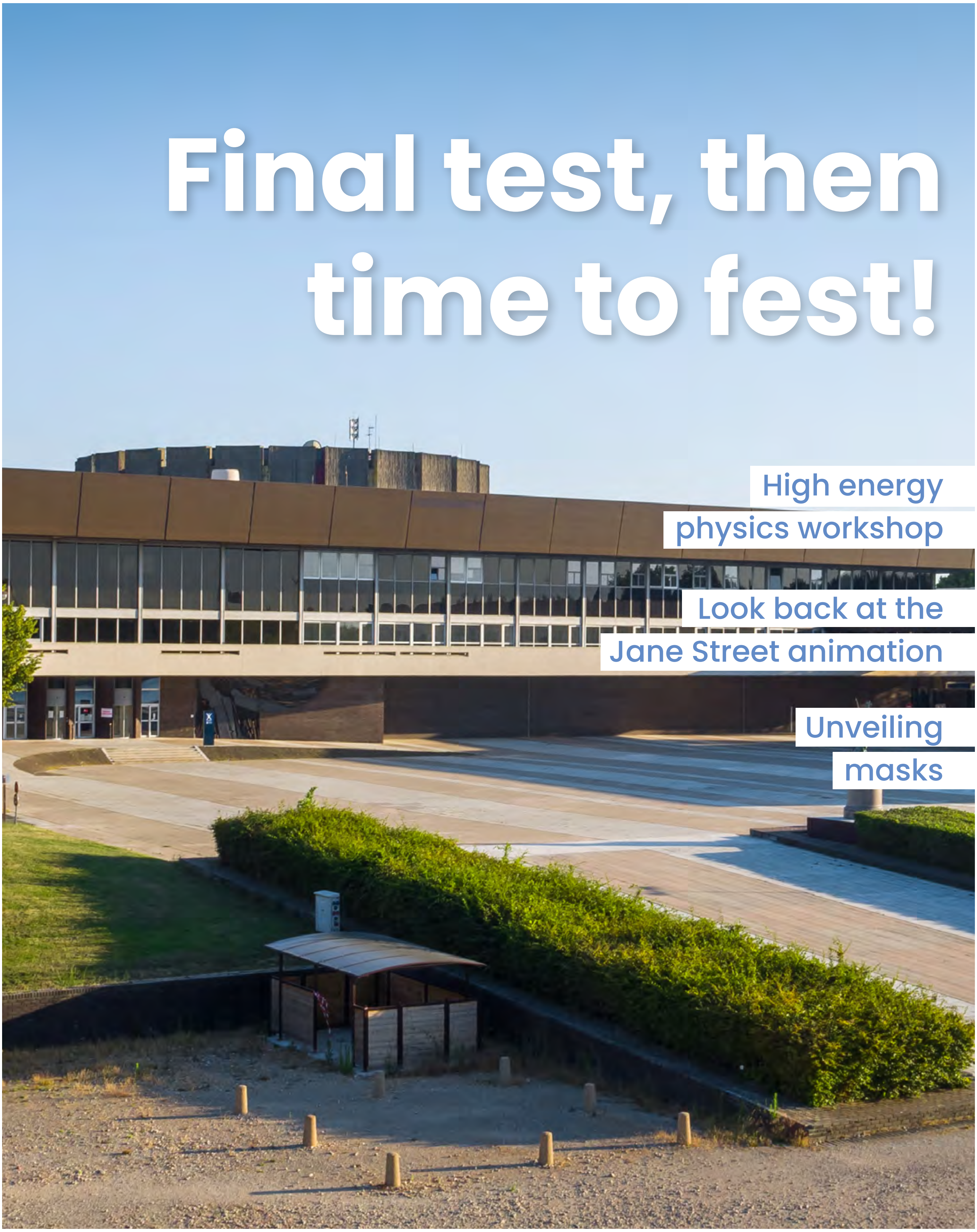
N°4
Monday, July 21TH

PHYSICS BEYOND FRONTIERS

International Physics Olympiad
FRANCE 2025



Final test, then time to fest!

