Unification | 8

54th International Physics Olympiad, ISFAHAN, IRAN

28 July 2024 - 7 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 MOBARAKEH STEEL COMPLEX

UNIFICATION
IPhO 2024 Isfahan, Iran
No. 8

International Physics Olympiad
Isfahan Iran 2024

THE ONLY CONTESTANT FROM KOREA

Minjae Kim is the sole contestant from the Republic of Korea. He has just graduated from high school and he cannot take part in another International Physics Olympiad in the future. But even though Korea had pre-registered for this Olympiad they changed their mind and decided not to come to this Olympiad. This happened before the final high-school exams; the participants in Olympiads are exempt from these exams in Korea because there is overlap between the subject matters, but since Korea's participation was cancelled, Minjae had to take those exams too, as they are very important for his future academic career. Undaunted, Minjae not only took his final exams, he also prepared for the Olympiad. He was allowed to use the facilities provided for the Olympiad students, but he was on his own with no support. He had to spend entire days in the lab all by himself in order to prepare for the experimental questions. And he had to come to Iran at his own expense. He came here accompanied by his sister. The organizers of this Olympiad tried their best to accommodate him. They even provided him with Korean translations of the Olympiad problems generated by AI, even though he had said that he can handle the English. Minjae says that the sentences were not that smooth, as translation between these two languages are known to be problematic, but the translations helped him to find the meanings of single words he had trouble with. He is not quite satisfied with his performance in the exams, but he is happy that he did his best. He has made friends with contestants from Boznia and Herzegovina, Montenegro, Mongolia, among other countries. He was happy with the food which he finds rather similar to Korean food, and he has bought some souvenirs to take home. It took a lot of courage for Minjae to try this trip on his own, and he is very happy that he came to Isfahan and Iran. He is looking forward to continuing his studies in Seoul University. We all wish him the best.

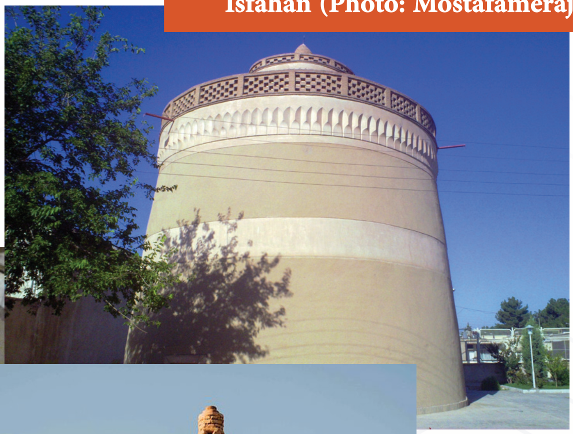
Graphic Designers
Mani Shafiei Sabet
Alireza Jarrah
Photographers
Moslem Shahmohammadi
Mohammad Mahdi Khosravinia

