Curriculum Vitae

Yao-Huan Tseng

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PERSONAL DATA

Sex:	Male
Citizenship:	Republic of China

EDUCATION

Ph. D.	1994-2000, Institute of Physics and Astronomy, National Central University

EXPERIENCE

2024/1 – now	Senior Research Scientist
2012/3 – 2023/12	Associate Research Scientist, Institute of Astronomy & Astrophysics, Academia Sinica
2017/1 – now	Editorial Board member, Chinese Physics Education, The Physics Education of Society of the Republic of China
2015/9 – now	Chairman, Science Monthly Society
2014/1 – 2015/12	Editor-in-chief, Physics Bimonthly, The Physical Society of Taiwan
2013/7 – 2015/8	Editor-in-chief, Science Monthly
2011/1 – 2014/12	Executive Council member, The Astronomical Society of the Republic of China
2003/08 – 2012/2	Assistant Research Scientist, Institute of Astronomy & Astrophysics,

	Academia Sinica
2005/02 – 2009/6	Joint assistant professor, National Taiwan University of Art
2000/3 – 2003/7	Postdoctoral Fellow, Physics department, National Taiwan University
2001/2 – 2002/7	Joint assistant professor, National Chiao Tung University
2000/5 – 2000/8	Visiting Scientist, CITA
1994/8 – 1995/8	Research assistant, Institute of Space Science, National Central University

HONOUR AND AWARDS

2015	THE 2ND AWARD OF THE 2ND WORLD CHINESE POPULAR SCIENCE WRITING
2000	THE 3RD AWARD OF THE 8TH KWOH-TING LI POPULAR SCIENCE WRITING

PUBLICATIONS (from 2004-now)

Papers in refereed journal

1. BURSTT: Bustling Universe Radio Survey Telescope in Taiwan, Lin H-H; Lin K-Y; Li C-T; **Tseng Y-H** et. al., PASP: 134(1039), id.094106 (14pp), Sep, 2022
2. Efficient Direct Method for Self-gravity in 3D, Accelerated by a Fast Fourier Transform, Krasnopolsky R; Ponce-Martinez MP; Shang H; **Tseng Y-H**; Yen CC, ApJS: 252(2),id.14(14pp), Feb, 2021
3. Direct Calculation of Self-gravitational Force for Infinitesimally Thin Gaseous Disks Using Mesh Refinement, **Tseng Y-H**; Shang H; Yen C-C, ApJS: 244(2),id.26(13pp.), Oct, 2019
4. Effects of Preheated Clusters on the Cosmic Microwave Background Spectrum, Saha K; **Tseng Y-H**; Taam RE, ApJ:721(2),1878-1890, Oct 1,2010
5. Clusters in preheating simulation and its effect on CMB spectrum, Kai-Yang Lin, Tak-Pong Woo, **Yao-Haun Tseng**, Lihwai Lin, Tzihong Chiueh, Mod. Phys. Letts, A, Vol.19, Nos. 13-16, p1035, May 30, 2004
6. Simulation of a Combined SZE and Weak Lensing Cluster Survey for AMiBA Experiment, Keiichi Umetsu, Tzihong Chiueh, Kai-Yang Lin, Jun-Mein Wu,**Yao-Huan Tseng**, Mod. Phys. Letts, A, Vol.19, Nos. 13-16, p1027, May 30,2004
7. Effects of Preheated Clusters on the Cosmic Microwave Background Spectrum, Kai-Yang Lin; Tak-Pong Woo; **Yao-Huan Tseng** ; Lihwai Lin ; Tzihong Chiueh, ApJ, 2004, 608L, 1L
8. The effect of bars and transient spirals on the vertical heating in disk galaxies, Kanak Saha; **Yao-Huan Tseng**; Ronald Taam, ApJ, 2010, 721, 1878
9. 《利用智慧手機測量聲速》，**曾耀寰**，物理教育學刊，2021 年，第 22 卷第 1 期
10. 《智慧手機在比色法濃度檢驗的應用》，**曾耀寰**，物理教育學刊，2018 年，第 19 卷第 1 期
11. 《利用智慧手機測量單擺週期》，**曾耀寰**，物理教育學刊，2017 年，第 18 卷第 1 期
12. 《透過智慧手機瞭解彈簧串聯和並聯現象》，邱家媛;**曾耀寰**，物理教育學刊，2016 年，第 17 卷第 2 期
13. 《具教育目的的小型電波望遠鏡動手作活動》，**曾耀寰**，物理教育學刊，2011 年秋季刊，第 12 卷第 1 期，p139
14. 《如何應用中學物理尋找系外行星》，**曾耀寰**，2011 年 11 月，兩岸四地首屆中學物理教學研討會論文集
15. 《非理工大學生之天文知識初探》，**曾耀寰**，海峽科學，2012 年 3 月第 3 期，p138