High energy physics workshop

Look back at the Jane Street animation

Unveiling masks

EDITO

Dear participants to the IPhO in Paris,

During this wonderful week you have the chance to share your passion for physics, and to discover a new city and new cultures. This experience will certainly transform you for a long time, and will enlighten the way you will experience science in the future. Unfortunately, among all of you, only 38 young women had this chance, which represents less than 10% of the participants. Only one third of the delegations includes at least one young woman but most female participants have to face this competition being the only woman in their group. Most probably, you will keep encountering a low number of women as you carry on with physics studies, as only 28% of worldwide researchers are women, this ratio is lower if we focus on physics. Such huge disparities, such deep inequalities, do not happen by chance, as it was reported by a recent UNESCO report.

Too many girls are held back by discrimination, biases, social norms and expectations that influence the quality of education they receive. Girls' under-representation in science, technology, engineering and mathematics education is deep rooted and puts a detrimental brake on progress towards knowledge and sustainable development. Science, technology and innovation are key in how we address the impact of climate change, in how we increase food security, improve healthcare, manage limited freshwater resources and protect our biodiversity. Girls and women are key players in crafting solutions to improve lives and generate inclusive society evolution that benefits to all.

A fair representation of women in science, and especially in physics is very important for science but also for women, and the society in general. At the French Physical Society, we are convinced that increasing the presence of women in science is not only a matter of equality, but it is a necessity for bringing more justice to society. The exhibition set up for you and showing the pioneer contributions of female physicists is there to offer role models from all over the world and remind everyone that women are part of many scientific adventures, a place that must be strengthened. In every country, to compensate for biased social standards, young female scientists deserve support from older scientists to comfort them in their choice, but they should also count on their male fellows' support. This is a path we try to build inside the French Physical Society. Building an inclusive work environment for all minorities is a challenge that all generations have to face now, to address the many scientific challenges ahead. These goals will only be achieved by joining different skills, competences, and cultures, and by gathering very different persons together. Diversity is a real chance and opportunity for science.

As young scientists, you have the power to make a difference. For your future in Physics, we wish you to remain curious, open-minded, and committed to making science a field where everyone, regardless of gender and origin, can flourish.

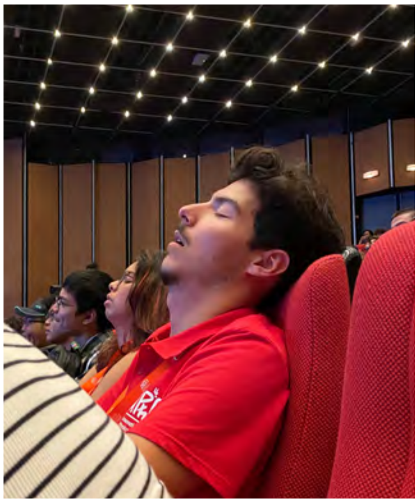
Caroline Champenois

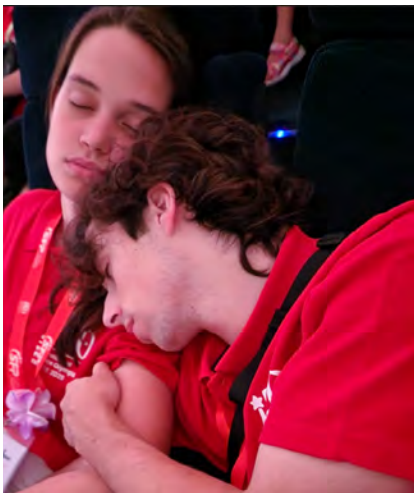
for the Women in Physics commission of the French Physical Society

Look back at the Jane Street animation

And some pics of Versailles

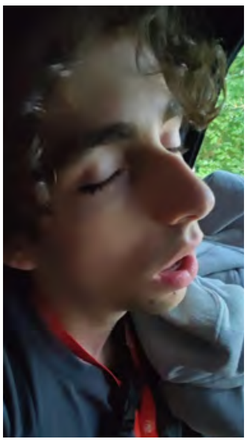
HIGH-ENERGY PHYSICS WORKSHOP

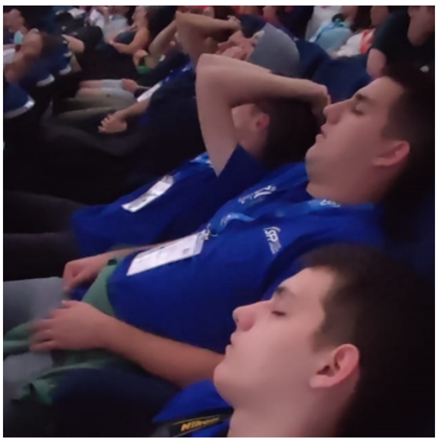













Unveiling Masks

Jean-Michel Courty et Edouard Kierlik

Translated from : Comment fonctionnent les masques de protection respiratoire – Pour la Science Magazine - n° 511, 2020


