

Postgraduate Application Form

UNIVERSITY OF CAMBRIDGE  
Postgraduate Admissions Office

Liu, Mr Hanpu

Course

MASt in Astrophysics (MASAS)

Department

Institute of Astronomy

Course start date

01 Oct 2024 (MT 2024)

Date submitted

22 Nov 2023

Mode of study

Full Time

PUF

No

Academic History

Sep 2020 - Jul 2024  
(Not yet obtained)

Bachelor of Science in Physics (Yuanpei College) - All or mostly full-time

93/100

Peking University (China)

Aug 2022 - Dec 2022

Undergraduate Visitor in N/A (N/A) - All or mostly full-time

4.00/4.00

University of California, Berkeley (United States)

Immigration

Nationality

China (1st)

Country of birth

China

Currently ordinarily resident

China

Country of birth is ordinary residence since birth

Yes

Estimated fee status

Overseas

Visa

Required

Visa type

I do not currently have a UK visa

Language

Type

TOEFL (Taken on 22 Oct 2022)

Reference No

1778 8102 2699 2273

Score

L: 30.0 R: 30.0 W: 30.0 S: 28.0  
T: 118

Document

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Adverse Effects of COVID

208/2000 chars

The lockdown policies in Spring 2022 led to a switch from the 100-point grading scale to pass/fail in two of my classes, Western Sociological Theory (Part 1) and General History of China, 2100B.C. ~ A.D.1840.

Scholarships

Apply for funding

Yes

Apply for Cambridge Trust

Yes

Apply for Gates Cambridge

No

\* Document not uploaded at the point of submission  
\*\* Other university

Curriculum Vitae

Uploaded

Career Goals

985/1000 chars

I envision myself conducting independent research in an academic institution. I am curious about physical laws governing the evolution of the Universe and hope to devote myself to advancing human understanding of astrophysics, in particular from a theoretical perspective. My excellent undergraduate academic achievements lend me confidence in my intellectual skills, and I take pride in my ability to tackle scientific and technical challenges in my research projects. Thus, the occupation of a researcher perfectly matches my scholarly interest, expertise, and ambition. I recognize the significant efforts required to meet the professional standards for this career. A MASt program following my Bachelor's degree will expose me to rigorous mathematical training. Then, I will pursue a Ph.D. in astrophysics with substantial original research, a necessary qualification for an academic career. I am thrilled to embark on this demanding and meaningful journey towards my career goals.

Additional Information to Support Application

0/1000 chars

Course Specific Questions

- Core - statement of interest

My four substantial undergraduate research projects on diverse astrophysical topics and techniques attest to my competence, versatility, and keenness to explore. For example, my favourite project, supervised by Prof. Xue-Ning Bai, focused on instabilities in protoplanetary disks. I calculated equilibrium solutions and unstable linear wave modes of the ringlike substructures in the disks. A self-consistent treatment of fluid bulk motion, dust–gas interaction, and turbulence demanded marathon derivations, which I steered through with ingenuity and perseverance. An unknown instability emerged. I identified the effective baroclinity as its core physical ingredient and suggested a new path to planetesimal formation in a realistic disk environment. We report our calculations in Liu & Bai 2023, MNRAS. Now, I still take a strong interest in astrophysical fluid dynamics. Past research engrossed me with the mass, energy, and angular momentum transport processes, where insights necessitated substantial quantitative formulation. At IoA at Cambridge, I hope to develop solid physical and mathematical expertise. This training will set the stage for my future inquiry into fluids, where I envisage applying analytical and numerical tools to evaluate detailed physics, such as radiation, MHD, and instabilities. I expect to hone my problem-solving and communication skills and gain an original insight into the Universe, which will decisively enable my career path as a researcher in astrophysics.
- Core - reasons for applying

My educational background and academic interests perfectly match what your program offers. As a physics major, I consistently earn grades above 85/100 in undergraduate physics and mathematics classes, which provides a solid foundation for rigorous MASt training. Besides formal lectures, I self-taught concepts in theoretical astrophysics using postgraduate course materials, e. g., Astrophysical Fluid Dynamics by Prof. Ogilvie. These advanced topics facilitated my undergraduate research, which strongly motivated me to take your taught courses as a preparation for fruitful academic career outcomes. I am also aware of the invaluable intellectual and communication skills attained from my research experiences, which I hope to refine through your research project requirements. The vibrant, world-renowned scholarly investigation at IoA will seed curiosity, foster inspiration, and open excellent prospects for my future independent study.

Astronomy - Extra Materials WP    Uploaded

Application Information

Academic Awards			
Outstanding Young Scholar	Innovative and substantial undergraduate research in astronomy with published results	31 Mar 2023	
Yang Jinfang Scholarship for International Exchange	Academic excellence in overseas exchange study	30 Jun 2023	£2,175.00
Shu Qi Scholarship for Astronomy and Physics	Academic excellence in physics studies and research in astronomy	31 Oct 2022	£544.00
Academic Innovation Award	Innovative research in astronomy	31 Oct 2022	
National Scholarship	Academic excellence in physics	31 Dec 2021	£870.00

Employment History	
No employment history entered	

Other Applications Made

Astrophysics	Dept of Astrophysical Sciences	Princeton University ( <i>United States</i> )
Astronomy	Department of Astronomy	Univ. of California, Berkeley ( <i>United States</i> )
Astronomy	Department of Astronomy	Harvard University ( <i>United States</i> )
Astronomy	Department of Astronomy	University of Arizona ( <i>United States</i> )
Physics		California Institute of Techno ( <i>United States</i> )

Personal Information

Identifying Information

Full name

Liu, Mr Hanpu

Date of birth

05 Mar 2002

Previous name

Legal gender

Male

Contact

Email

liuhanpu@stu.pku.edu.cn

Phone

+8613269072541 (1st)

Skype address

Home address

Same as contact address

Contact address

18 Guo Gong Zhuang Zhong Jie,  
Room 2101, Unit 1, Block 2, Fengtai  
Qu, Beijing, Beijing, 100070, China

Valid until

Dependants

Partner

WILL NOT bring partner

Child

WILL NOT bring children

Disability

Disability

No

Further information

Adjustment for Interview

Adjustment required

No

Details

College Preferences

College

Trinity College (1st)  
St John's College (2nd)

Current Membership

College

Not College member

Visa Requirement

Visa type

I do not currently have a UK visa

Study Visas

Applicant previously

HAS NOT STUDIED in the UK

Visa not entered

Funding Application

Cambridge Trust

You will automatically be considered by the Trust for any awards for which you are eligible.

