2023 ACADEMIA SINICA
EARLY-CAREER INVESTIGATOR
RESEARCH ACHIEVEMENT AWARD

林 明 楷
中央研究院天文及天文物理研究所副研究員

代表著作：

- **Lin, M.-K.**, 2019, Dust Settling Against Hydrodynamic Turbulence in Protoplanetary Discs, *Monthly Notices of the Royal Astronomical Society,* Volume 485, Issue 4, p.5221-5234.
- **Lin, M.-K.**, 2021, Stratified and Vertically Shearing Streaming Instabilities in Protoplanetary Disks, *The Astrophysical Journal*, Volume 907, Issue 2, id.64, 20 pp.
- Bi, J., **Lin, M.-K.**, Dong, R., 2021, Puffed-up Edges of Planet-opened Gaps in Protoplanetary Disks. I. Hydrodynamic Simulations, *The Astrophysical Journal*, Volume 912, Issue 2, id.107, 10 pp.

簡評：

林博士運用數學分析及三維的數值模擬，研究行星形成的完整過程，說明湍流、垂直結構、磁場、熱運動等機制在此過程中的作用。特別是他對於「垂直剪切流不穩定性」理論的研究結果， 在了解微行星形成機制和星盤觀測結果方面有重大影響。

簡歷：

林明楷博士是一位理論天文物理學家。他以結合數學分析和大尺度電腦模擬的方式深入瞭解行星和行星系統在年輕恆星周圍的原行星盤中是如何形成和演化的。

林明楷在 2008 年於英國劍橋大學取得學士和碩士學位，並於 2011 年在劍橋大學數學與理論物理系完成博士學業。他於 2011 年至 2014 年間在加拿大理論天文物理學研究所擔任博士後。2014 至 2016 年間，他在美國亞利桑那大學擔任首位『斯圖爾特天文台理論和計算天文物理獎』博士後。2016 年 11 月，林明楷加入中央研究院擔任助研究員，並在 2021 年升等為副研究員。他也是國家科學理論中心天文物理組的現任召集人。

林明楷在 2022 年獲得傑出人才基金會年輕學者創新獎，2021 年獲得國家理論科學研究中心年輕理論學者獎，以及在 2020 年獲得臺灣物理學會傑出年輕物理學者獎。他在 2020 年獲取中央研究院前瞻計畫補助。

Dr. Min-Kai Lin is a theoretical astrophysicist interested in the formation of planets and planetary systems. His research combines mathematical analyses with advanced computer simulations to gain insights into how planets form and evolve within protoplanetary disks surrounding young stars.

Min-Kai earned his Bachelor's and Master's degrees from the University of Cambridge in 2008. He then completed a Ph.D. in the Department of

Mathematics and Theoretical Physics at the University of Cambridge in 2011. He pursued postdoctoral research at the Canadian Institute of Theoretical Astrophysics, University of Toronto, from 2011 to 2014. Later, he served as the inaugural Steward Observatory Prize Fellow in Theoretical and Computational Astrophysics at the University of Arizona from 2014 to 2016. In November 2016, Min-Kai returned to Taiwan to join ASIAA as an Assistant Research Fellow and was promoted to Associate Research Fellow in 2021. He is also the current Co-ordinator of the Theoretical and Computational Astrophysics group at the National Center for Theoretical Sciences.

Min-Kai's contributions to astrophysics have been recognized with several prestigious awards. In 2022, he was honored with the Young Scholars' Creativity Award from the Foundation for the Advancement of Outstanding Scholarship. Before this, he received the Young Theoretical Scholar Award from the National Center for Theoretical Sciences in 2021, as well as the Outstanding Young Physicist Award from the Taiwan Physical Society in 2020. He was the recipient of an Academia Sinica Career Development Award in 2020.