© Bruno Vacaro

Amid the COVID-19 Pandemic interest in respiratory masks has surged, although they are not new. But how do they work?

FFP2 standard, surgical mask, or homemade mask… These terms have inundated our daily lives with the COVID-19 pandemic. As physicists, it is not our role to provide recommendations on the use of these protective devices to minimize the risk of contamination. However, we can investigate the physical mechanisms underlying their functioning. One might assume that masks primarily act as sieves. This assumption is far from accurate!

Filtering aerosols

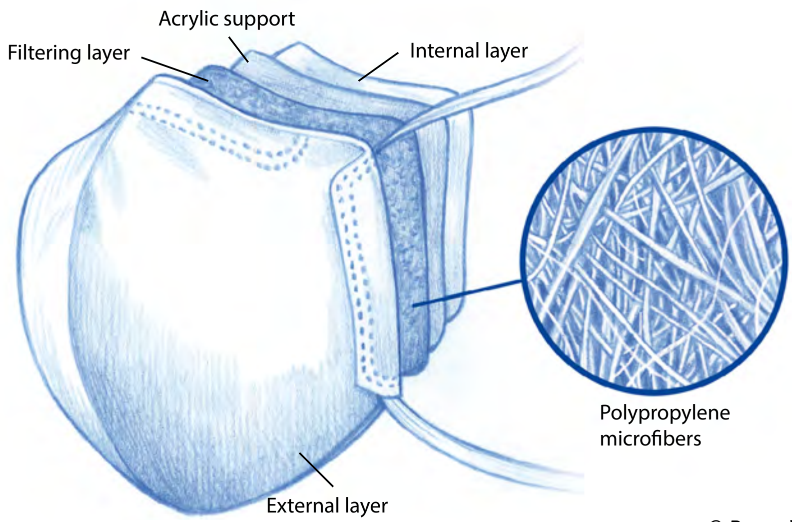
When coughing, sneezing, speaking, or simply breathing, we produce aerosols: in other words, we emit particles of various sizes into the exhaled air. These are typically water droplets with diameters ranging from 1 micrometer (one-thousandth of a millimeter) to 100 micrometers, which rapidly evaporate and release bacteria (0.5 to 5 micrometers) and viruses (0.02 to 0.3 micrometers, 0.1 micrometer for the SARS-CoV-2 virus responsible for COVID-19) into the air.

The largest particles fall to the ground quickly. In contrast, the lighter ones remain in suspension. In still air, the sedimentation time for particles of 20 micrometers in diameter over a height of 3 meters is approximately 4 minutes, and this time quadruples each time the particle size is halved: it already exceeds 1 hour for particles of 5 micrometers.

In an epidemic situation, air can be filtered using a mask to protect our respiratory system from aerosols laden with pathogens. The first filtering effect that comes to mind is the sieving effect: like in a colander, only particles smaller than the holes should be able to pass through the mask. However, there is a major challenge: the smaller the pores, the better the filtration, but the harder it becomes to breathe through the mask. If the mask is to be usable without mechanical assistance, a submicron filter, which would be necessary to sieve bacteria and viruses, is impractical.

Fortunately, other mechanisms are at play and allow for the trapping of particles of all sizes within the mask. Typically, the mask contains a somewhat thick layer composed of non-woven but rather intertwined fibers (see the box on the opposite page). When a particle, carried by the air flow through the filter, collides with a fiber, it adheres permanently due to intermolecular forces known as Van der Waals forces. Therefore, it is essential to understand the mechanisms leading to particle-fiber collisions.

