Exposition MAGNÉTIQUE

Le pouvoir de l'attraction



cnrs · métropole GrandNancy · La Région Grand Est · IEEE MAGNETICS · ijl INSTITUT JEAN LAMOUR · UNYS · MAT-PULSE · FRANCE 2030 · PROGRAMME DE RECHERCHE · UNIVERSITÉ DE LORRAINE · SFP Société Française de Physique



Engines, wind turbines, induction hobs, subway tickets, or bank cards...

Even though magnetism is omnipresent in our environment, this physical phenomenon remains largely unknown to the general public.

Through experimentation, manipulation, and observation, the MAGNÉTIQUE exhibition invites visitors to explore the principles and effects of magnetism, which are at the core of many everyday applications.

About



MAGNÉTIQUE: 4 zones to dive into the heart of magnetism with nearly 60 interactive experiments.

The MAGNÉTIQUE exhibition allows a broad audience to become familiar with magnetism and enables each visitor to engage in their own scientific exploration through hands-on experimental setups.

Experiments punctuate the visitor's journey, challenge their knowledge, and invite them to discover the properties and applications of magnetism—a source of fascination for millennia.

The exhibition explores themes at the heart of contemporary challenges where magnetism plays a central role. No electric mobility or renewable energy sources like wind power would be possible without powerful magnets! And to address data storage challenges, nano-magnetism and spintronics are opening up promising new possibilities.

The exhibition highlights innovations from the latest research, particularly those conducted in France, to shape the future of energy and digital technology.

Hélène Fischer, the creator of the exhibition

Hélène Fischer is a French physicist specialized in nanomagnetism and spintronics. A professor and researcher at the University of Lorraine, she is also recognized for her science communication efforts, particularly through this exhibition. She coordinates all outreach activities within the SPIN Research Program.



In 2019, she was awarded the Jean Perrin Prize by the French Physical Society for her contributions to the dissemination of science.



An exhibition accessible to everyone

The exhibition is aimed at all audiences, young and old, from the age of 8.

It offers several levels of interpretation:

- Short texts titled «What to do? What to see?» placed at the front of tables provide accessible instructions for everyone.
- Table plaques provide more detailed explanations to further explore the topics discussed.
- A booklet for young audiences and families offers a simplified route, complete with an interactive question-and-answer game.
- Videos available on touchscreen kiosks enrich the experimental journey by providing visual and interactive supplements.





A document for professionals (teachers, mediators, etc.) is available upon request to prepare for visits and educational activities.

The minimum required space is 250 m², which can be extended up to 400 m² to include a space dedicated to animation or research.

Would you like to rent the exhibition?
Send an email for more information to the following address:
helene.fischer@univ-lorraine.fr

Magnetism, where to find it?



Zone 1

The first zone of the exhibition aims to introduce the public to magnetism by exploring its fundamental properties, identifying its various possible origins (magnets, electric currents, Earth's magnetic field), and visualizing the different magnetic fields.

The journey begins with interactive experiments exploring the attraction and repulsion between different magnets. Visitors are encouraged to observe that the intensity of these phenomena varies depending on the magnets used, revealing their diversity, with some being very powerful and others not.

Visitors then discover the essential properties of magnets: the systematic presence of a North pole and a South pole, as well as the functioning of a compass. Using compass networks, iron powder, and ferrofluids, they visualize the magnetic field generated by a magnet and observe that not all materials react the same way in its presence.

The journey continues with an exploration of the relationship between electricity and magnetism. Visitors learn that electric current generates a magnetic field, a phenomenon widely used, for example, in the magnetic sorting of metal waste.

Finally, the zone invites visitors to dive into the study of Earth's magnetism: its origins, manifestations, evolution over time, and its interactions with solar magnetism, which gives rise to the fascinating auroras borealis.

Zone 2

Magnetism, how do you explain it?

This zone focuses on the origins of the magnetic properties of materials.

It offers a journey into the infinitesimally small, the scale at which the phenomena responsible for the behaviors of magnetic materials can be observed.