16. 《Raspberry Pi 在天文演示上的應用》，**曾耀寰**，2013 年 8 月，第十一屆物理演示實驗教學研討會論文集
17. 《科普傳播的另一條路》，**曾耀寰**，2015 年 4 月，2015 年科學傳播國際研討會論文集
18. 《透過智慧手機瞭解彈簧串聯和並聯現象》，邱家媛、**曾耀寰**，物理教育學刊，2016 年，第 17 卷第 2 期，p57-66
19. 《利用智慧手機測量單擺周期》，**曾耀寰**，物理教育學刊，2017 年，第 18 卷第 1 期，p65-76
20. 《智慧手機在比色法濃度檢驗的應用》，**曾耀寰**，物理教育學刊，2018 年，第 19 卷第 1 期，p59-72
21. **Tseng, Y.-H**, Shang, H, Yen, C. –C, “Direct calculation of self-gravitational force for infinitesimally thin gaseous disks using adaptive mesh refinement”, ApJS:244(2)(2019)
22. Shang, H., Liu, C.-F., Wang, H.-H., Bu, D., Krasnopolsky, R., **Tseng, Y.-H**., and Gu, P., “Formation of Isothermal Disks around Protoplanets. III. Three-Dimensional Locally Isothermal Simulations”, ApJ, in prep (2019)
23. Shang, H., Wang, H.-H., Liu, C.-F., Bu, D., Fung, J., Krasnopolsky, R., **Tseng, Y.-H**, and Gu, P., “Formation of Isothermal Disks around Protoplanets. II. Three-Dimensional Global Simulations ”, ApJ, in prep (2019)

MAJOR RESEARCH ACHIEVEMENTS

A. Hardware Maintenance (CPU/GPU cluster)

Before 2003 CFD-MHD group has only 4 single-processor and 2 dual-processor machines. These machines are not well-organized as a PC cluster for high performance computing. I setup two pc cluster, 111-node cfd-mhd pc cluster with 13 single-processor(13x1), 33 dual-processor machines(33x2) and 4 dual Quad-Core machines(4x8) and 98-node PC cluster with 8 single Quardcode machines(8x4) and 8 dual Quad-code machines(8x8) in 2009. 8 of computation nodes are implemented with low-end GPU cards which form a testbed for GPU computation. For a simple direct nbody calculation, it can reach 88 times speedup with NVIDIA GeForce 8800GT.

Besides the PC cluster for CFD-MHD group, I manage the CP cluster for whole institute. The CP machines are all updated to a Mac-mini cluster with 16x4 nodes. The updated CP cluster is still served for all IAA users. These computation nodes are well connected with Gbps network switch and share with one common 24TB storage, which is suitable for parallel computing. For monitoring the cpu loading of each cp machine, I provide a script for user to show the real-time status (fig.1). Besides the cpu loading, the script can show who are using the machine for easy maintenance. The updated CFD-MHD cluster consists of 8 GPU computers. Each one is equipped with two GPU cards(GeForce GTX660Ti) and 8 GPU cards totally. I am working on a simple direct nbody parallel/GPU code which can run on a more than 10M particles case. I also work on optimization of different programs by parallel scheme. I spend time to build/use a GPU cluster as testing bed and share my experience with Sam Tseng. It is a good experience for current Theory GPU cluster. Now the theory group has its own GPU cluster(4x4 Nvidia P100) managed by Sam.

