MONASH University
School of Physics and Astronomy

OzGrav
ARC Centre of Excellence for Gravitational Wave Discovery

Prof. Ilya Mandel
School of Physics and Astronomy
Monash University
Australia

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Dear Hong Kong Laureate Forum selection committee:

I am writing this letter to very strongly support the application of my former PhD student Yui Ming **Mike Lau** to participate in HKLF.

Mike is one of a very rare breed of young astrophysics theorists who is comfortable in all approaches to the problem – analytical, phenomenological, and numerical. He has remarkable breadth for his career stage, having worked on topics as diverse as gravitational-wave sources, dynamics, mass transfer in binaries, stellar evolution, computational hydrodynamics applied to both common envelopes and planetary engulfment, and rapid binary population synthesis. He is eager to ask the tough questions and seek answers on his own, but is also a very pleasant collaborator and team player. Mike is an excellent communicator and a very clear writer. Mike is both very intelligent and very hard-working. He is a natural leader through his ability and dedication. Mike has the necessary skills and drive to be a successful astrophysicist, and I warmly endorse him for this opportunity. Below, I discuss a few examples that justify this view.

I first met Mike in 2018, when I was a professor at the University of Birmingham in the UK, and Mike was a student at Oxford. Mike took up a summer research project in my group at Birmingham. Mike's goal for this project was to explore the observing prospects for double neutron star systems with the planned LISA space gravitational-wave detector. Mike wrote his own code for simulating the detectability of gravitational waves from binary neutron stars with LISA. He dealt with thorny issues such as the contribution of highly eccentric signals. He explored the expected spatial distribution of Galactic double neutron stars, which has an impact on their detectability, and interfaced with a galaxy catalogue to investigate the contributions from other galaxies in the local group. He became an expert on modelling isolated binary evolution with my group's rapid binary population synthesis code COMPAS. Ultimately, Mike determined that LISA could observe several tens of binary neutron stars, which could be distinguished from double white dwarf binaries through their masses and eccentricities. Mike wrote up his results in Lau et al., 2020, *Detecting Double Neutron Stars with LISA*, MNRAS 492, 3061, arXiv:1910.12422. (It's worth saying that Mike's drafts of the paper were among the clearest of any first student research paper I supervised.)

When Mike finished his undergraduate degree, I was very fortunate to convince him to continue our collaboration by coming to Monash University for his PhD. He was a

member of my group here since September of 2019 until completing his PhD in 2023. He achieved maximum marks in every rubric of his candidacy.

When we discussed possible research directions for his PhD, it was very clear that Mike wanted to attack the toughest problems that would enable him to learn the most. Rather than continuing with population synthesis models, he chose to dive into smooth particle hydrodynamics. He mastered the Phantom SPH code under the guidance of its lead author Prof. Daniel Price (who, along with Dr. Ryo Hirai, acted as Mike's co-supervisor). Mike explored the common envelope phase in massive stellar binaries, a field which has seen only a few papers due to its complexity. Mike resolved multiple technical issues with stabilising the stars and confirming that the dynamical inspiral is consistent with expectations from wind-tunnel drag simulations. He obtained very interesting results on the impact of the equation of state and the contribution of recombination energy to the ejection of the envelope, confirming the robustness of his results with resolution studies. In particular, Mike's work, published in two first-author papers, demonstrated the very crucial role played by radiation pressure and by helium recombination energy in common envelopes in massive binaries.

Mike independently secured a prestigious pre-doctoral fellowship at the Flatiron Center for Computational Astrophysics. There, he collaborated with Matteo Cantiello and Adam Jermyn to study the capture of planets by stars using hydrodynamical simulations. Mike very quickly came up to speed on this new topic, immediately focussing on some of the salient features, from the susceptibility of the planet to tidal disruption and ram pressure ablation, to the rate of energy release through hydrodynamical drag and subsequent transmission through an optically thick envelope, to the potential observational constraints from both transient lightcurves and chemical abundance enhancements. Mike's approach successfully combined detailed numerical models with an understanding of the underlying physics, leading to a study of hot Jupiter engulfment by a red giant star. He led a paper based on this work.

While Mike's papers often carry multiple co-authors, he really leads the projects on which he appears as first author from beginning to end, i.e., from project formulation through code development to the analysis and interpretation of results and the paper writing. It is worth saying that since his first paper draft, Mike's papers have been among the clearest of any research papers, not to mention student research papers, that I've had the pleasure of collaborating on. One of Mike's special strengths, which he developed very early in his research career, is his ability to critically evaluate his work. When Mike would share a plot that he created and I or other collaborators would start musing about how to investigate some aspect of it that we hadn't anticipated, it almost inevitably turned out that Mike had already thought about it, figured out the best way to examine it, and had the results in hand.

I will not list all of Mike's 16 papers (including 5 first-author ones – an impressive haul 5.5 years after starting his PhD), but will highlight a few more. Mike led an investigation of the impact of rapid mass accretion on the radial expansion a star (this time using a 1-dimensional stellar evolution code, MESA, along with analytical insights), and wrote an important paper on the consequences of this phenomenon. He contributed to my group's rapid binary population synthesis code, COMPAS, and to the COMPAS methods paper. He was recently invited to be a co-author on an article for the Encyclopedia of Astrophysics, a testament to his standing in the scientific community.

Mike won the prestigious Croucher Fellowship and Croucher Research Fellowship, taking the latter to the Heidelberg Institute for Theoretical studies in Germany. He is doing fantastic work there, continuing to deepen our understanding of mass transfer physics using a wide variety of computational tools and analytical insights. For example, Mike is exploring hydrodynamical drag and ablation to studying the impact of radiation transport on the common envelope phase.

Mike is very engaging, organised, and skilled at scientific communication. For example, while at Monash, he was a fantastic contributor to group activities. For example, he organised a weekly session on whiteboard derivations in my group, serving as one of the most regular presenters. These white-board sessions became sufficiently successful that they are now attended by several faculty members in addition to grad students and postdocs!

Mike is one of the strongest students (the strongest on several metrics) whom I supervised at Northwestern University, the University of Birmingham, and Monash University, which places him on par with or ahead of former students who have gone on to prestigious postdoctoral and faculty positions. I expect Mike to take full advantage of the opportunity provided by the HKLF meeting to interact and exchange ideas with other researchers. In the longer term, I anticipate that Mike will take advantage of the opportunities provided by this meeting as a step in a successful academic career.

In conclusion, I'd like to quote what one of Mike's examiners, Prof. Enrico Ramirez-Ruiz (UC Santa Cruz, a renowned expert in the subject) had to say about the PhD thesis: "This is an excellent body of work and there is no question that the thesis is outstanding. While the candidate has been highly prolific in his publication rate, his portfolio of work includes papers that are deep, thorough, and broad, and so they are having a long lasting impact in the field. To me, his general sense of promise based on imagination, energy, and black-belt skills as a computational theorist makes Mike Lau one of the most outstanding PhD candidates I reviewed over the past decade. His work is deep, reliable, and ultimately profound."

Sincerely yours,

Ilya Mandel
Professor of Theoretical Astrophysics
OzGrav Chief Investigator
ARC Future Fellow
School of Physics and Astronomy
Monash University
19 Rainforest Walk
Clayton, VIC 3800
Australia
ilya.mandel@monash.edu