No identified awards.

Gates Cambridge Scholarships (Overseas)

Apply for Gates Cambridge

No

Personal Statement

0/3000 chars

Harding Scholarship

Mastercard Foundation

UKRI

Department Funding

College Funding

Based on the information you have provided, you are eligible to apply for these awards.

**Girton Joyce Biddle Scholarship**

You have applied for Girton Joyce Biddle Scholarship

Sheepshanks Studentship in Astronomy

You have applied for Sheepshanks Studentship in Astronomy

The Quantedge – Cambridge Refugee Masters Scholarship

You have applied for The Quantedge – Cambridge Refugee Masters Scholarship

Wolfson College & Rowan Williams Cambridge Studentship

Separate application form  
To be considered for this studentship, applicants should complete and return a separate application form to the Trust, which has been designed to assist the Trust in the identification of eligible candidates. The Rowan Williams Cambridge Studentship application form is available at <https://www.cambridgetrust.org/our-scholarships/highlighted-scholarships/rowan-williams-cambridge-studentship>.  
Notes for applicants:  
The Rowan Williams Cambridge Studentships are not available for courses offered by the Institute of Continuing Education, premium rate courses offered by the Judge Business School (including MBA, MFin, EMBA etc.) or for courses where the fees are charged at the higher Clinical rate.  
Selection panels will assess applications taking regard of the severity of barriers faced to pursuing higher education at the University of Cambridge.

Your Funding

Funding Sources

No funding sources entered

## Declaration

The information you have provided forms the legal basis of your application to the University of Cambridge. We reserve the right to refuse admission in the event of any misrepresentation by you. Submission of an application does not imply an offer of admission.

- The University of Cambridge, the Cambridge Colleges, the Gates Cambridge Trust and the Cambridge Commonwealth, European and International Trust (and their collaborators) will use your personal information for the purpose of processing your applications for admission and funding and deciding whether to offer you a place for the course you have applied for. For further information on the use of your personal information during the application process, please see [How we use your personal information \(for applicants\)](#).
- I certify that all the information given in this application is complete and accurate. I also understand that if I have given false or misleading information, the University of Cambridge will not admit me as a Postgraduate student and may take legal action against me.
- I certify that I am the original and sole author of all work submitted as part of this application, except where clearly indicated otherwise.
- I understand that if my application is unsuccessful, the papers relating to it will be destroyed and cannot be returned.

**I confirm that I have read, understand and agree to the above declarations.**



Name: Liu Hanpu  
Department: Yuanpei College  
Major: Physics

Sex: Male      DOB: Mar.05,2002  
Period of Study: 2020.09-2024.07  
ID: 2000017708

Academic year	Course Title	Hours	Unit	Grade	Academic year	Course Title	Hours	Unit	Grade
20-21/1	Entrance Education Course for Freshstudents	34	1	P	21-22/2	Theoretical Mechanics(A)	68	4	89
	An Introduction to Ideological & Moral Culture and Laws	34	2	92		Seminar for Equilibrium	34	2	92
	The Literature of Su Shi and His Life	17	1	96		Statistical Physics			
	Events and Policies	34	2	P		General Physics Lab(1)	68	3	91
	Introduction to Computation(B)	54	3	90		Chinese SanShou	32	1	84
	Mechanics	68	4	98		Methods of Mathematical Physics(2)	51	3	87
	Military Theory	32	2	98		Electrodynamics(A)	68	4	92
	Social practice and service learning, Part I	34	1	P		General Physics Lab(2)	68	3	91
	Fitness	32	1	91		Western Sociological Theory(Part 1)	34	2	P
	Advanced Mathematics A(no. 1)	96	5	92.5		Critical Thinking and Academic WritingΔ	34	2	95
	Linear Algebra A(I)	80	4	98		Learning Data Science with Python	48	3	98
						Methods of Mathematical Physics(1)	51	3	94
						General History of China, 2100B.C. ~ A.D.1840	32	2	P
20-21/2	Shadowboxing	32	1	93	22-23/1	Berkeley Changemaker: public speaking*	17	1	A
	Social practice and service learning, Part II	30	1	P		Supervised independent studies*	68	4	P
	Outline of Chinese Modern History	34	2	98		Quantum mechanics*	68	4	A+
	Electromagnetism	68	4	94		Numerical analysis*	68	4	A
	Thermal PhysicsΔ	51	3	95	22-23/2	Topics in AI for Scientific ComputingΔ	34	2	90
	Data Structure and Algorithm(B)	48	3	92.5		Optics	68	4	88.5
	Advanced Mathematics A(no. 2)	96	5	98		Modern Physics Laboratory I	102	3	91
	Linear Algebra A(II)	80	4	98.5		Fundamentals of Electronic Circuits and Experiments(1)	68	3	97
21-22/1	A Survey of Mao Tsetung Thoughts and Theory of Socialism with Chinese Characteristics	51	3	88		Republic	51	3	95
	Equilibrium statistical physics	68	4	88		Modern Western Social Thoughts	34	2	88
	Applied Statistics	51	3	95		-----END-----			

Registrar: 

Educational Administration Division

Note: Courses marked with \* indicate credits transferred from other universities including overseas academic institutions (Unit and Grade are original). Courses marked with Δ indicate English taught courses at Peking University. Courses marked with + indicate minor or double major program courses. Courses marked with # indicate retaken courses. Grading System: A+(95-100), A (90-94), A-(85-89), B+(81-84), B(78-80), B-(75-77), C+(72-74), C(68-71), C-(64-67), D(60-63), F(<60). Other Designations in Grading: P(Pass), I(Incomplete), IP(In Progress), F(Fail),W(Withdraw),EX(Exempt).

