Unification 5

54th International Physics Olympiad, ISFAHAN, IRAN

25 July 2024 - 4 Mordad 1403

IPhO 54th International Physics Olympiad Isfahan Iran 2024

بنی آدم اعضای یکدیگرند
که در آفرینش ز یک گوهرند
چو عضوی به درد آورد روزگار
دگر عضوها را نماند قرار

AT NAQSH-E JAHAN

WIFICATION
IPhO 2024 Isfahan, Iran
No. 5
IPHO 54th International Physics Olympiad Isfahan Iran 2024

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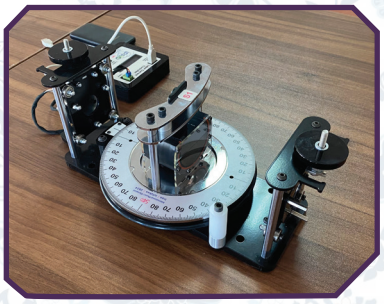
AN EXPERIMENTAL SAGA

The experimental questions took months of preparation under the supervision of Seyed Mahdi Fazeli. The first question was designed by Alireza Noroozshad, the second by Abolfazl Ebrahimi, based on a paper by Muhammad Taghi Tavassoli's research group. Many individuals assisted in formulating the questions and testing the equipment. The instruments were built by two knowledge-based companies: the instrument for the first question was built by Ava Smart World headed by Mehdi Sheydayi, that of the second question by Fan-Amooz headed by Hazem Faripoor. Each instrument was tested at least three times before being set up for the examination. Two 10 kW UPS and stabilizer systems were installed. They were tested prior to the examination by turning off the power to the examination hall: the instruments kept working for the ten seconds it took for the emergency generator to kick in. So, there was no chance of a power-out ruining the exam. The air-conditioning system was turned on 5 days prior to the exam to stabilize the room temperature and keep it constant for the duration of the exam.

The discussion session started at 2 PM, the questions were finalized around 11:30 PM. Two suggestions for Question 1, and one suggestion for Question 2 had to be put to vote. For Question 1 one suggestion was accepted and the other rejected. For Question 2 the suggestion to make all students use the provided calculators to find the



uncertainties in their answers, was accepted. Once the questions were finalized their translations began and lasted until 6:30 AM the next day. The first to hand in their translations were Bosnia and Herzegovina, and Turkey. The very patient leaders from China, Vietnam, and Mongolia were the last to do so. The team from the Korean Republic, consisted of one person with no leaders. She had said that she could handle the English version of the question, still Mahtab Jalalvandi used the Deeple application on the Olympify platform to translate the questions into Korean for her, and both versions were made available to her. The exam session was under the supervision of Pooriya Gharooni, and it went on quite well. The only unforeseen situation, was one student feeling nauseous who had to be attended to. There were 198 cubicles for the contestants, but 197 students registered for the exam of which 4 were no-shows.

The grading of the questions has started in earnest. The graders were shown the instruments and the grading schedule was explained to them. The graders have been divided into seven groups of two. The load of questions has been equalized using the database of the last Olympiad in Japan, so that the number of high-scoring and low-scoring countries assigned to each group is distributed evenly between the grading teams. The team leaders will post the results of their grading first, and then the grading teams will post their results. These should be ready by Friday evening which is the sixth day of the Olympiad. Sajjad Moradnejad spent five days explaining to ChatGPT how to use OCR to create the appropriate Excel files based on the raw data the contestants had acquired during the exam, the results will be graded automatically by Excel in parallel with the graders. These results will be used to double-check the grades obtainde by the graders.

Besides the individuals named above, quite a few had important roles in formulating the questions and testing the devices. They are: Dariush Ghaemi, Sajjad Moradnezhad, Amin Basiri, Mohammad B Seyedin, Behzad Ranjbari, Kazem Rajabi, Reza Montazeri-Namin, Mohammad-Mehdi Moosavi, Sina Fathi, Ali Ghanbari, Romina Babayi, Ali Tavakkuli, Ali Nezami, Mohammad Hossein Lutf-Zaman.