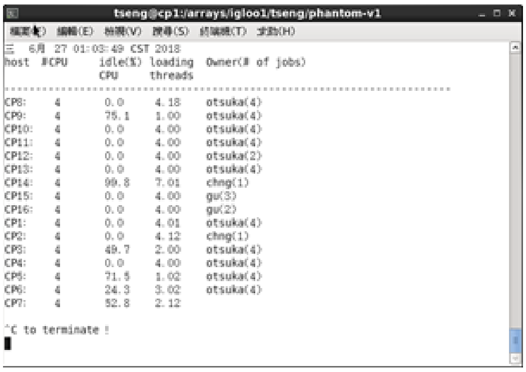

Fig.1 cp cluster monitoring interface

The cp cluster is a common computing facility for all IAA members. Although there are few larger scale computing resources for specific scientific projects, it is a valuable resource for those who need to test their sequential/parallel programs or execute small science projects.

B. Code Development and Programming (Fortran and C languages/MPI /OpenMP/CUDA/OpenACC)

1. GPU Programming and Hardware Testing

--Working on galactic bending instability with Dr. Kanak, we started from a rigid halo that did not respond from the halo to the gravitational effect of the disk and found warp. The simulations will be done under the assumption of a live halo that includes the back-reaction from the halo to the embedded disk. All works are done with public software named Gadget, developed by Prof. Volker Springel on IAA pc cluster. Due to the high speed of GPU, I wrote a GPU/MPI code to simulate galactic dynamics. The gravity solver is done by direct nbody method. Direct nbody method is more precise than others, e.g. Oct-Tree scheme used by Gadget code. Because of high speed GPU, 4 GPU cards can reach to the speed of few hundred CPU cores.

--Encourage people using GPU machine, I help Pin-Gao to use FARGO3D on Theory GPU cluster. FARGO3D is the successor of the FARGO code with MPI/CUDA. FARGO3D is a HD and MHD parallel code and very popular for planet/protoplanet disk simulation. I test the performance of GPU/CPU in 2018. The speed-up of one GPU(P100) is about 77 times of the CPU. It is great helpful for Pin-Gao’s research.

--To benefit the computing power of the GPU cards, I write two versions of the direct n-body codes, the CUDA version and the OpenACC version. The CUDA version is faster than OpenACC version. CUDA is a parallel computing platform and API model created by Nvidia company and only works for Nvidia GPUs. OpenACC is a programming standard for parallel computing and designed to simplify parallel computing of CPU/GPU systems. So it is easy to implement the code with OpenACC. I can rewrite the code with few OpenACC directive lines and run 50M particles to simulate the dynamics of a DM/bulge/disk galaxy on the TIARA GPU cluster (Fig.2). It is a good experience for GPU programming. For those who have a sequential code and want to benefit from GPU as soon as possible, they can adapt the OpenACC. For better performance, they can take more time to study the CUDA language and their algorithm on their projects.

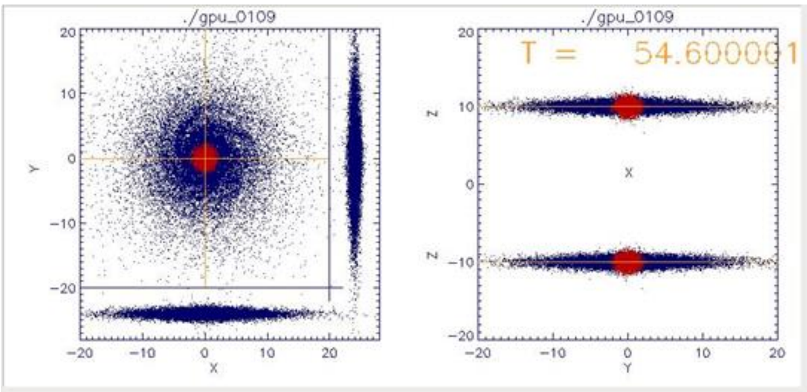

Fig. 2, A 50M collisionless particles simulation

--To benefit the power of GPU further I also study the application on python. Python is an interpreted, high-level, general-purpose programming language. Python is becoming the most used interpreted languages for data analysis, especially for astronomical visualization and analysis. CuPy is an open-source matrix library accelerated with NVIDIA CUDA. CuPy's interface is highly compatible with NumPy; in most cases it can be used as a drop-in replacement. All I need to do is just replace NUMPY with CuPy in my Python code. I wrote some simple python codes to benchmark the performance of CuPy on IAA’s P100 machine. The comparisons show that the benefit of GPU depends on the size of the problem in general. If the size of the matrix is larger than 100000, the CuPy is faster than Numpy (done by CPU) for three different cases(Fig. 5). It can be 100 times faster than Numpy when the size of the matrix is 10^7. It is a good experience for Python users.