Printing Date: Sep.04,2023



Name: Liu, Hanpu  
Birthdate: 03/05/2002

**Beginning of Undergraduate Coursework**

**2022 Fall**

Program: Undergrad Non-Degree/NonFinAid  
Major: Undergraduate Non-UC Campus Visitor

<u>Course</u>		<u>Title</u>	<u>Att</u>	<u>Earned</u>	<u>Grade</u>	<u>Points</u>
ASTRON	199	SUPERV INDEP STUDY	4.0	4.0	P	0.00
COLWRIT	11	CHANGEMKR PUB SPK	1.0	1.0	A	4.00
MATH	128A	NUMERICAL ANALYSIS	4.0	4.0	A	16.00
PHYSICS	137A	QUANTUM MECHANICS	4.0	4.0	A+	16.00
			<u>Att</u>	<u>Earned</u>	<u>Gr Units</u>	<u>Points</u>
Term GPA	4.000	Term Totals	13.0	13.0	9.0	36.00
Undergraduate Career Totals						
Cum GPA	4.000	Cum Totals	13.0	13.0	9.0	36.00

**End of UC Berkeley Undergraduate Coursework**

# TRANSCRIPT INFORMATION

Office of the Registrar  
University of California  
Berkeley, California 94720-5404

## History

The University of California was created by an Act of the State Legislature in 1868, and classes have been given at Berkeley since 1873.

## Units of Credit

Until September 1966, credits were recorded as semester units (hours). From September 1966 through summer 1983 credits were recorded as quarter units (hours). Beginning with the fall term, 1983, credits are recorded as semester units (hours). Quarter system requires 180 units for bachelor's degree. Semester system, 120.

## Transfer Credit

Only credit that is accepted by the University is indicated on the transcripts of Berkeley students. Individual courses are not shown.

Examinations and credits accepted are indicated on the transcript in the same manner as transfer credit.

## Course Numbering System

- 1 - 99 -Lower division courses
- 100 - 199 -Upper division courses
- 200 - 299 -Graduate courses
- 300 - 499 -Professional courses for teachers or prospective teachers
- 600 - 602 -Special Study

## Grades of Scholarship

### Grades

The work of all students on the Berkeley campus is reported in terms of the following grades:

- A - Excellent
- B - Good
- C - Fair
- D - Barely Passed
- F - Failure
- P - Passed at minimum level of C-
- NP - Not Passed
- S - Satisfactory or passed at a minimum level of B-
- U - Unsatisfactory
- I - Work incomplete, due to circumstances beyond the student's control, but of passing quality
- IP - Work in progress; final grade to be assigned upon completion of entire course sequence
- M - Temporary administrative grade; not included in grade point computation

The grades A, B, C, and D may be modified by plus (+) or minus (-) suffixes.

### Grade Points

Grade points per unit are assigned as follows:

A=4, B=3, C=2, D=1, and F=none. When attached to the grades A, B, C, and D, plus (+) grades carry three-tenths of a grade point more per unit, and minus (-) grades carry three-tenths of a grade point less per unit than unsuffixed grades, except for A+, which carries 4.0 grade points per unit as does an A.

Courses graded P, NP, S, U, I, IP, or M are not used in computing the grade point average.

## Academic Standing

### Good Standing

*Undergraduate:* C average

*Graduate:* B average or better on all work attempted at any UC campus after a bachelor's degree.

### Academic Probation

Undergraduate students are placed on academic probation if at the end of any term their cumulative grade point average is less than 2.0 (C average) computed on the total of all courses undertaken in the University. However, in the Colleges of Chemistry and Engineering, probation is determined on a term basis.

## Credit Codes

Credit codes may determine the calculation of credit or annotate a course entry as follows:

## Current Records System

### Fall 1995 to Present

*Note:* An "I" assigned as of Fall 1973 to present is not included in grade point computation.

### Pass/Fail Courses

PN - Course offered only on Pass/Not Pass basis  
EPN - Undergraduate grading option Passed/Not Passed  
ESU - Graduate grading option Satisfactory/Unsatisfactory  
SUS - Graduate courses offered only on Satisfactory/Unsatisfactory basis

PN, EPN, ESU, SUS courses are not included in units ATTM (attempted) or units PSSD (passed), but are included in CREDITS COMPLETED.

### Prefixes

- C - Cross-listed
- H - Honors
- N - Summer course
- R - Reading & Composition
- W - On-line

## Previous Record Systems

### Prior to Fall 1975

*Note:* An "I" assigned prior to Fall 1973 is included in grade point computation as an F grade.

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Academic reference for Mr Hanpu Liu

MASt in Astrophysics

Referee Details

Name	Professor Xue-Ning Bai	Job title	Professor
Email	xbai@tsinghua.edu.cn	Department	Institute for Advanced Study
Phone		Institution	Tsinghua University
Relationship	Supervisor	City	Beijing
Known for	1.5 years	Country	China

Reference

Academic ranking	The best performance you have known in the last 5 years
	25
Student potential	Outstandingly original/creative/independent of thought
Course suitability	Exceptionally Suitable

Reference provided as uploaded file. Please see the next page.



