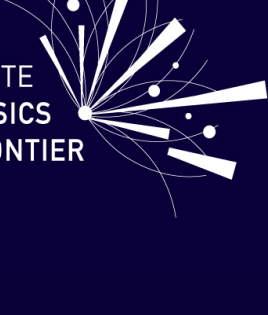



SAPHIR NEWSLETTER

MILLENNIUM INSTITUTE
FOR SUBATOMIC PHYSICS
AT HIGH-ENERGY FRONTIER
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2024 NOVEMBER & DECEMBER – RECENT NEWS

RESEARCH

RECOMMENDED ARTICLES

“Long-lived particle phenomenology in one-loop neutrino mass models with dark matter”

Authors: Carolina Arbeláez, Giovanna Cottin, Juan Carlos Heio, Martin Hirsch, Tessa B. de Melo

This work (which is currently under review) is a collaboration between SAPHIR researchers and both national and international colleagues. It explores the collider and dark matter phenomenology of a model capable of explaining both the origin of neutrino masses and dark matter simultaneously. These two topics are among the biggest unknowns in particle physics. We propose concrete and feasible strategies, including novel long-lived particle signatures at the LHC, to put this model to the test.

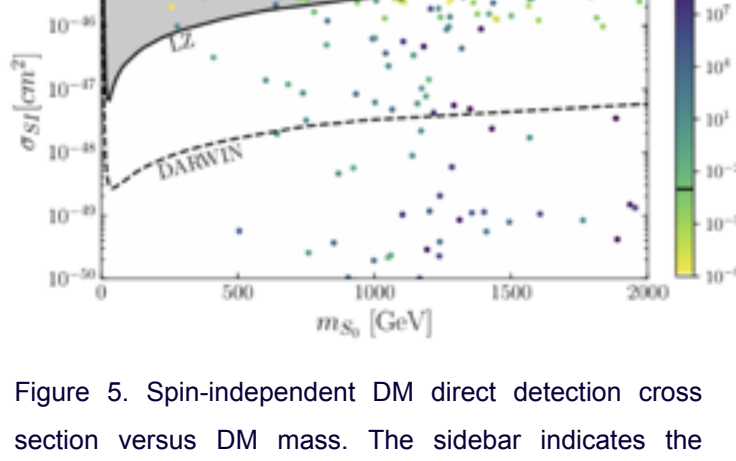


Figure 5. Spin-independent DM direct detection cross section versus DM mass. The asterisk indicates the lifetime of the H^{++} scalar, with blue (yellow) points corresponding to long-lived (short-lived) H^{++} . The strip is the lifetime corresponding to $c\tau < 1$ nm, which is the threshold above which we consider a particle to be long-lived. The H^{++} particle is long-lived for the majority of points that satisfy current direct detection constraints, including all the points that evade future detection by DARWIN.

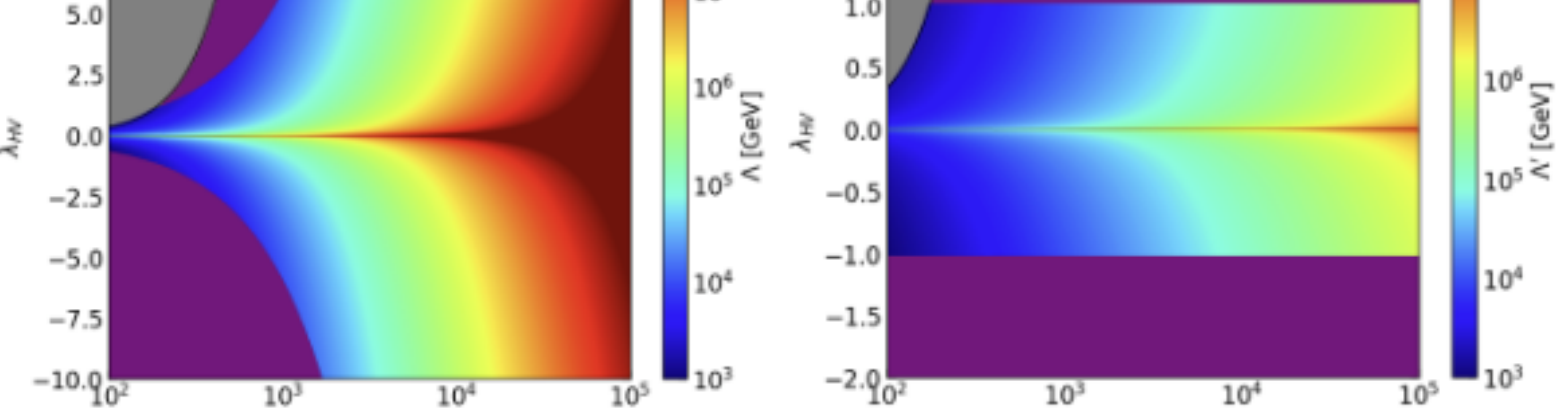
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“Vector dark matter from the 5-dimensional representation of $SU(2)_L$ ”