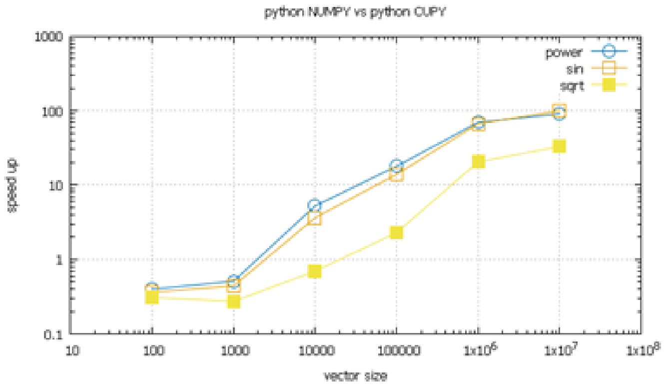

Fig. 5 The performance of the CuPy on one Nvidia P100 card

2. Algorithm Development and Simulations with the Antares group (past CFD-MHD)

-- I supervised one summer student I-Lin Yeh in 2017 summer student program with Ruben Krasnopolsky. The goal of the project is to speed up the existing N-body/SPH code named GANDALF developed by UK researchers (https://gandalfcode.github.io/). GANDALF is a hybrid self-gravitating fluid dynamics and collisional N-body code primarily designed for investigating star formation and planet formation problems. GANDALF is written in C++/python and parallelized by MPI and OpenMP. We successfully modify the gravity part to use GPU/CUDA library and raise the performance. His work was presented in poster in 2018 Annual Meeting of the Physics Society of Taiwan and awarded the "Honorable Mention of Student Poster Presentation". After I-Lin graduated, he got 5 admissions of PhD programs from US and UK. He accepted the offer from UCSD plasma Physics this year and study now.

--I developed a Fortran/C code to calculate self-gravity with AMR grids and speed up with OpenACC and CUDA both using the method developed in Tseng et al. (2019). Instead of solving the complete potential function problem with standard FFT method, we calculate the force in infinitesimally thin disks in Cartesian and polar coordinates by a reproducing kernel, which is similar to a spectral method, but without the necessity of imposing periodic boundary conditions and can be implemented by direct N-body (Fig.3). The new scheme works both for a uniform grid and an AMR grid and keeps the same 2nd precision. Although the computation is scaled with N^4 for 2D cases, the direct N-body is much easier and intuitive to implement in GPU. The OpenACC version is about 48 times faster in real benchmarks. We also ported to a CUDA version in AMR cases (Fig. 4) with multiple GPUs. The performance can reach up to ~ 500 times of the CPU case, depending on the number of active cells as shown in Table 1. I will develop a self-gravity AMR library to be implemented to the Antares2D code.

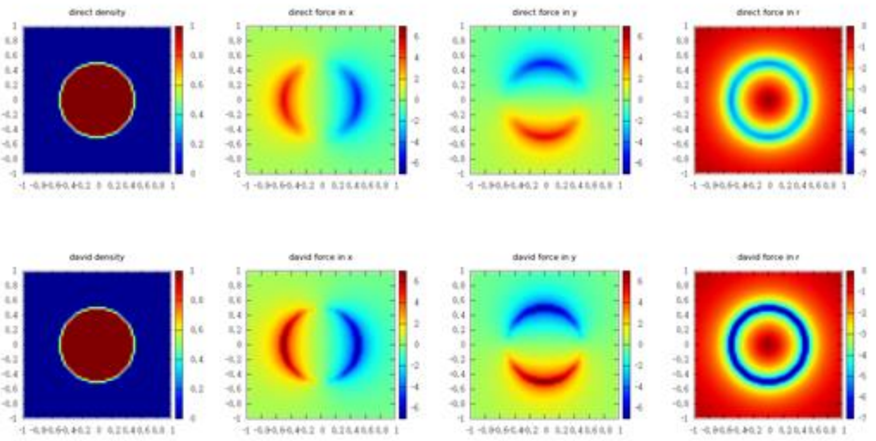

Fig.3, A uniform disc case. The upper one is the normal way, the lower one is Prof.Yen's method.