Institute for Advanced Study & Department of Astronomy  
Tsinghua University, Beijing 100084, China



Nov. 7, 2023

To whom it may concern,

I am a professor at the [Institute for Advanced Study](#), Tsinghua University, and am jointly affiliated with [Department of Astronomy](#). I am a theoretical and computational astrophysicist working mainly on protoplanetary disks (PPDs) and planet formation, as well as certain topics in plasma astrophysics. I am writing to recommend Mr. Hanpu Liu for admission to the MAST program at DAMTP. **He is \*the\* very best student I have ever worked with.**

I have known Hanpu since June 2022. He just wrapped up his first project with Prof. Greg Herczeg at KIAA, Peking University (which neighbors Tsinghua) as a 2nd year undergrad student, looking for something different and, more difficult... According to Greg, he was already treating Hanpu as “a good postdoc” except for “lacking the experience to find his own problems”, and he never had a \*grad student\*, including native speakers, who could write with such logical clarity. Today, I can testify that these words are not exaggerated.

Knowing Hanpu’s exceptional potential and ambition, I offered Hanpu a very hard-core but timely problem. It is motivated from the newly established observational paradigm (thanks to ALMA) that ring-like substructures are nearly ubiquitous among PPDs, which reflect concentration of mm-sized dust in turbulent pressure bumps. It has been widely speculated that such ring-like substructures are the preferred locations to form planetesimals from dust particles, as the first step towards planet formation. The leading theory for planetesimal formation, the streaming instability (SI), however, is unexpected to operate (which requires pressure gradient and low turbulence) in such turbulent pressure bumps. On the other hand, recent simulations did find strong dust clumping (towards forming planetesimals) in such pressure bumps, but the physical mechanism remains unclear.

Hanpu’s project **aims to investigate the physical mechanism behind dust clumping in turbulent pressure bumps**, through a combination of linear instability analysis and numerical simulation. Pressure bumps in disks can be subject to the “Rossby-wave instability” (RWI), whose nonlinear evolution typically forms a giant vortex. While known since the late 1990s, its linear analysis is mathematically highly complex, involving numerically solving the eigenproblem of an intricate linear system in the  $r$ - $\phi$  plane. Hanpu **further incorporated dust to the formulation**, which **pushes the complexity to a whole new level**. First, he needs to incorporate a driving force together with viscosity and dust diffusion to achieve an equilibrium state. In the presence of dust, even this step becomes nontrivial where one can only solve numerically over a high-resolution grid (size  $N$ ). Then, he needs to derive the linear perturbation equations on top of this equilibrium, implying that the equilibrium solution must be obtained *precisely* to ensure exact cancellation of background terms. Finally, he solves the full eigenproblem (of a  $4N \times 4N$  matrix) to find the relevant (i.e., unstable) eigenstates (growth rate and eigenfunction).



Institute for Advanced Study & Department of Astronomy  
Tsinghua University, Beijing 100084, China



Hanpu started to work on this problem in 2022 summer. He was able to quickly read through the literature to develop a solid understanding of the general physical picture and underlying science. He also managed to successfully construct the equilibrium solution which, after experimenting with a few different approaches, achieved extremely high precision needed for the next step. In mid-August, after entering the project for just one month, Hanpu took a pause and travelled to Berkeley to work on another intern project. He resumed this project in February this year after returning from the US. **Amazingly, in just 2 months, he completed the most complicated part of the project: conducting the linear analysis and identifying the global unstable modes.** This part is already beyond my expertise. Hanpu, almost all on his own, learned the relevant math and identified the appropriate package to successfully handle the calculation. Not just so, he also closely examined the eigenmodes to compare with those in the classical RWI, and came up with a comprehensive physical interpretation of his findings. The result, which we term dusty RWI (DRWI), reveal that the presence of dust strongly alters the properties of the RWI and make it split into two unstable branches. One of them share similar origins as the classical RWI, while the other is entirely new with distinct physical properties.

To further understand the physical consequences of the two DRWI branches, **Hanpu took the Athena++ MHD code, and in just another 2 months, conducted a set of hybrid dust-gas two-fluid simulations** not only to testify his findings of linear growth, but also studied the nonlinear outcomes of the DRWIs. He showed that while the classic RWI tends to form a big vortex that gather nearly all the dust, the new DRWI makes the turbulent dust ring nearly intact, while being able to drive additional dust clumping. This property is remarkable and implies that the new DRWI is very likely the physical mechanism that we are seeking for!

Hanpu has been writing up the paper as he works on the project. **His logical thinking and writing skills are just extraordinary.** His first draft was already of professional quality, making it a pure pleasure to read, a luxury I almost never enjoyed even editing papers from postdocs. Except for the introduction part that I made more edits, the overall process is like refereeing a well-polished paper where my job was mainly to raise minor clarification questions. Overall, **it took only 6 months in total (work+write) when Hanpu actively works on this project,** plus just another month to get it accepted by MNRAS.

I invite you to take a brief look at Hanpu's paper to **see how much he has done, all from scratch:** analytical calculations with near 100 equations, plus a well-controlled group of simulations. The is well beyond what a typical project for an undergrad student. In fact, I offered this problem to an applied math post-graduate student (gap year) a couple years ago, and he failed right at the beginning. What's more impressive is that **despite of all the technical complexities, Hanpu is able to** see through the math to **focus on the underlying physics and scientific picture**, which are mostly reflected in the physical interpretations and discussion in the paper that are all written by himself. He also came to discuss with me about potential follow up projects to extend this work to 3D, and did some preliminary studies before starting yet another research project with Kohei Inayoshi at KIAA.



