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Dated 19 May 2025

Reference Letter: Mr. Simon Man Chun Yeung

To whom it may concern,

I am pleased to strongly recommend Mr. Simon Man Chun Yeung. I am the current PI of the CUHK LSC and KAGRA groups in Hong Kong, the current gravitational-wave lensing sub-group chair, and an Assistant Professor in charge of 11 graduate students and two postdoctoral researchers. I met Mr. Yeung for the first time in 2021 and have met with him almost daily since then. I am familiar with most of the publications and preprints he has worked on since 2021. Please, however, note that I am not commenting on Simon's involvement in non-lensing gravitational-wave projects, as my involvement in these efforts has not been substantial.

Mr. Yeung has made significant contributions to the field of wave optics lensing. One critical avenue in the community is to develop tools to detect and analyze various gravitational-wave lensing signatures, including strong lensing, microlensing,and millilensing. Mr Yeung's work lays out a numerical foundation for studying one of the primary methods to search for wave optics lensing, which is the limit where gravitational waves couple with small-scale lenses in diffraction limit, causing wave patterns similar to those seen in double slit experiments. For the first time since 2017, I am personally very excited because I believe we have made significant progress, thanks to Mr. Yeung's recent work.

Mr Yeung's recent work is two-fold, with the second project being accidental. As of around 8 months ago, in his first project he wanted to tackle the problem of microlensing parameter estimation. Mr. Yeung in particular worked with the question "given how numerically expensive it is for us to model wave optics lensing using the package Mr. Yeung created, how can we recover wave optics effects in parameter estimation which requires order 100s of millions of robust waveforms that need generation?" This has been an unsolved problem since 2017, hindering LVK progress on the microlensing side. Mr Yeung has not solved the problem, but he has made significant progress towards solving it by avoiding waveform generation in the parameter estimation using phenomenological models that he has shown could recover the wave optics effects in the large majority of the cases. Mr. Yeung had set a plan to publish the results, but he came across strange waveforms that could not be recovered with this phenomenological waveform. As we now understand, these strange waveforms were caused by complex, exponentially damped lensing images that do not exist in the geometrical optic theory. Mr. Yeung is currently writing an article about these images and their consequences for gravitational-wave lensing. This is his second project, which we decided to complete before the first one, in order to understand the impact of these images on our phenomenological model and to see if we can modify the phenomenological model to ultimately recover the strange features they cause as well. These has been analytical work discussing these images in caustic crossing theory by Lo et al. and Picard-Lefshetz theory by Feldbrugge et al., but the consequence of these complex images on gravitational-wave data-analysis is not understood.

Throughout this project, Mr. Yeung is using his own wave optics modelling package which he created after publishing his first work in MNRAS in 2023 after a lengthy work investigating so-called Type-II images. He released a software publication on the package a few months ago. It is a pleasure to work with Mr. Yeung in this regard on wave optics parameter estimation, because most people who are able to do data analysis with gravitational-wave waveforms are not also experts in wave optics theory. What most of our collaborators are doing is implementing new wave optics lens models using a look-up table, which targets specific wave optics lens models, but are not able to recover generic features. Mr. Yeung's ambition is to recover these effects

entirely generically, and I think within a year or two, I think the wave optics parameter estimation problem will have been solved.

To place Mr. Yeung's work into context, according to a growing global consensus, strong lensing will become detectable in the coming years. Strong lensing, according to many independent authors, will likely be accompanied by microlensing and therefore wave optics lensing. Thus, working out the wave optics lensing challenges needs to be done before these first detections. This means that the work is not only theoretical but is deeply rooted in an observational problem.

In his first project in 2021 which culminated in the 2023 MNRAS publication, Mr. Yeung studied Type-II images in the wave optics problem. It was in fact one of the first works on this since the work by his at the time mentor, Mark Cheung (now PhD at Johns Hopkins). Since this early work that he started already in his Bachelor's, Mr. Yeung has grown to become an independent researcher, with good physical insight. One of the reasons for this is perhaps his involvement in mentoring a Master's student from KU Leuven, in which he took a mentoring role.

As for his personality, he is conservative in his assessment of science and I am happy to see that he is now more careful than 3 years ago as a BSc student. This is usually the hallmark of a more experienced scientist. He is pleasant to interact with. I would rate Simon's work as significantly more difficult and ambitious than the projects of most of the PhD students I have worked with. The wave optics lensing as a field is highly theoretical, and bridging the field with concrete data analysis requires cross-disciplinary knowledge that is hard to come by.

All in all, Mr. Yeung has already done significant work establishing his name in his sub-field, successfully led projects, demonstrating maturity as a PhD student, and mentored an MSc student. In terms of his track record, he published his first paper as a result of his BSc study and has a preprint on his software development work. He has made progress with an incredibly difficult project, one which I have seen many PhD students drop due to challenges. Thus, I give Mr. Yeung my highest recommendation.

Sincerely,

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