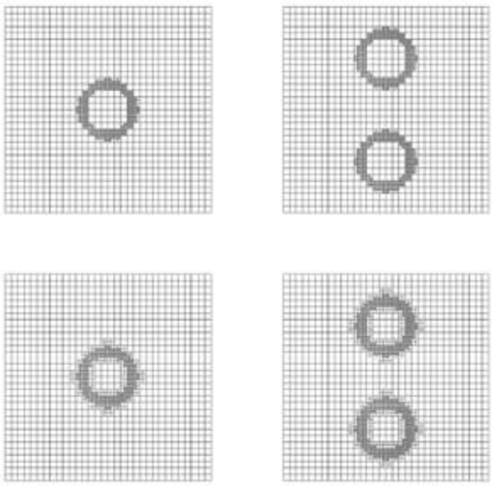

Fig. 4, Illustration of the grid structure for AMR with $N_k = 2^k$; k = 5 and L = 3 for the disks D_2 (left) and $D_{2;2}$ (right) under the ILR refinement (top) and the VLR refinement (bottom).

AMR(1, D_2)-N_k	Fortran (sec)	CUDA (sec)	Fortran/CUDA
128	1.58E+2	4.29E+0	3.68E+1
256	2.71E+3	7.28E+0	3.72E+2
512	4.11E+4	1.56E+1	2.63E+2
1024	–	1.71E+2	*
2048	–	2.63E+3	*

AMR(1, $D_{2,2}$)-$N_k \times N_k$	Fortran (sec)	CUDA (sec)	Fortran/CUDA
128 × 128	1.62E+2	4.39E+0	3.69E+1
256 × 256	2.68E+3	5.29E+0	5.07E+2
512 × 512	–	1.57E+1	*
1024 × 1024	–	1.71E+2	*
2048 × 2048	–	2.62E+3	*

Table 1. The computational time for AMR(1,D_2) (top) and AMR(1,$D_{2;2}$) (bottom) simulation by Fortran and CUDA. The symbol “-" means that the computational time is more than one week and “*" means that no calculation. The result shows that CUDA is faster than Fortran about 263 times at N_k = 512.

The algorithm is implemented to the 3D case. The preliminary result is ok. CUDA is faster than Fortran about 600 times for N_k=64 case, but the elapsed time is too long. Fortran needs about 3.8 days to finish the gravity calculation of level-2 refinement for one step only, CUDA needs 9.6 minutes. CUDA takes 5.8 hours to finish one step for N_k=128. It is not practical for one GPU card to solve 3D cases with N_k larger than 64. Further optimization is needed.

3. Parallel Computing with CHARMS

I assisted and tuned codes for better performance in parallel computing. For example, in the past year, I worked with Sienny to parallel her chondrule dynamics code with MPI. With MPI, it can shoot more than a few thousands of particles at the same time. The particle number is limited by the number of CPU available. I also provided consultation and discussions for optimization for parallelization.

I am also working with Chun-Fan Liu on optimization and trouble-shooting for parallelization of the HOCHUNK3D code, to be hosted through CHARMS. HOCHUNK3D is a Monte Carlo radiative transfer code that iteratively solves dust temperature and produces emission maps and SEDs. The use of random numbers in Monte Carlo code makes domain decomposition almost impossible, and the advance of high-resolution simulation largely increases the total cell number. The situation results in a huge amount of memory (64+ GB) required for each MPI parallel process that exceeds hardware memory in current multi-core architecture. We are adopting the method of OpenMP in order to share the memory among CPUs of the same node, as one MPI process but multiple threads.

4. Code testing

Based on the Antares code, I am working the comparison between different Godunov hydrodynamic codes, e.g. Athena++ and CHOLLA. The first testing is 2D shock. I found the artificial spike (Fig.5) in the middle shown in Antares, Athena++ and CHOLLA code. It seems due to the different time integration scheme, interface reconstruction and Riemann solvers. Further studies are needed. The Antares code is using HLLC solver and 3 reconstructions. I will implement additional Riemann solvers and reconstructions to treat Antares code as a test bed for choose proper combination of Riemann solvers and reconstructions.