Institute for Advanced Study & Department of Astronomy  
Tsinghua University, Beijing 100084, China



Lastly, let me add that Hanpu is no longer “lacking the experience to find his own problems” when Greg first recommended him to me. Nowadays, he actively participates in my group meetings, where he often asks thoughtful questions; he regularly reads arXiv papers, and presents them in journal clubs where he not only describes the results, but also offers his own comments. I can tell that **he has gradually established scientific intuition** of what is novel, what is important, and where certain research field is evolving.

Overall, Hanpu is a perfect student beyond what I can dream of. With extremely solid math skills and physics intuition and rapidly developed scientific taste, his intellectual potential is virtually unlimited. In the meantime, he is kind and modest, always ready to learn from others, which is another valuable quality among people as smart as him. As I stated earlier, he is *\*the\** very best student among 20+ students I have worked with, mostly from top universities in China. This is only the 2<sup>nd</sup> time I rank a student to be the best. The last time being the last year, when I said so for a student recently enrolled in the PhD program at Caltech. That student is about as well developed as Hanpu intellectually, and is scientifically even more matured. However, I would rank Hanpu higher because he is better self-organized, which allows him to better focus: it is remarkable that he worked on four completely different projects in 2 years without interfering with each other, with two papers already out and another one in preparation. (The other student simultaneously worked on many more projects but only managed to finish a small fraction of them due to the distractions). He is definitely comparable to, if not better than, the best students admitted to Princeton and Harvard astrophysics where I spent my PhD and postdoc. For all these reasons, **I recommend Hanpu for admission in strongest possible terms**. Please do not hesitate to contact me if you have any questions.

Sincerely,

Xue-Ning Bai

Professor

Institute for Advanced Study and Department of Astronomy

Tsinghua University, Beijing 100084, China

Tel: (+86)-10-6278-9981

Email: [xbai@tsinghua.edu.cn](mailto:xbai@tsinghua.edu.cn)

Webpage: <http://i.astro.tsinghua.edu.cn/~xbai/>

Academic reference for Mr Hanpu Liu

MASt in Astrophysics

Referee Details

Name	Professor Gregory Herczeg	Job title	Professor and Associate Director for Science
Email	gjh1@pku.edu.cn	Department	Kavli Institute for Astronomy and Astrophysics
Phone		Institution	Peking University
Relationship	Research supervisor	City	Beijing
Known for	4 years	Country	China

Reference

Academic ranking	The best performance you have known in the last 5 years See letter
Student potential	Outstandingly original/creative/independent of thought
Course suitability	Exceptionally Suitable

Reference provided as uploaded file. Please see the next page.



**Kavli Institute for Astronomy and Astrophysics**  
**Peking University**  
**北京大学科维理天文与天体物理研究所**



Gregory J. Herczeg, Professor and Associate Director for Science  
[gherczeg1@gmail.com](mailto:gherczeg1@gmail.com) +86 186 0077 6566

2023 September 20

Dear PhD admissions committee,

This is a fun letter to write! It's the kind of letter that I will probably never write again, so thank you in advance for indulging my format. My assessment below may sound crazy. I try to write honest-ish letters. None of the description below is an exaggeration. Anyway, you probably should not really trust letters, but trust Mr. Liu's set of letters enough to interview, and then enjoy the interview!

Mr. Liu is a generational talent. Among the undergrads, PhD students, and postdocs I have worked with (not just supervised), he is probably the best – without any correction for career stage. The undergraduate students I have directly advised at Peking University include people who had successful PhDs from Princeton and Caltech, one prize fellowship winner, one prof at a very good R1, and others similarly competitive. **Compared to those outstanding scientists, Mr. Liu stands out as extraordinary.** Since his second year as a bachelor's student, I discuss science with Mr. Liu as if he were a strong postdoc already. He couples this talent an extremely pleasant and humble personality and works well with others.

Mr. Liu's now-four projects are all pretty different. He began working with me in his first year at PKU. As a 1<sup>st</sup>/2<sup>nd</sup> year undergrad, **he owned his paper** in a way that I have only seen from advanced and top PhD students. I seeded the idea, then he ran with it. He dove into the science, refined the questions, and then led the structure of the paper and wrote it all. This effort was helped through discussions with co-authors. Mr. Liu embraced these discussions, including criticisms, and always responded positively and not defensive. Mr. Liu then wanted to explore other science questions and approaches, so he has been working with others.

In his second first-author paper, with Xue-Ning Bai, Mr. Liu used ATHENA++ simulations to discover the dusty Rossby Wave Instability, which may be important for planetesimal formation. Prof. Bai's letter will describe his performance, but as an added note, in my experience, PhD students who work with Prof. Bai are slow to publish because of the

learning curve and expectations for paper quality. Mr. Liu's latest paper, in preparation, is on black hole accretion with Prof. Kohei Inayoshi. He also worked with Dr. Gaspard Duchene at Berkeley on machine learning for analyzing protoplanetary disk images – machine learning was his favorite class at PKU, also perhaps his hardest course.

Anyway, I'm now going to list random things.