Visitors can understand why certain materials and objects, like magnets, are permanently magnetized, why others, such as iron, are always attracted to a magnet and can become magnetized, and why some seem to be non-magnetic.

But are they really non-magnetic? And are these behaviors sensitive to temperature?

Models illustrate these different magnetic behaviors, which result from varying magnetic arrangements at the infinitesimally small scale.





Zone 3 Magnetism, What for?

The third zone invites visitors to explore the fundamental laws of electromagnetism through interactive experiments, while highlighting their many applications in everyday life.

From the outset, visitors discover the existence of a particular force called the « Laplace force » which occurs when an electric current passes through a region exposed to a magnetic field. This force is essential for the operation of electric motors and the development of green mobility.

Further along, the phenomenon of electromagnetic induction is demonstrated. This principle, which generates electricity when a conductor moves through a magnetic field, forms the basis of alternators and wind turbines.

Finally, two experiments illustrate the effects of eddy currents—those currents induced in massive conductors. They play a key role in devices such as heavy truck brakes and the incline simulators in stationary bikes.

Other experiments illustrate the principle of **electromagnetic levitation** used in certain high-speed trains, induction heating, electrical transformers, WiTricity (wireless electricity) used in wireless phone chargers, as well as the RFID system used in anti-theft devices or other access cards.

Magnetism, what role does it play in a computer?

Zone 4

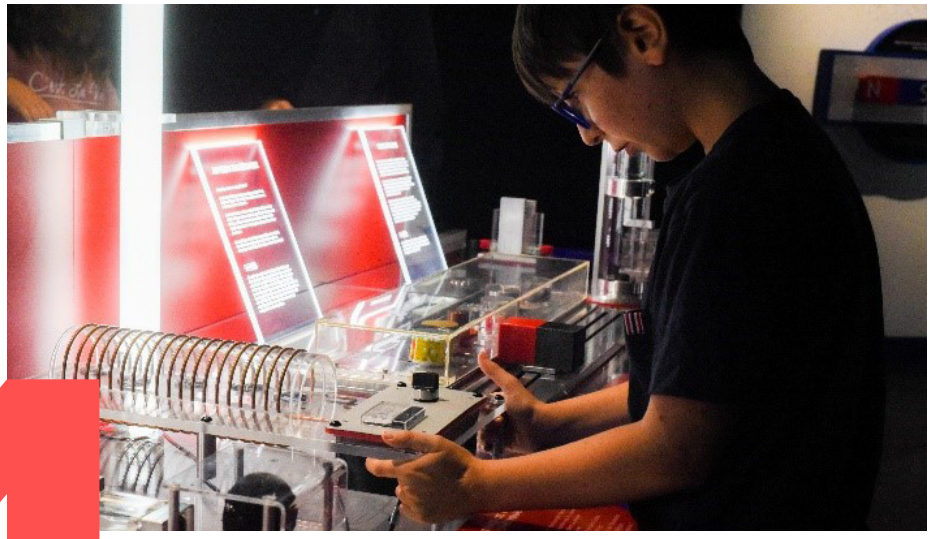
The fourth zone is entirely dedicated to the computer, revealing the fundamental role of magnetism in its operation, particularly in data storage.

After an introduction to binary coding, visitors explore the principle of writing and reading a byte of information on a magnetic medium using a giant model that demonstrates the operation of a hard drive.

The walk then leads them to discover that many everyday objects function through the manipulation of magnetization, whether it's bank cards, subway tickets on a microscopic scale, or even refrigerator magnets on a millimeter scale.

The visit continues with an explanation of giant magnetoresistance, a groundbreaking discovery that revolutionized the performance of modern hard drive read heads. This advancement, which earned French physicist Albert Fert the Nobel Prize in Physics in 2007, is placed in the context of recent research.

Examples illustrate these innovations: writing with ultrashort laser pulses and coding on four states. All aim to make data storage faster, more compact, and more energy-efficient.