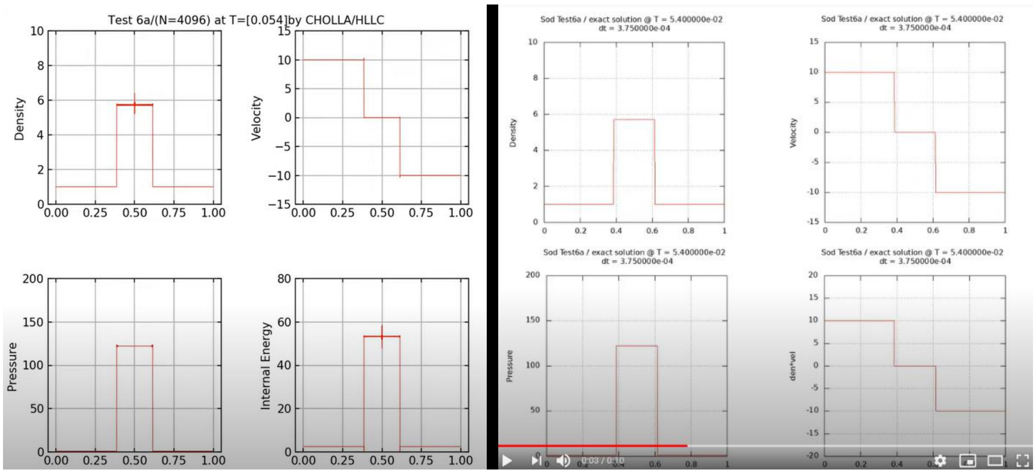

Fig. 5, An 1D colliding shock. The left part is done by CHOLLA, the right is the exact solution.

code comparison of supersonic Kelvin-Helmholtz Instability (KHI). Mandelker et al. (2016) analyse the linear Kelvin-Helmholtz instability (KHI) of a cold, dense slab or cylinder in 3D flowing supersonically through a hot, dilute medium. The system is parametrized by three parameters: the density contrast between stream and medium, the Mach number of stream velocity. I am trying to simulate the 2D KHI cases for 3 different Godunov codes, e.g. Athena++, CHOLLA and Antares(Fig.6). The purpose of the comparison is to find out the proper scheme/solver for supersonic KHI problems. It would be helpful for KHI along the shock problems.

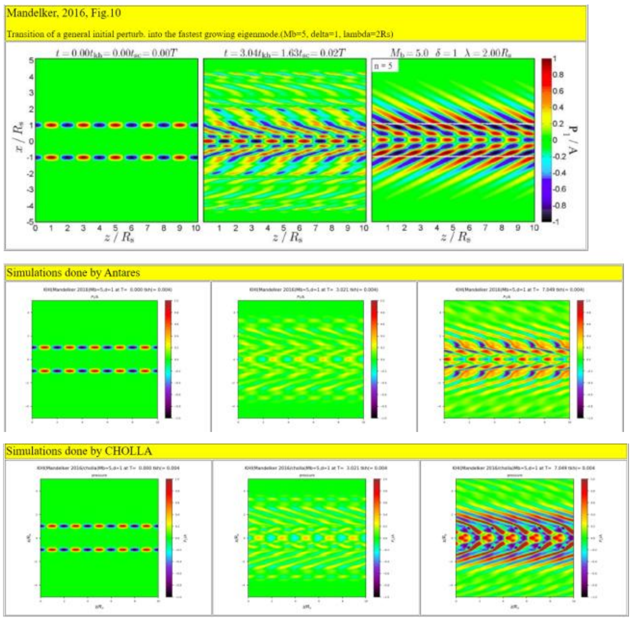

Fig.6, Transition of a general initial perturbation into the fastest growing eigenmode. The upper one is done by Mandelker et al.(2016), the middle one is done by Antares code and the lower one is done by CHOLLA code.