- Prof. Kohei Inayoshi started working with Mr. Liu in summer 2023. After a month, Prof. Inayoshi told me that he would write Mr. Liu the best reference letter of his life. Prof. Inayoshi is not even a letter writer(!) because Mr. Liu already has three references and felt that the balance between them is already strong.
- At a 2022 summer school with 40 students, someone asked about the physics of polarization of light. Ruobing Dong and I, both professors and supposed experts (Ruobing got his PhD from Princeton on scattered light imaging), flailed around talking about scattering off water and lenses, but the student wanted to know the details. Hanpu asked hesitantly if he can try to explain. He then went to the whiteboard and explained the detailed physics of how photons are polarized.
- Hanpu started preparing his PhD admissions essays in the summer! Every other top student (and basically everyone else) waits until deadlines, and then they rely on talent to make it work. In contrast, Hanpu is always overprepared. He is a runner and approaches his career with the same mentality. His life is not a sprint.
- Despite being a perfectionist, Hanpu understands the need to sacrifice perfection to finish projects.
- I am a native English speaker, have written papers for two decades, am an editor for AAS Journals, and at least some people tend to think that I write and structure arguments well. Somehow, by his second year as an undergraduate, despite English as his second language and being late to really learning the language, **Mr. Liu's writing was clearer than my own.**
- Sometimes his English-as-a-second-language will creep in, when he cannot find the exact word to use. An example of this was when he used "give voice to" instead of weighting values by errors -- but the logic was always there.
- Another criticism of his written language: Hanpu overuses semi-colons, though he somehow uses them correctly.

- When discussing specific details, Mr. Liu finds the key references from 30 years ago that others in the discussion failed to identify.
- At the major Protostars and Planets conference (~750 people), Mr. Liu asked two curious and interesting questions in front of everyone. In an intimidating environment, very few PhD students were bold enough to ask even one question (and many senior people asked questions as self-promotion rather than curiosity). He remembers his questions, ask him about them!
- Hanpu co-refereed a paper with me, because I needed his contributions. He found some areas of the paper that needed improvement. In my own oversight, I had not co-refereed with supervisees before at any level (PhD students or postdocs). This was the first time that it was scientifically compelling, and I would have turned down the request without Hanpu's expertise.
- Hanpu never needs anything suggested twice. A practical example, his very first plots were poor, so I suggested that he improve them (with only vague descriptions of how to improve). His next plots were very clear and instructive. This applies to theory, writing, and everything else.
- Hanpu should be a theoretical astrophysicist, but unlike most excellent theory people (Prof. Xue-ning Bai and Prof. Lile Wang both come to mind), Hanpu embraces the uncertainty in observations, a rare trait.
- Mr. Liu needs to work out the physics before understanding concepts, which I am told is a trait of the best theorists. However, he is humble enough to learn from the literature and from others.

In summary, Mr. Liu is the most talented person I have ever worked with. His depth is extraordinarily. To complement his extraordinary talent, Mr. Liu is a wonderful and amazingly humble person, always kind to others. He has contributed as a co-author on papers, balancing his desire to be a perfectionist with a natural understanding that he, an undergrad, probably should not be too harsh on PhD student papers. His default instinct is to help, not judge, those who are less talented.

I wrote a while ago that, if I compared Mr. Liu, then a second-year undergraduate, directly to Hubble Fellows and again without correction for career stage, I said that Mr. Liu did not yet have the breadth of experience to define exactly what problems to work on. Now? I am not so sure. He initially thought of his PhD essays as if he were developing a program on his own, although he since tailored them to the application needs. However, his PhD experience and development should be different than other students.

I am very curious what direction Mr. Liu will take in research. I think that the ideal advisor would have been Peter Goldreich, someone who provides a strong physics background that could then be applied to anything from the solar system to cosmology. He has the brain of a theorist but embraces uncertainty like an observer.

We always like to think that we have been helpful in developing the careers of others. I am pretty happy to think that I have played an important role for some people! For Hanpu, though? I don't know. I guess that some of my approach has been marginally useful, maybe in just letting him be himself and letting him enjoy his research. In any case, he is a delightful and talented person, and I am very thankful that I've been able to work with him.

I strongly recommend that your department accepts Hanpu into your PhD program and then nurtures his curiosity.

Yours Sincerely,

A handwritten signature in blue ink, appearing to read 'Gregory J. Herczeg', written in a cursive style.

Gregory J. Herczeg  
Professor and Associate Director for Science  
KIAA, Peking University

We thank you for your time spent taking this survey.  
Your response has been recorded.

Below is a summary of your responses

[Download PDF](#)

Institute of Astronomy

**Important: please read before continuing**

In this form, you will be asked a series of questions to help us gather information about your **previous** university study. The questions relate to your previous study, not the course that you are currently applying to. Depending on department procedures, relevant contextual data may have a small impact on some funding opportunities, so if your application is eligible for University funding, we encourage you to fill in this form.

You will be given the opportunity to tell us about any events or circumstances that have had an impact on your education, and limited your ability to perform in your studies. **You do not need to provide personal or detailed information about these circumstances**, we only ask you give details of the **impact** that they have had on your studies.

Please only provide the information that you are asked for in the form, and leave the text box blank if you cannot/ do not wish to respond. You should only provide information in the form if you feel comfortable to do so. Your application will not be disadvantaged if you choose not to respond to the questions, and your academic merit will be assessed based on the information you provide in other parts of the application. Once you have completed this form, you will need to download a PDF copy of your answers to upload to the [applicant portal](#). You will be given the option to download the PDF at end of the form, and you will also receive a copy by email. This

the PDF at end of the form, and you will also receive a copy by email. This will be sent to you as soon as the form is submitted.

Your first name:

Hanpu

Your surname:

Liu

Your email address:

liuhanpu@stu.pku.edu.cn

Confirm your email address:

liuhanpu@stu.pku.edu.cn

**The following questions relate to your experience of studying at undergraduate/ bachelor's level.**

Your undergraduate/ bachelor's institution:

Peking University

Did you undertake your degree full-time or part-time?

☒ **Full-time**

☐ Part-time (for any part of the degree)

When choosing your university, were there any factors other than grades that you felt limited your choice of institution?

*e.g. not being able to live away from home, financial considerations, concerns about fitting in*

I opted to study at a university in my home country because the tuition and living costs were considerably more affordable. Studying overseas was a financial challenge to my family.