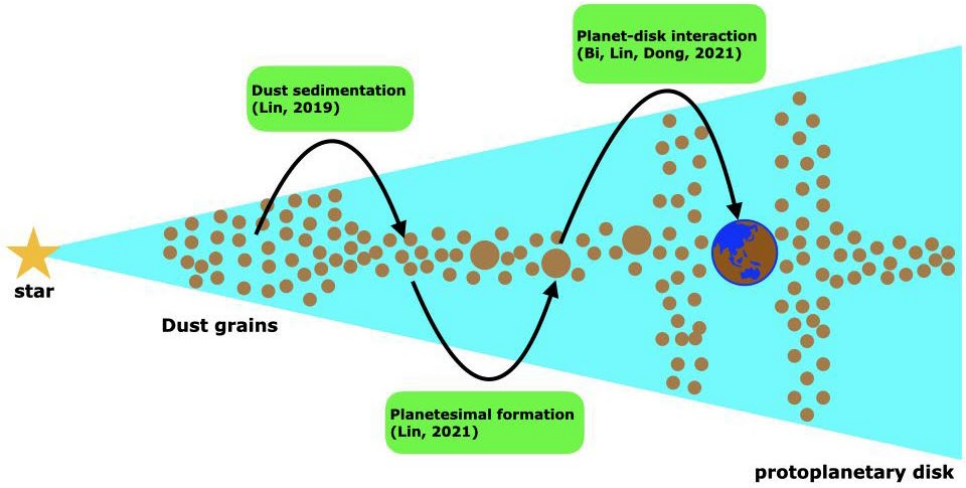
代表作簡介：

行星是由微行星所組成，而微行星則是在環繞新恆星的氣態『原行星盤』中由塵埃聚集而成。在 Lin（2019）和 Lin（2021）兩篇著作裡，我深究塵埃與星盤氣流相互作用的複雜物理。我利用高解析度電腦模擬，發現塵埃沉降的過程——可以說是微行星形成的第一步——只在星盤有足夠的塵埃質量時才能發生。我進一步用數學分析發現，即使這一步成功了，塵埃層也極可能受到劇烈不穩定性的影響，因而阻礙微行星形成。

然而，觀測上行星形成很有效率，而新行星還會與星盤互動。我和中研院天文所暑期學生利用電腦模擬行星與星盤的互動細節，發現新行星會以三維的方式「膨脹」其周圍的塵埃（Bi, Lin, and Dong, 2021）。這是過去二維計算無法捕捉的結果，但對於解釋星盤觀測卻有重要影響。這些問題挑戰了我們對現今行星形成與演化論以及觀測，迫使我們思考新的研究方向和方式。

Planets are formed from planetesimals, themselves formed from small dust grains embedded in gaseous “protoplanetary disks” (PPDs) around young stars. Dust-gas interaction therefore plays a critical role in planet formation. In Lin (2019) and Lin (2021), I explore the fundamental physics of dust-gas interaction in realistic models of PPDs. Using high-resolution numerical simulations, I showed that the sedimentation of dust grains to the disk midplane — arguably the first step to planetesimal formation — can only proceed if there is enough dust in a turbulent disk. I then used mathematical analyses to show that, even when settled, dust layers are subject to violent instabilities that could still hinder planetesimal formation. These difficulties challenge our understanding of modern planet formation and inspire new directions for future research.

On the other hand, observations suggest that planets form efficiently and likely continue to interact with their surroundings after their formation. Together with a student from the ASIAA Summer Student Program, we carried out detailed numerical simulations and discovered that a newly born planet can “puff up” its surrounding dust grains in a complex, fully 3D fashion that cannot be captured by previous 2D models (Bi, Lin, and Dong, 2021). Our finding can potentially be applied to distinguish between planet and non-planetary origins of substructures that are often observed in PPDs.



得獎感言：

我深感榮幸獲此殊榮。感謝中研院及評審委員會的肯定，天文所以及理論中心提供的優良學術環境，國科會及國家計算中心提供的豐沛資源與設施，以及前輩與同事的幫助。感謝家人堅定的支持讓我得以專注研究。希望這個獎能時刻提醒自己保持好奇心，並以決心應對挑戰。我將繼續以熱情與熱忱勇往前行。

I am deeply honored to receive this award. I sincerely thank Academia Sinica and members of the evaluation committee for this recognition. I thank the Institute of Astronomy and Astrophysics, as well as the National Center for Theoretical Sciences, for their support and fostering an environment of excellence in fundamental sciences. I also thank the National Science and Technology Council and the National Center for High-Performance Computing for providing the resources and facilities that made this work possible. I thank my mentors and collaborators for their help on my academic journey. I am grateful to my family, especially my wife, for their unwavering support that allowed me to focus on my research. May this award serve as a reminder to always pursue curiosity and accept challenges with determination. I am eager to continue this path with renewed enthusiasm and passion.