From right to left Romina Babayi, Sina Fathi, Mohammad-Mehdi Moosavi, Alireza Noroozshad, Seyed Mahdi Fazeli, Pooriya Gharooni, Ali Ghanbari, Dariush Ghaemi, Abolfazl Ebrahimi, Mohammad B Seyedin, Sajjad Moradnezhad, Ali Tavakkuli.

OUT AND

ABOUT

WHY ARE YOU A PHYSICIST?

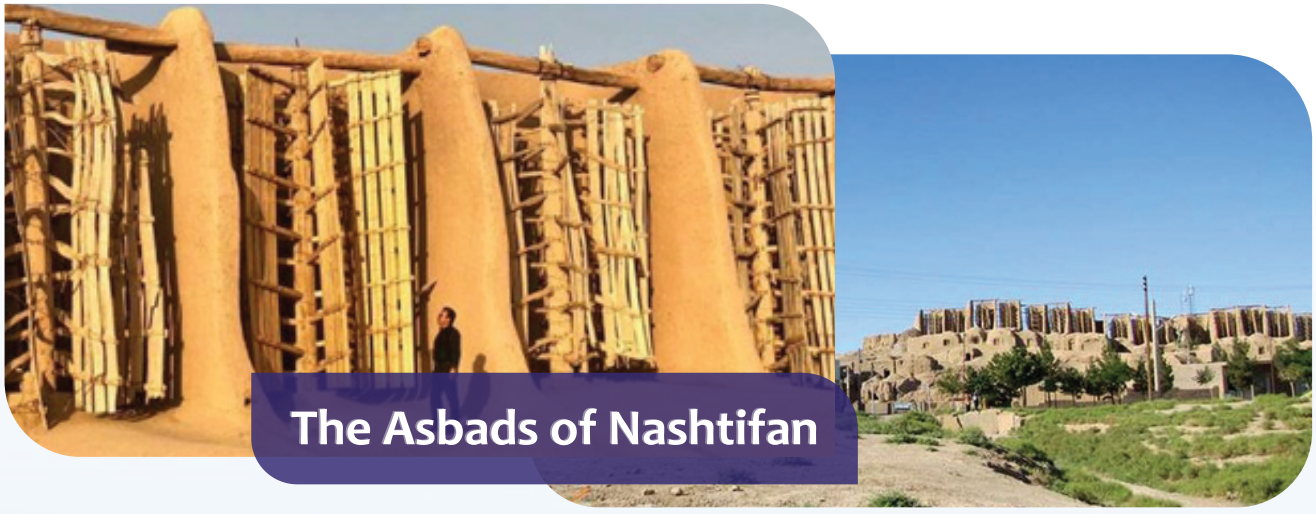
Prof. Cumrun Vafa
Chair, Department of Physics; Hollis Professor of Mathematicks and Natural Philosophy

My voyage in the realm of physics had its origin in my deep interest in the fundamental properties of our universe. What are the building blocks of everything around us? How particles interact and what determines the fabric of space and time? These questions very much intrigued me, and created the incentive for my academic research.

My interest lies especially in string theory, a promising framework for trying to unify all the forces and material components of nature within a uniform theoretical structure. This unification not only tries to explain but to predict the phenomena in our universe, and to act as a bridge between quantum mechanics and general relativity.

The mathematical structures of theoretical physics are undeniably beautiful. This beauty is not only in their form, but in their ability to describe the complexities of the world. This aesthetic appreciation together with the philosophical search for the answer to questions such as why the world exists and how it works, feeds my thirst for physics.

In my professional career I had the honor of helping to form new ideas and tools in string theory which help increase our understanding and broaden the frontiers of science. My role in guiding the next generation of physicists when they confront complex and challenging concepts, is also very important. Physics is not just a job; it is also a commitment to the future of our discipline, a commitment which guarantees its growth and the continuation of its impact on scientific and technological vistas.