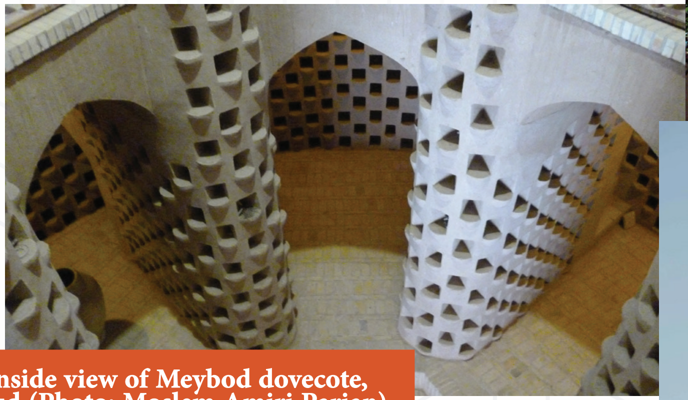


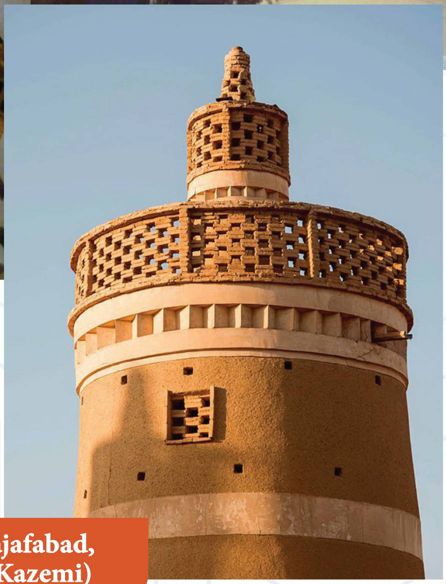
DOVECOTES

Dovecotes, or pigeon towers, are structures constructed to house pigeons or doves in order to collect their droppings. In the past, the droppings were used mostly as fertilizers, but were also used for leather tanning or in making gunpowder.There is evidence for these structures going back to 1300 years ago in Northern Egypt and in Iran. In his travelogue, written in 1677 ACE, Jean Baptiste Tavernier who had visited Iran nine times, has stated that there were about 3000 dovecotes around Isfahan. The estimated 300 surviving dovecotes around Isfahan go back to that era, about 400 years ago.

The height of these structures can be between seven to fifteen meters. They can be cylindrical or polygonal. Small turrets at the top have a lattice of openings large enough for doves or pigeons, but not large enough for predator birds to get inside. Inside the building pigeonholes have been constructed for the birds to nest. One such building in ***Meybod***, ***Yazd***, built during the reign of the ***Qajars***, could house 4000 pigeons. The interior is cool in summer and in winter the dovecote protects the birds from cold winds. In the age of chemical fertilizers, these buildings have lost their functionality. Most of these buildings are mud buildings. But the use of ***sarooj*** (a traditional water-resistant mortar used in Iranian architecture) has kept many of them standing. Yet they need preservation, some have been registered as national heritage sites, and some restoration work has been carried out by the Ministry of Cultural Heritage.


Kabootar-Khaneh in Isfahan (Photo: Mostafameraji)


Inside view of Meybod dovecote, Yazd (Photo: Moslem Amiri Parian)


Kharoun Dovecot in Najafabad, Isfahan (Photo: Mehdi Kazemi)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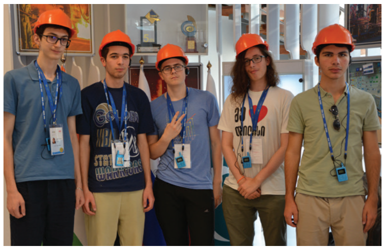
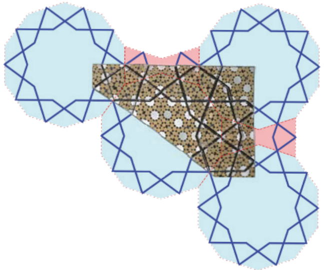


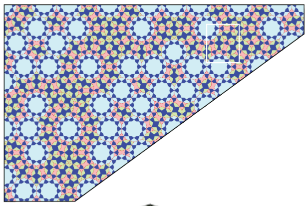


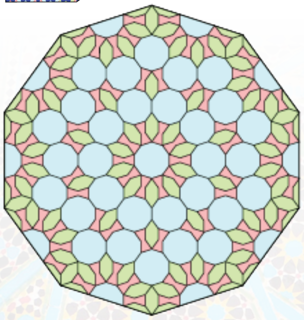












Darb-i Imam shrine, Isfahan, Iran

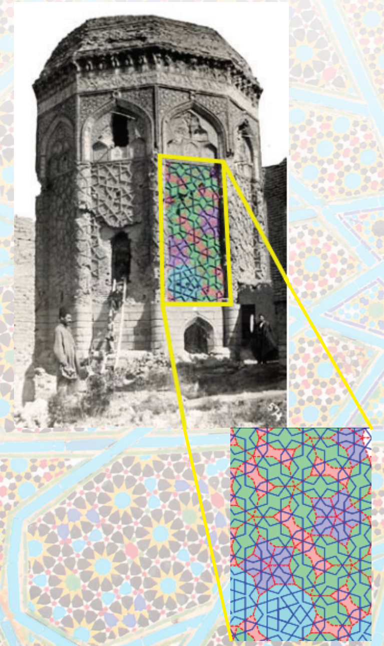
Penrose Tiling in Islamic Architecture

In the 23 February 2007 issue of Science, the physicists Peter Lu of Harvard University and Paul Steinhardt of Stanford University, have proposed that between the 13th century and 15th century Islamic architects had discovered the secret of covering the plane with decagonal and pentagonal patterns. This form of tiling corresponds to what was only recently discovered in nature, the quasi-crystals, whose diffraction pattern displays fivefold symmetry. This kind of pattern is forbidden for crystals because crystals are made of repeating interlocking units that fill the space, but you cannot fill the space with a repeating pattern that has fivefold symmetry. Quasi-crystals are similarly made up of interlocking units that fill the space but their pattern never repeats even if extended infinitely in any direction. The most famous quasi-crystal pattern is "Penrose tiling" named after the Oxford mathematician, Roger Penrose.

