, Taiwan Oct. 2017
Invited colloquium, Chung Yuan Christian University, Taiwan Oct. 2017
- *Dust-free modeling of dusty protoplanetary disks*
Exoplanets and Planet formation, Shanghai, China Dec. 2017
TIARA/CHARMS Mini-Workshop on Disks in the Protoplanetary Systems, Taiwan Jul. 2017
Cross-Strait Symposium of Astrophysics, ASIAA, Taiwan Jul. 2017
Asia-Pacific Regional IAU Meeting, Taipei, Taiwan Jul. 2017
- *Hydrodynamic models of dusty protoplanetary disks*
ALMA Band 1 Workshop, ASIAA, Taiwan Jan. 2017
- *Vortex dynamics in protoplanetary disks*
EANAM 7, Beijing, China Oct. 2016
- *Non-ideal gravitational instabilities in protoplanetary disks*
Exoplanets I, Davos, Switzerland Jul. 2016
- *Hydrodynamic processes in protoplanetary disks*
API Colloquium, University of Amsterdam, The Netherlands Jun. 2016
- *Hydrodynamic activity in protoplanetary disks*
Colloquium and CompAS seminar, ASIAA, Taipei, Taiwan Apr. 2016
Lunchtime talk, University of Leicester, UK Mar. 2016
Journal club talk, Queen Mary University of London, UK Mar. 2016
- *Vortex (and spiral) instabilities in structured protoplanetary disks*
Protoplanetary DISCUSSIONS, University of Edinburgh, UK Mar. 2016
- *How to fragment protostellar disks with your bare hands*
FLASH talk, NOAO, Tucson, Arizona, USA Feb. 2016
- *Vertical shear instability in protoplanetary disks*
Protoplanetary Disk Dynamics and Planet Formation, Yokohama, Japan Sep. 2015
In the Spirit of Lyot, Montreal, Canada; CITA fluids talk Jun. 2015
IAUS 314: Young Stars & Planets Near the Sun, Atlanta, USA May 2015
- *On the formation of one-armed spirals in locally isothermal disks*
Disc Dynamics & Planet Formation, Larnaka, Cyprus Jun. 2015
Star and Planet Formation in the Southwest, Tucson, USA Mar. 2015
- *Strange aspects of locally isothermal astrophysical disks and the stability of magnetized massive*

- disks*
UC Berkeley CIPS seminar Feb. 2015
- *Gap formation and stability in non-isothermal protoplanetary disks*
Characterizing Planetary Systems Across the HR Diagram, Cambridge, UK Jul. 2014
 - *From the complex plane to planet formation*
CITA (ISIMA talk), University of Arizona Jul. 2014
 - *Dust trapping in protoplanetary disk vortices*
University of Toronto Mar. 2014
 - *Large-scale hydrodynamic instabilities and structures in protoplanetary disks*
Centre for Star and Planet Formation/Niels Bohr Institute, Copenhagen, Denmark Jan. 2014
 - *Gravitational instability of planetary gaps and its effect on orbital migration*
IAUS 299: Exploring the Formation and Evolution of Planetary Systems, Victoria, Canada Jun. 2013
University of Toronto May 2013
 - *Large-scale hydrodynamic instabilities in protoplanetary disks*
MIT, Harvard-Smithsonian CfA Apr. 2013
 - *Large-scale vortex formation in protoplanetary disks*
Cornell University (invited colloquium), Princeton University Feb. 2013
University of Toronto Nov. 2012
 - *Vortices and spirals at gap edges in 3D self-gravitating disk-planet simulations*
American Geophysical Union Fall Meeting, San Francisco, USA Dec. 2012
Instabilities and Structures in Protoplanetary Disks, Marseille, France Sep. 2012
 - *Planet migration with gravitationally unstable gaps*
University of Cambridge Oct. 2011
 - *Vortex instabilities in self-gravitating disc-planet interactions*
Baroclinic Instability and Protoplanetary Accretion Disks, Ringberg, Germany Jun. 2011
 - *The stability of self-gravitating gaps*
ASIAA; University of Cambridge Nov. 2010
 - *Spin down of protostars through gravitational disk torques*
East Asian Numerical Astrophysics Meeting, ASIAA, Taiwan Nov. 2010
International Summer Institute for Modeling in Astrophysics, UC Santa Cruz, USA Aug. 2010
 - *Type III migration in a low viscosity disc.*
American Museum of Natural History, New York City, USA Jan. 2010
 - *Type III migration in a low viscosity disc.*
Winter Workshop on Planetary Astrophysics, KIAA, Peking University, China Dec. 2009
University of Cambridge Oct. 2009
 - *Vortices in planetary migration*
Dynamics of Discs and Planets, Cambridge, UK Aug. 2009
 - *Three-layer magnetoconvection*
UKMHD, Coventry University, UK Jun. 2009

OTHER WORK EXPERIENCES

UC Santa Cruz

ISIMA summer student 2010
Project: Numerical simulations of star-disk interaction, with M. Krumholz and K. Kratter

DAMTP, University of Cambridge

Summer student 2007
Project: Three-layer magneto-convection, with L. Silvers and M. Proctor

ASIAA, Taipei, Taiwan

Summer/visiting student

Project: Bar-driven density waves in galactic disks, with C. Yuan and D.C.C. Yen

2005, 2006

REFERENCES

Professor You-Hua Chu

ASIAA

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