4



At the end of the journey, visitors are invited to reflect on the challenges related to the resources required for the production of high-performance magnets, which are essential for the energy and digital transitions. Whether for wind turbines, storage devices, or electric cars, these technologies rely on powerful magnets containing neodymium, a rare earth element whose extraction raises controversies. The surge in demand for magnets makes this resource strategic, at the heart of significant geopolitical and environmental issues. MAGNÉTIQUE highlights research aimed at addressing these challenges by developing powerful magnets without neodymium or by establishing a recycling system capable of recovering this valuable resource.

The reflection then extends to another major issue: the enormous energy expenditure linked to the exponential growth in data storage needs. This is where spintronics comes into play, an innovative field that combines electronics and magnetism. Particularly active in France, this field explores solutions to meet the incredible challenge of storing ever-increasing amounts of information while significantly reducing energy consumption and using only sustainable materials.

A challenge for the future: strong magnets and data storage

MAGNETIQUE in figures

MAGNÉTIQUE, the exhibition accessible to both young and old, has welcomed numerous visitors throughout its tour



+ 100 000 people

Media coverage of MAGNÉTIQUE

145

appearances in the media: press, TV, radio, articles on the Internet, videos

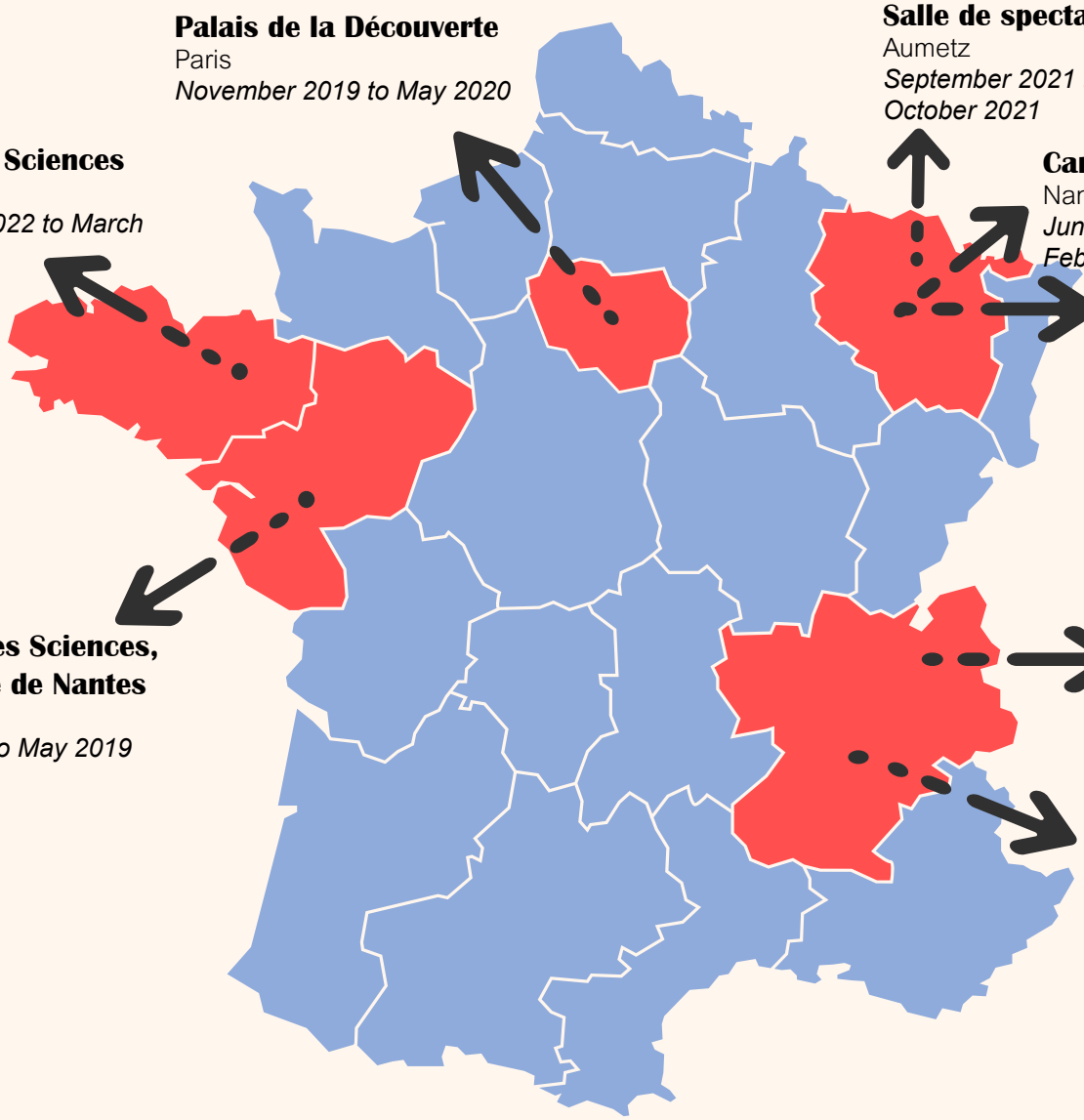
+60 experiments and manipulations

4 large thematic zones

2 Labels prestigious

MAGNÉTIQUE has been labelled 80 years of CNRS and the Year of Physics 2023-2024

6 support organisations privileged



MAGNÉTIQUE travels in France

MAGNÉTIQUE, derived from the MAGNÉTICA exhibition created in 2017 at the Jean Lamour Institute as part of the Escales des Sciences program at the University of Lorraine, was produced with the participation of students from Mines Nancy and the ENSAD of Nancy. It was exhibited several times in Lorraine. The exhibition evolved with the support of Universcience and was presented at the Palais de la Découverte in 2019-2020. It was later enriched with a new scenography during its visit to the Espace des Sciences in Rennes in 2022-2023. The exhibition was then hosted at La Rotonde in Saint-Étienne, continuing its remarkable journey.

Partners