5. Science Visualization: 360° Panoramic Images and Videos for Sciences

For better viewing of 3D simulation results, I use SPLASH visualization software to generate a 360 degree disk-planet movie (Fig.7). SPLASH is a free and open source visualization tool for Smoothed Particle Hydrodynamics (SPH) simulations in one, two and three dimensions, developed mainly for astrophysics. It provides the tool to generate 360 degree images after v2.8.0. The 360-degree photos let you look around in any direction from a single standing position. You can share the 360-degree photos everywhere from Facebook and Youtube, even using VR platforms like Google Cardboard. It is not only for visualization and data analysis but also for public outreach purpose. You can see a simple circumplanet disk simulation via the following qr code with a smartphone.

360 movie

Fig.7, A Jupiter-size planet is orbiting a solar-mass star. Two spiral arms generated around the planet.
(https://www.facebook.com/plugins/video.php?href=https%3A%2F%2Fwww.facebook.com%2Fyaohuan.tseng%2Fvideos%2F1887249284629912%2F&show_text=0&width=560)

C. Service (Computing, Education and EPO committees at IAA)

1. **ASIAA Computing Committee and HPC Committee in the Theory group**

As a former chair and current computing committee member, I keep managing on the stability of computing facilities and extension of the computing resource. As the IAA expands, the computing facilities and servers are updated and more centralized smoothly. Most of the IAA computing servers are now virtualized for redundant purpose. A IBM tape library was built in B3 for backup the users and project data. All these services are supported for institute research.

I attend the regular computing meeting on Monday and provide my professional options to chair. I also service as the substitute of the committee chair as he is not available and chair the regular meeting.

As a representative to the Department of Information Technology Services(ASCC), I attend the liaison meeting twice per year. This position should be faculty level and familiar with computing which is more convenient to negotiate with ASCC, e.g. ASCC section chief or even chair. The cp cluster is the only computing cluster facility for all iaa users. It is old, not so fast, but it really provides a computing resource for those who do not access other project facility, e.g. Theory group. I also spend time to build/use a GPU cluster as testing bed and share my experience with Sam Tseng. It is a good experience for current Theory GPU cluster.

I am one of the HPC committee members in Theory group. The role of the HPC committee is to plan the future development of the Theory computing facilities, clarify the needs and cost, set the user policies. Under Min-Kai’s (committee chair) management, the HPC facility is running smoothly.

2. **Education**

I gave a numerical astrophysics course to the students of the Taipei First Girls High School in 2020. It is an 6x3-hours course for science gifted class. The materials are based on the extendible Stellar Dynamics Toolbox(NEMO). Students can learn about the basis of stellar dynamics, programming, visualization and simulations. They will give a presentation of their simulation in the end (Fig.8).

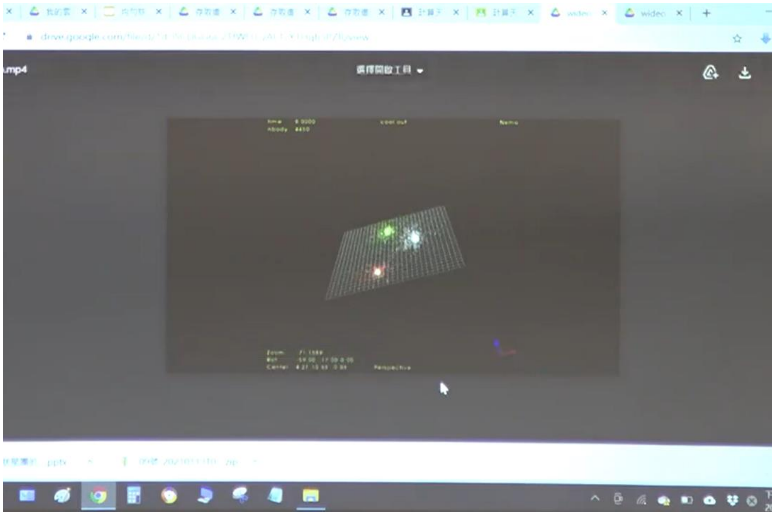

Fig. 8, 3 galaxies collision by one of the students.

Advise one summer student I-Lin Yeh to implement a SPH code (GANDALF) in 2017 IAA Summer Student Project. For this project, titled "Computational Astrophysics," we have selected the numerical solution of a fluid flow involving the Newtonian gravity field generated by a mass distribution, which is very useful in several aspects of astrophysics. It is particularly useful for our research group in ASIAA, because we are developing numerical simulation codes for which the gravity field is an important factor. I-Lin Yeh produced good code in the C++ language implementing an algorithm able to simulate the flow of a mass distribution affected by its own gravity, by carefully merging and combining the power of a particle hydrodynamics code (written in C++) with a GPU-based N-body code (written in a combination of C++ and CUDA) able to efficiently compute gravity on a GPU-enabled machine. The initial conditions of the fluid were generated using a Fortran code, and Python was used to visualize the results.