Authors: Patricio Escobedo, Sebastián Acevedo, Paulo Argüeso, Gonzalo Benítez-Iñiguez, Pablo Solar, and Alfonso Zurek

The Minimal Dark Matter (MDM) paradigm, i.e. the idea that dark matter can be the neutral component of a field feeling the weak interaction, was proposed in 2006 and originally was studied only in the context of spin-0 and spin-1/2 dark matter candidates. Since 2017, our group has been exploring the MDM idea for spin-1 dark matter candidates. In previous works, we studied the cases where the new massive spin-1 field has two components (doublet) or three components (triplet).

In this work, we explore the case where the new spin-1 has five components (quintuplet). This is the culmination of our efforts, because this is the bigger spin-1 field that can reasonably explain the nature of dark matter. We show that, contrary to the general expectations, this model is both consistent and a viable candidate for dark matter, and it provides a rich phenomenology. We studied in detail the main signals and the possibilities for discovering or rule out the model. I want to emphasize that the paper was mainly developed by students (all the authors except me).



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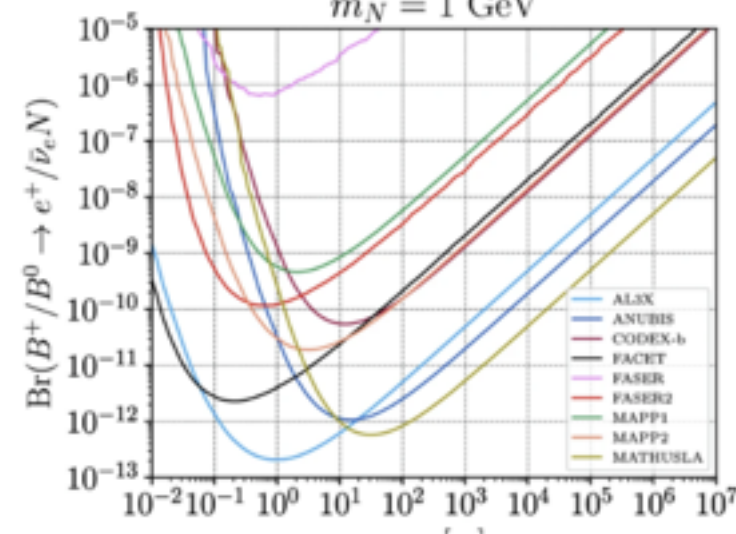
SUGGESTED PAPER

This article was recommended by Giovanna Cottin:

“A C++ program for estimating detector sensitivities to long-lived particles: Displaced Decay Counter”

Authors: Florian Domingo, Julian Ganther, Jong Soo Kim & Zeren Simon Wang

This recent paper is authored by one of my collaborators. The work presents an open source software (which I am currently testing myself) able to predict the probability of decays of a long-lived particle at several proposed collider experiments. I recommend it as, in our group, my students are currently studying similar predictions, and I believe it can be a useful tool that efficiently encapsulates the different detector geometries. It is also a tool that can globally aid in making the physics case for new experiments, via quick computational testing of new, long-lived physics.



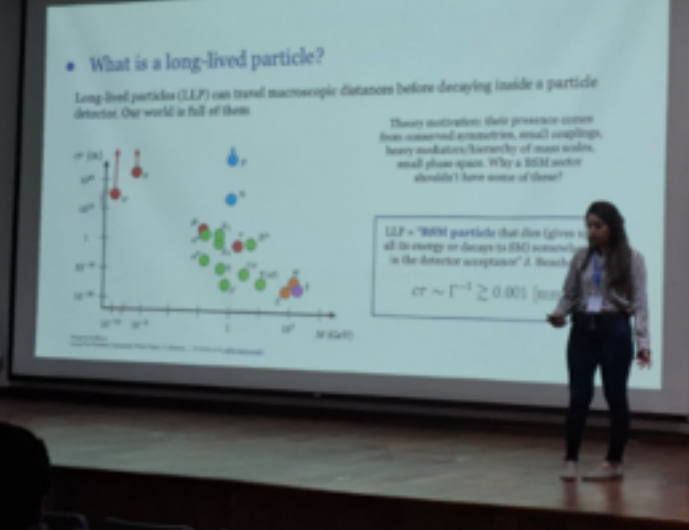
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CONGRESS

Our associate researcher, Dr. Giovanna Cottin, participated in the Latin American Symposium on High Energy Physics (SLAHEP) with a plenary talk titled “Long-Lived Particles.”