The MAGNÉTIQUE exhibition benefits from broad support, reflecting the interest and enthusiasm it generates. Many partners, institutions, and enthusiasts have come together to support this unique event. Their commitment highlights the significance of this initiative and its impact on the fields of science, culture, and art.

Thanks to this valuable and diverse support, MAGNÉTIQUE has established itself as an unmissable event, attracting a wide audience and deepening our understanding of the connections between creativity and innovation.

The Jean Lamour Institute: The Jean Lamour Institute is a scientific research center dedicated to materials, metallurgy, and nanotechnology, located in Nancy. It brings together more than 500 researchers, engineers, and technicians, working on cutting-edge innovation and industrial projects.

CNRS: The CNRS (National Centre for Scientific Research) is the largest public research institution in France. It covers all scientific fields, contributing to the advancement of knowledge and innovation.

The University of Lorraine: The University of Lorraine is a multidisciplinary institution located in the Grand Est region of France, with over 60,000 students. It stands out for its research excellence, diverse academic programs, and international collaborations.

Lorraine Université d'Excellence: LUE, recognized in 2021 under the IDEX/I-SITE programs, brings together Lorraine-based partners around key scientific fields to strengthen their international leadership and address major economic and societal challenges.





PEPR SPIN: The SPIN Research and Priority Equipment Program (PEPR Spintronics) is an exploratory program within the France 2030 investment plan. Co-led by the CEA and CNRS and funded with 38 million euros, it aims to support a new cycle of innovation in spintronics.

SFP: The French Physical Society (SFP) is a scientific association that promotes research, dissemination, and teaching of physics in France. It brings together researchers, educators, and enthusiasts to highlight advancements in physics.

L'IEEE Magnetics Society: The IEEE Magnetics Society is an international scientific organization dedicated to advancing research, technologies, and applications in the field of magnetism. It brings together researchers and professionals from around the world and works to disseminate knowledge, notably through the training of young engineers and scientists.

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#ExpoMagnétique