Characters remaining: 819

Did you have any essential regular commitments that impacted the extent to which you could dedicate yourself to your studies? If so, please explain the impact of this on your studies.

*e.g. caring responsibilities, being a single parent or guardian, employment during studies*

Characters remaining: 1000

Did you experience any serious disruption to your studies that prevented you from studying for at least 3 months over the course of a year? If so, please explain the impact of this on your studies. It is not necessary to provide details about the nature of the disruption.

*e.g. illness, bereavement*

Characters remaining: 1000

**The following questions relate to your previous experience of university study at all levels (undergraduate and/or postgraduate).**

Some students get off to a slower start than others in their studies, and later show an upward progression in their marks.

Were there any circumstances that you feel initially inhibited your academic performance? If so, please provide details of the impact on your studies, and the change in circumstances that allowed you to improve your performance.

Characters remaining: 1000

Please use the space below to let us know about anything else that has had an impact on your studies or educational pathway. You might like to explain any incomplete qualifications or course changes.

My study at University of California, Berkeley was an education abroad program. I visited Berkeley as an exchange student, enrolling in classes and earning credits that were recognized by my home institution (Peking University). I also had the opportunity to conduct an astrophysics research project using machine learning at Berkeley. Admission to the program was highly competitive.

Characters remaining: 615

# Hanpu Liu

Yiheyuan 5, Haidian Qu, Beijing, China

✉ liuhanpu@stu.pku.edu.cn

## Education

### Peking University (Yuanpei College)

BACHELOR OF SCIENCE, PHYSICS (EXPECTED IN JUL 2024)

- GPA: 93.1/100.0 or 3.93/4.00

China

Sep 2020–Present

### University of California, Berkeley

EDUCATION ABROAD PROGRAM

- GPA: 4.00/4.00

California, USA

Aug 2022–Dec 2022

## Research Experience

### Multi-messenger Clues of Early Supermassive Black Hole (SMBH) Growth

Peking Univ., Beijing, China

ADVISOR: PROF. KOHEI INAYOSHI ✉

2023–Present

- Constrained SMBH major merger rates from quasar statistics
- Assessed millihertz gravitational wave (GW) detection of individual merger events and background GW spectrum
- Theorized electromagnetic follow-up channels associated with millihertz GW events

### Hydrodynamical Instabilities in Protoplanetary Disks

Tsinghua Univ., Beijing, China

ADVISOR: PROF. XUE-NING BAI (REFERENCE WRITER) ✉

2022–2023

- Calculated unstable linear wave modes in turbulent dust-trapping rings
- Conducted Athena++ multifluid dust simulations in 2D and 3D
- Demonstrated links between the instabilities and planet formation
- One first-author paper published in MNRAS

### Parametric Inference with Machine-Learning-Based Disk Image Prediction Models

Univ. of California, Berkeley, CA

ADVISOR: DR. GASPARD DUCHÊNE ✉

2022–2023

- Evaluated high-dimensional and multi-modal posteriors with parallel tempering MCMC
- Designed Gaussian process kernels to handle correlated image fitting residuals
- Developed a full physical parameter estimation pipeline of disks imaged by HST, with extensions to ALMA and JWST

### Observational Diagnostics of Outbursting Young Stellar Objects

Peking Univ., Beijing, China

ADVISOR: PROF. GREGORY J. HERCZEG (REFERENCE WRITER) ✉

2021–2022

- Built multi-component emission models of viscously heated disks
- Synthesized model photometry & spectra and fit to data
- Proposed color- and spectral line-based criteria to search for outbursting disk candidates
- One first-author paper published in ApJ

## Publications

### PUBLISHED

**Liu, H.**, Bai, X.-N. 2023, MNRAS, 526, 80: *The Dusty Rossby Wave Instability (DRWI): Linear Analysis and Simulations of Turbulent Dust-Trapping Rings in Protoplanetary Disks*

**Liu, H.**, Herczeg, G.J., Johnstone, D., et al. 2022, ApJ, 936, 152: *Diagnosing FU Ori-like Sources: The Parameter Space of Viscously Heated Disks in the Optical and Near-infrared*

Contreras Peña, C., Herczeg, G.J., Ashraf, M., ..., **Liu, H.**, et al. 2023, MNRAS, 521, 5669: *Photometric and spectroscopic monitoring of YSOs in nearby star-forming regions - I. Eruptive YSOs*

### IN REVIEW

Ashraf, M., Jose, J., Lee, H.-G., ..., **Liu, H.**, et al. 2023, MNRAS: *An Outburst and FU Ori-type Disc of a Former Low Luminosity Protostar*

IN PREP

**Liu, H.**, Inayoshi, K., 2023: *Multi-messenger Clues of High-Redshift Supermassive Black Hole Mass Assembly*

## Coursework & Skills

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**Physics** – Classical Mechanics, Electrodynamics, Quantum Mechanics, Statistical Mechanics and Thermal Physics, Fluid Mechanics, General Relativity, Optics

**Astrophysics** – Stars, Protoplanetary Disks, Planet Formation, Supermassive Black Hole Evolution

**Mathematics** – Univariate and Multivariate Calculus, Linear Algebra, Complex Analysis, Equations of Mathematical Physics, Numerical Analysis

**Data Science & Statistics** – Frequentist & Bayesian Statistics, Machine Learning, AI for Science

**Computer Science** – *Programming languages*: Python, C++, MATLAB – *Operating Systems*: Linux, Mac OS, Windows – *High-Performance Computing*: distributed/shared memory parallelization

**Software** – Astropy, Athena++, emcee, PyTorch, LaTeX, Git

## Honors & Scholarships

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2023	<b>Outstanding Young Scholar (for research excellence)</b> , Yuanpei College, Peking University <b>Yang Jinfang Scholarship for International Exchange</b> , Peking University	¥20,000
2022	<b>Academic Innovation Award (top 1% in Peking University)</b> , Peking University <b>Merit Student (top 5% in Peking University)</b> , Peking University <b>Shu Qi Scholarship for Astronomy &amp; Physics</b> , Peking University	¥4,000
2021	<b>Pacemaker to Merit Student (top 1% in Peking University)</b> , Peking University <b>National Scholarship (top 1% in Peking University)</b> , Ministry of Education of China	¥8,000

## Presentations

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Poster: *Diagnosing FU Ori-like Sources: The Parameter Space of Viscously Heated Disks in the Optical and Near-infrared*. Protostars and Planets VII (international conference), Kyoto, Japan, Apr 2023.