At the scales considered, it is shown that air flow is dominated by viscous effects and is laminar: as the air approaches a fiber, the streamline, which is initially regular, separates to flow around the fiber and then rejoins behind it. In first approximation, the particles carried by the air follow these streamlines.



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If the distance separating the fiber from the streamline carrying the particle is less than the radius of the particle, the particle will collide with the fiber and adhere to it: this is the interception effect, which is more significant for larger particles.

However, particles do not always follow the streamlines exactly. This is particularly true for large particles, which have inertia due to their mass: like a car taking a turn too fast, instead of following the air around the fiber, they continue «straight» and collide with it. This is the inertial effect.

As for small particles, they are subject to Brownian motion, caused by continuous impacts with air molecules in thermal agitation: their trajectories are erratic and do not follow the streamlines. When such a particle passes near a fiber, it can diffuse towards it and adhere. Unlike the inertial effect, capture by diffusion is more significant for smaller particles and slower flow rates.

In addition to these effects, there may be electrostatic captures when the particle is electrically charged. When we take stock, we realize that filter efficiency is lower for intermediate-sized particles (see the graph in the box).

In practice, the filtering layer of masks is typically composed of polypropylene fibers with a diameter of about 5 micrometers and forming pores ranging from 10 to 20 micrometers, which are much larger than the sizes of viruses and bacteria. Filter efficiency is thus ensured by the thickness of the filter: the thicker it is, the more capture events described above occur, and fewer particles pass through.

However, efficient filtering has two consequences: on one hand, breathing becomes more difficult; on the other hand, if the mask is not perfectly fitted to the face, air can enter through gaps between the mask and the face. The result is that choosing the «right mask» necessarily involves a compromise between various requirements: filtration quality, ease of use, and user comfort.

Surgical Masks and FFP2 masks

Two types of devices can be distinguished. First, there are «surgical masks.» Their primary objective is to prevent large particles emitted by the wearer, such as droplets, from dispersing into the environment. Efficient filtration of small airborne particles is not a design goal: in practice, it is very poor.

Standardized tests measure the percentage of 0.06 micrometer particles (the size of a virus) that pass through the mask when the air flow rate is set to 85 liters per minute, characteristic of very rapid breathing. With surgical masks, the results can vary widely, ranging from 4% to 90%, due to air leakage around the edges of the mask. Such a mask is less satisfactory for prolonged contact with sick individuals but remains useful otherwise, as it blocks droplets in both directions and helps prevent touching the face with hands.

The second category consists of «protective respirators.» These are the masks most commonly discussed today: they are designated FFP (for filtering facepiece), followed by a number indicating the filtration efficiency. These respirator masks are designed to filter the air and reduce the number of particles and pathogens inhaled by the wearer.

For example, an FFP2 mask must filter at least 94% (FFP3: 99%) of an aerosol containing particles with a median diameter of 0.06 micrometers and have total leakage from outside to inside (including filtration and facial seal) of less than 8% (FFP3: 2%) of the inhaled air. This requires that respirators be perfectly fitted to the face, typically with two elastic straps around the head and a nose clip.

Effective filtration, difficult breathing

Since masks are designed to be well-fitted and thick to filter the air effectively, they present a resistance to airflow, which is measured by evaluating the overpressure required to ensure flow: this overpressure is on the order of 2 millibars for an FFP2 mask during rapid breathing. Although this seems small, it is of the same magnitude as the pressure variations involved in our lungs.

Therefore, prolonged use of a mask in stressful situations can lead to headaches. This is why some masks are equipped with exhalation valves, which facilitate expiration and reduce the resistance during exhalation.

Figures

1. **A surgical mask** (on the left) prevents the wearer's droplets from dispersing into the environment.

A protective respirator mask (on the right), when properly fitted, blocks particles present in the inhaled air.