If Lu and Steinhardt are right, the Islamic architects had discovered a form of mathematics 500 years before it was formally described in the West. Islamic architects used patterns called girih (a Persian word meaning 'knot') to create their tiles. Lu examined "a few thousand" photos of real mosques and found that although decagonal girih patterns became increasingly common from 1200, nearly all are periodic and so are not quasi-crystals. But then he found a photo of the Darb-I Imam shrine in Isfahan, Iran, built in 1453. Its decagonally symmetric motifs on two different length scales are a telltale sign of a quasi-crystal. Working with Steinhardt, his former undergraduate adviser and a quasi-crystal expert, Lu found that the Darb-I Imam girih pattern can map onto a Penrose tiling. There were a few defects, but these are superficial, says Lu, and were likely introduced by workers during construction or repair. "We realized that by the 15th century, these architects had the makings of quasi-crystals," says Lu.

Crystal expert Emil Makovicky of the University of Copenhagen, Denmark, studied girih patterns for 2 decades. His analysis of the patterns on a tomb in Maragha, Iran, built in 1197, concluded that they map onto Penrose tiles and was published in a 1992 book about fivefold symmetry.

How mathematically sophisticated were these medieval architects? "We haven't done an exhaustive search of Islamic architecture by any means," says Lu. "There could be a perfect quasi-crystal pattern waiting to be found."



GUNbad-i Kabud in Maragha, Iran

Source: Science 315 (23 Feburary 2007) 1066.

WHAT DID YOU THINK ABOUT THE THEORETICAL EXAM?

Serazus Salekin Samin | Bangladesh

The exam turned out to be quite challenging, especially in the third section (T3), which was heavily focused on mathematical concepts. I found myself struggling with some of the more complex problems, and unfortunately, I ran out of time before I could fully address all the questions. To make matters worse, the number of worksheets provided was insufficient for the workload, so I often felt rushed. When I asked for additional pages to work on, the response was surprisingly delayed; it took about half an hour for the extra sheets to arrive, which only added to my stress during the exam. Overall, the experience was pretty overwhelming.

Frane Andelic | Croatia

The theoretical exam was in my opinion more tiresome than fun, it was too focused on numerical calculations and calculus rather then neat physics tricks. Due in part to the aforementioned calculations which took more time than physical derivations and the shear amount of subproblems, the given exam time wasn't sufficient to complete all of the tasks. All in all the exam wasn't the best experience, but the surrounding activities compensated for it.

Armen Gazazyan | Armenia

I think it was a little bit different from the one I expected. The style was really interesting and the problems were from real scientific research, which made them more interesting. Overall I think it was slightly more difficult than I expected.

The key and the cup

The weight of the key exerts a torque on the key and it will acquire some angular velocity. As the cup falls, the distance between the key and the pen/rod decreases, but the angular momentum of the key has to remain constant therefore its angular velocity has to increase: the key will easily wrap once or twice around the pen/rod increasing the friction between the string and the pen/rod to such an extent that it can support the weight of the cup.
In fact, if the friction coefficient between the pen/rod and the string is μ and the string has wrapped around the pen/rod by an angle θ, one can show that to counteract a force f at one end of the string it is enough to exert a force $fe^{-\mu\theta}$ to the other end of the string. For example, if the cup weighs $1\ \mathrm{N}$, and the friction coefficient is about 0.5, the cup can be stopped with a force of about $0.002\ \mathrm{N}$.

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secretariat@ipho2024.ir

Ministry of Education | Isfahan University of Technology | Shahid Rajaee Teacher Training University | Young Scholars Club

"WHAT'S COME OVER HEISENBERG? HE SEEMS TO BE CERTAIN ABOUT EVERYTHING THESE DAYS."

Sidney Harris, Einstein Atomized (Copernicus Springer-Verlag, 1989)