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Re: Reference letter in support of Mr Cheung Yui Hin Marvil

I am writing to offer my unreserved support for Yui Hin Marvil Cheung's PhD application in Mathematics at the University of Bristol (2025 start).

Marvil is currently following the very competitive Part III Mathematics course at Cambridge and has consistently been a first-class student during his undergraduate degree here. I have had the pleasure to know Marvil since January 2023, when he was in second year and I supervised him in Fluid Dynamics. Marvil was my best student (among five) that year, being very enthusiastic about the subject, very competent at solving the problems (I marked all his written work) and, importantly, very good at communicating his ideas verbally to me and the student he was paired with.

I then supervised Marvil for a two-month long summer research internship at the end of his second year between July and August 2023 in the Department of Applied Mathematics and Theoretical Physics at Cambridge. His project was entitled *Data-driven classification of experimental stratified turbulence*, and involved performing data analysis on Matlab and modelling. The project was motivated by a large experimental dataset of density-stratified turbulence, an important fluid dynamics phenomenon relevant to heat and mass transfer in the oceans. The challenge was to find a low-dimensional description of the temporally intermittent dynamics observed in the real-world, noisy data, which Marvil did by leveraging his mathematical background in probabilities and dynamical systems. He carried out this project with dedication, enthusiasm, and ability, all of which impressed me given he was only in his second year. Marvil read the relevant literature and combined his mathematical and programming skills, ease at grasping complex phenomena, and physical intuition to find exciting new patterns in the data. Marvil showed great initiative by recognizing the limitations of the Markov chain model (initially suggested by myself) early on and independently developing a more sophisticated network-based model of intermittency. His results revealed subtle but meaningful shifts in the transition probabilities between 'clusters' in a low-dimensional phase space and in the residence times in each cluster across dozens of experiments under increasing levels of turbulence. My previous experience with summer research students suggests that Marvil has above-average research skills and potential, even among Cambridge undergraduates who are already highly-competitive. His results were significant enough to be incorporated into an existing draft of a Letter, which I recently submitted for publication in *Europhysics Letters* (now under review, available on the arXiv at <https://arxiv.org/abs/2411.08062>). Marvil shared his results (which span pages 4-6 of the manuscript), wrote the initial code to produce the necessary figures (figures 5-7) and reviewed the draft before submission, giving excellent comments and suggestions, showing great maturity. Marvil also interacted very constructively with two other co-supervisors (Dr Miles Couchman and Dr Xianyang Jiang) and was always comfortable presenting his results to the three of us, as well as taking and implementing our feedback.

I have also interacted with Marvil in Magdalene College up to this day. Marvil is involved in extra-curricular societies and is highly sociable. He is bright, interesting, intellectually stimulating, considerate, articulate, and never shy to question something he does not understand (unlike some other students). These soft skills made him an absolute pleasure to supervise and, I believe they give him an edge for research over other outstanding mathematicians. I would love to supervise him for a PhD, but he clearly chose to pursue pure mathematics.

I believe Marvil is developing into an outstanding young mathematician, and that he would thrive and grow further by doing a PhD at Bristol. I recommend him very strongly. Do not hesitate to get in touch for further information.

Yours sincerely,

Dr A. Lefauve