3. EPO committee

I have served the Education and Public Outreach(EPO) committee at IAA for many years.

As a former chair and current EPO committee member, participating and organizing Academia Sinica annual Open House activity and public lectures are the major tasks in committee for many years. Besides these activities I participate in the editorial board of the ASIAA Quarterly Press from beginning (2010). ASIAA Quarterly (IAAQ) Press is a A3-side 8-page material for local high school students by request. The IAAQ is to promote our facility, projects and current research topics, introduce our research staff, and raise awareness of the many contributions from astronomy (Fig.9). As the member of IAAQ editorial board, I wrote few articles for public. (Fig.10)

[redacted]

Fig. 9, Students are reading the IAAQ at 2019 AS Open House Day.

Fig. 10, IAAQ articles published in 2020 summer, 2020 autumn and 2021 spring issue.

To promote the Citizen Science in astronomy, I applied the science population project grant from the Ministry of Science and Technology (MOST) in 2015. Citizen science (also known as community science, crowd science, crowd-sourced science, civic science, volunteer monitoring, or online citizen science is scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists. The project was a half-day activity and hold at museums, e.g. Taipei astronomical museum, museum of natural science, science and technology museum and museum of marine biology and aquarium. The activity is in the form of student camp and covers 3 different scientific areas, astronomy, biology and meteorology, which are also the core projects in Zooniverse project (https://www.zooniverse.org/). Not only the science contents provided by the local researchers in the citizen science camp but also showing the public how to participate the existed Citizen science project, even working out local Citizen science projects with local researchers. It is the first time for this kind of activity for public (Fig. 11). The public are not only learn science knowledge from lectures but also participate the science research, e.g. galaxy morphology classification which is first step to study the evolution of galaxies. Although it is new, it gave a new perspective of learning science for public. Besides for public, the further scientific research is also exciting, e.g. machine learning.

Fig. 11, The activity is hold at Hualien Girl's Senior High School at East Taiwan.

Professional skill/service

1. Fortran and C language
2. Python coding
3. MPI coding
4. OpenMP coding
5. CUDA coding
6. OpenACC coding
7. Construction and management of PC cluster
8. Popular science writing

OTHER SIGNIFICANT CONTRIBUTIONS

Invited Talks:

1. "PC cluster computation on astronomy" at Construction and application of cluster computation workshop 2006, Plasma and space science center, National Cheng Kung University, Taiwan (2006).
2. "雷達英雄後傳之電波天文學", 臺大科教中心科學史沙龍, 台灣大學思亮館, 2018/4/30

3. “雷達與電波天文學”, 大眾科學講座, 台北市科學教育中心, 2019/10/4
4. “電磁波聯盟”, 臺大科教中心科學史沙龍, 南投車籠埔斷層保存園區, 2019/11/9
5. “網路公民科學”, 專題演講，東海大學應用物理系, 2019/11/29
6. “百年何短短之桂冠遺珠天文篇”, 臺大科教中心科學史沙龍, 華山藝文特區, 2020/10/18

Members of Editorial Board:

Member of Chinese Physics Education editorial board (2017/1 ~)
Editor-in-chief of Physics Bimonthly magazine (2014/1 ~ 2015/12)
Editor-in-chief of Science Monthly magazine (2013/7 ~ 2015/8)
Deputy chief editor of Physics Bimonthly magazine (2012/1 ~ 2013/12)
Deputy chief editor of Science Monthly magazine (2004/1 ~ 2013/6)
Member of Physics Bimonthly magazine editorial board (2004/1 ~ 2011/12)
Member of Graphic Science magazine editorial board (2007/10 ~ 2020/12)
Member of Little Leonardo magazine editorial board (2006/1 ~ 2020/12)
Member of Science Monthly magazine editorial board (1998 ~ 2003)
Member of Earth Kids magazine editorial board (2001 ~ 2004)