Poster: *AI for Science: Super-Resolution Imaging*. School of Mathematical Sciences, Peking University, Beijing, China, Jun 2023.

Seminar: *Near-Infrared Interferometry of Protoplanetary Disks*. Department of Astronomy, Peking University, Beijing, China, Oct 2021.

## Service, Activities & Development

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Peer review: *Reviewer in Training for MNRAS*, contributed to quality and clarity assessment of a manuscript, 2023.

Student physician: *Cycling Association of Peking University*, received training in medical service for outdoor cycling, Nov 2023.

Volunteer: *Office of Student Financial Aid, Peking University*, prepared and distributed daily essentials gift packages to new students with financial hardship, Aug 2023.

Student ambassador: *Peking University Open House*, counseled prospective students on physics studies and academic careers, Jun–Jul 2023.

Summer school: *Protoplanetary Disks and Planet Formation*, studied observational diagnostics, physical processes and latest techniques in depth. Aug 2022.

Name: Liu, Hanpu

Last (Family/Surname) Name, First (Given) Name Middle Name

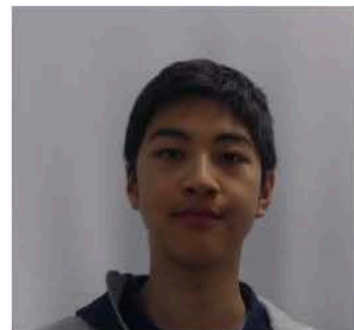
Email: 1874053247@qq.com

Gender: Male

Date of Birth: March 05, 2002

Appointment Number: 1778 8102 2699 2273

Test Date: October 22, 2022



Liu, Hanpu  
Yuanpei College, Peking University  
Yiheyuan 5  
Haidian Qu, Beijing 100070  
China

Inst. Code	Dept. Code
2672	61
4034	61
3451	61
4833	61

Country of Birth: China

Native Language: Chinese

Test Center: APCN-5849 - San Francisco - California Street

Test Center Country: United States

## Security Identification

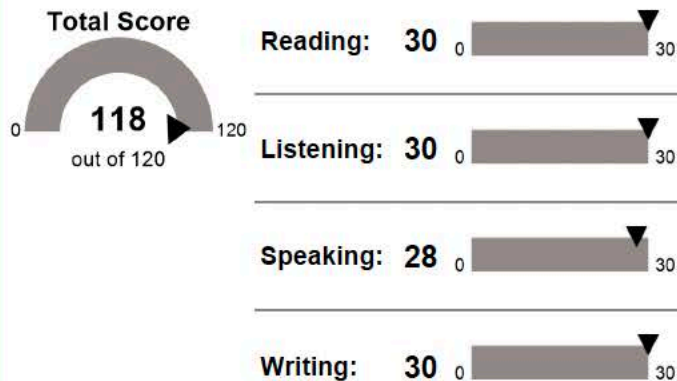
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## October 22, 2022 Test Date Scores

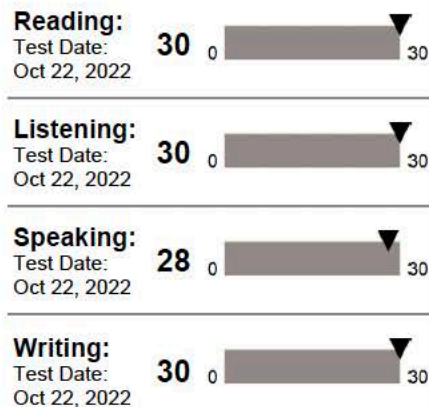


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118  
out of 120



A total score is not reported when one or more sections have not been administered.  
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**Liu, Hanpu**

Date of Birth: March 05, 2002

Appointment Number: 1778 8102 2699 2273

Test Date: October 22, 2022

#### SCORE RANGES

Total Score	0–120
<b>Reading</b>	<b>0–30</b>
Advanced	24–30
High - Intermediate	18–23
Low - Intermediate	4–17
Below Low - Intermediate	0–3
<b>Listening</b>	<b>0–30</b>
Advanced	22–30
High - Intermediate	17–21
Low - Intermediate	9–16
Below Low - Intermediate	0–8
<b>Speaking</b>	<b>0–30</b>
Advanced	25–30
High - Intermediate	20–24
Low - Intermediate	16–19
Basic	10–15
Below Basic	0–9
<b>Writing</b>	<b>0–30</b>
Advanced	24–30
High - Intermediate	17–23
Low - Intermediate	13–16
Basic	7–12
Below Basic	0–6

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The Institutions and Department code numbers shown on the front page are the ones you selected before you took the test.

Dept.	Where the Report Was Sent
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01, 04-41, 43-98	Admissions office for graduate study in a field other than management (business) or law according to the codes selected when you registered
02	Admissions office of a graduate school of management (business)
03	Admissions office of a graduate school of law
42	Admissions office of a school of medicine or nursing or licensing agency
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