2. **Respiratory protection**
A mask designed to protect against pathogenic particles in the air we inhale must have sufficiently thick filtering layers. Additionally, it must fit well on the face to prevent air from entering through the sides (which can occur with a simple surgical mask). In particular, if the wearer is a man, he should be clean-shaven. These masks can typically be worn for only a few hours at most before they need to be discarded + Filtration Layer (Non-Woven Polypropylene), Inner Layer (Non-Woven Polypropylene), Acrylic Support, Outer Layer (Non-Woven Polypropylene), Polypropylene Microfibers

3. **Filtration mechanisms**
Three primary mechanisms are at work in the filtering layers of masks. Inertial Impaction: the particle follows an air streamline but, due to its mass, deviates from this path by continuing straight and colliding with a fiber. Interception: The particle follows an air streamline and comes into contact with a fiber if its radius is larger than the distance between the fiber and the streamline. Diffusion: the particle follows an erratic trajectory due to Brownian motion, which brings it close to a fiber; this effect concerns only sufficiently small particles. These different mechanisms result in filtration efficiency being maximal for very small or large particles and less effective for intermediate-sized particles + Diffusion Effect, Effects of Diffusion and Interception, Effects of Inertia and Interception, Particle, Streamline, Fiber.

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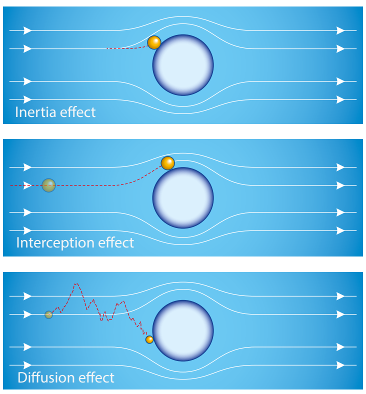

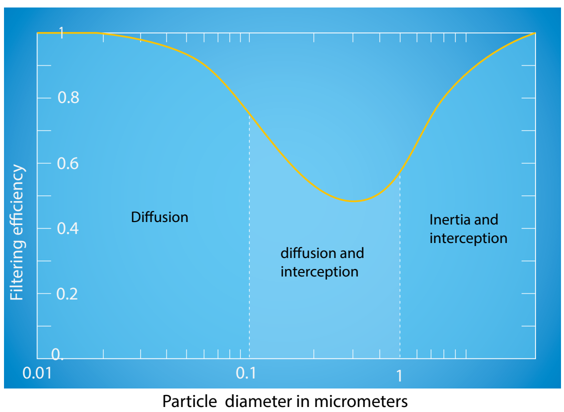


PORTUGAL


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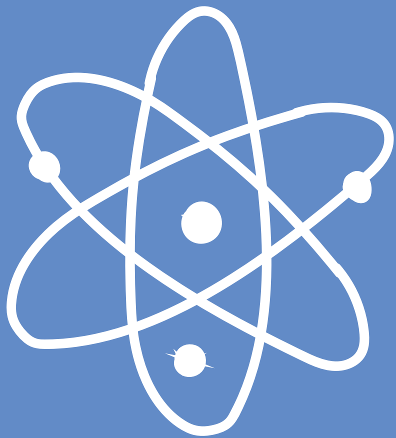
UNITED STATES OF AMERICA


FRANCE


TAIJIKISTAN


TURKMENISTAN

Physics on this day



JULY 21, 2000

Fermilab announces the discovery of the tau neutrino

The family of leptons - particles insensitive to the strong force and not composed of quarks - is made up of electrons (discovered in 1896), muons (1936) and tau (1976). Each of these leptons is associated with a neutrino, with no charge and very low mass: the electron neutrino (discovered in 1956), the muon neutrino (1962) and the tau neutrino.

The latter was discovered at Fermilab (USA) at the Tevatron gas pedal by a collaboration dedicated to this research: DONUT (Direct Observation of the NeUtrino Tau), which began operating in 1997. The official announcement was made at Fermilab, and this neutrino is the latest particle to be discovered before that of the Higgs Boson in 2012.

Schedule

Monday, July 21

Students

9:00AM – 2:00PM: Theoretical exam

4:00PM: – 5:00PM: Experimental conference

5:00PM: – 6:00PM: Drumteam workshop

6:00PM: – 7:00PM: Sponsors exhibition

7:00PM – 10:00PM: Mid term party

Leaders & observators

10:30AM – 1:00PM: Brunch cruise (Jane Street) - Quai d'Austerlitz

5:00PM – 7:00PM: Sponsors exhibition

7:00PM – 10:00PM: Mid term party

Join us on : **@ipho_2025**

Happy birthday to

Marie Gaillard
from France

Promitheas Panagiotis Nikou
from Greece

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Société Française de Physique

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