The Asbads of Nashtifan

In a large region in the Eastern Iran which includes parts of Sistan and Baluchistan, South Khurasan, and Razavi Khurasan, intense winds blow for 120 days, from the end of May until September. These winds are known as the 120-day Sistan winds. The inhabitants of this region in Iran as well as some regions in Afghanistan, for centuries have used these winds to grind wheat during the harvest season. They have built mills with vertical blades and axes that turn the grindstone when these winds blow. These windmills are called Asbad in Iran. Each Asbad is a two-storey structure. The lower level houses the grindstone and the top level holds the wheel (axis and blades). The height of some these Asbads can reach 12 meters. The main material used in building Asbaads are clay, mud, straws, and wood.

About 40 of these windmills were built wall to wall, around every village. Besides grinding wheat, these windmills also protected the village from the winds. They constituted the village's defensive wall against the wind. Some of these windmills have survived in their original form and are still functional in the Nashtifan village of Razavi Khurasan. Nashtifan translates to 'the wind's sting'. Some sources have dated the Asbads of Nashtifan back to the Safavid era (1501-1736).

PERSIAN MINIATURES

The prophet of the old Persian religion, Manichaeism, is famed to have been a painter who had himself illustrated his sacred book, the Arzhang. Sassanid palaces are also known to have had wall paintings and murals. Yet the evidence for these are fragmentary. It is from the time of the Mongol rulers of Iran, the Ilkhanids (1253-1353), that the earliest examples of the particular style of Persian painting known as miniature have survived. The Chinese influence that these conquerors brought from the East, started a tradition that reached its high point in the 15th and 16th centuries. The early supporters of this form of art were the courts who commissioned illustrated copies of classic works of Iranian literature. Later on, miniatures were commissioned by wealthy patrons, not for complete works, but for inclusion in collections of paintings known as ***muraqqa'***.

Persian miniatures have certain features that make them unique and recognizable: faces are normally depicted in three-quarters view. Buildings appear as if they are viewed from a 45-degree angle. The main characters in the scene are of the same size. Figures that are farther away are placed higher up in the painting; there is no sense of perspective. Gardens, buildings, vegetation, are shown as if viewed from different angles at the same time. The colors are rich and plain. There are no shadows, and the lighting is even.

The French painter, Henri Matisse, who visited an exhibition of Persian carpets and miniatures in Munich in 1910, stated that Persian miniatures had shown him the possibilities of his sensations. Paul Gaugin, and Wassily Kandinsky have also been said to have been influenced by Persian miniatures. Persian miniatures continue to inspire modern Iranian artists. In 2020 UNESCO included the art of miniature in its Representative List of the Intangible Cultural Heritage of Humanity.

1: Majnun (wearing orange) spies on his beloved, Layla, standing in the doorway (c. 1556-1565).

2: Joseph chased by Potiphar's wife, Kamaluddin Behzad (1488)

3: Nighttime in a City, attributed to Mir Sayyid Ali (c. 1540)

4: Fereydun in the guise of a dragon, attributed to Aqa Mirak (c. 1524-1534).

In the dairy farms belonging to a major food company, the milk production suddenly started to fall. Nobody could figure out why. Then one executive came up with an idea, he said: "Let us hire a theoretical physicist. These are quite intelligent people and maybe they can find an answer." So they hired a theoretical physicist to work on the problem. The physicist worked for several weeks and then announced that he'll give a seminar to explain his results. On the day, all the executives and important people came to the seminar. The physicist went to the white board and drew a circle and said: "Let us assume we have a spherically symmetric cow... ".

The Hot Potato

If you place a slice of potato inside a hot oven and let it remain there for a while, it will change color. For this to happen, the water contained in the potato needs to evaporate. The picture above is an example of this transformation. As you can see, the edges have changed color much sooner and to a much larger degree. How can you explain this in a quantitative manner?

(Hint: Can you find an analogy between the laws governing the flow of water at the edges of the potato slice, and the laws relevant to electric fields in the vicinity of a conductor? For example, if we take the vapor flux density, to be analogous to an electric field, what quantities would be analogous to electric potential or electric charge?)

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