Francisca Garay, SAPHIR's alternate director, attended a prestigious workshop on elementary subatomic particles in France, as well as the “ATLAS Week.”

The event took place from November 4th to 8th in Mexico City.



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The third edition of the “ECFA Workshop on e+e- Higgs Top Electroweak Factories” was held in Paris from October 8th to 11st. This event marked the conclusion of a series of workshops dedicated to electron (e+e-) physics, experiments, and detectors.



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RECENT NEWS FROM SAPHIR

Dr. Sergey Kuleshov, Director of SAPHIR, was appointed Chair of the Collaboration Committee for the NA-64 experiment at CERN.

“New Challenges for ATLAS: The Role of Flexes in Processing Information from Silicon Pixels”

Professor Sergey Kuleshov was appointed Collaboration Board Chair of the NA-64 experiment at CERN. Dr. Kuleshov has distinguished himself for his scientific quality and is recognized for his knowledge and experience in the area of High Energy Particle Physics.

ATLAS experiment is one of the detectors that are part of the Large Hadron Collider (LHC) at CERN. Its application and operation have allowed the investigation of a wide range of concepts and phenomena related to modern physics, including the discovery of the famous Higgs boson and particles that could constitute dark matter.



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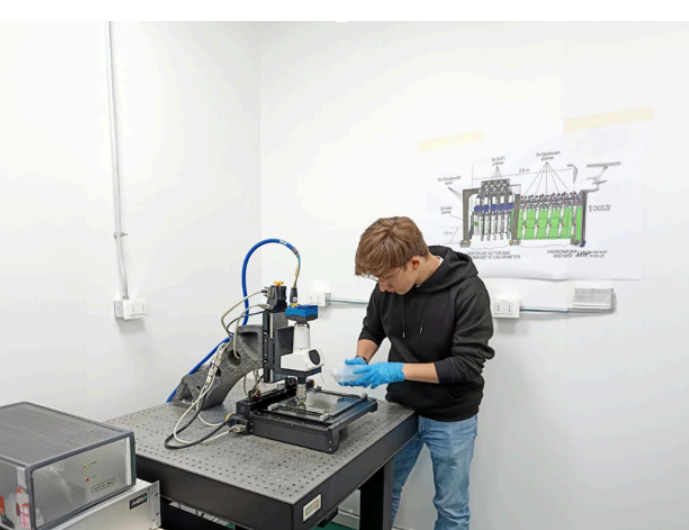
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“The Giant Universe Opened Up by Particle Microscopes”

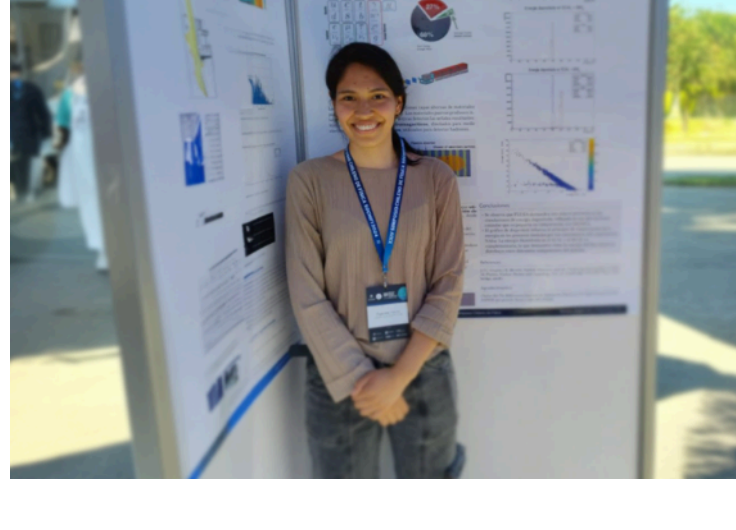
The development of cutting-edge knowledge, technologies, and the dynamic nature of the scientific community represents a complex and essential task. The time required to collect data and analyze information to construct new frameworks is extensive, involving long hours of data processing and meticulous logging of results.

FLUKA Software Simulations in Calorimeter Modelling

Pascale Tilleria, a SAPHIR student, was awarded Best Poster on the first day of the XXIV Chilean Physics Symposium (SOCHIF 2024) for her work using FLUKA software simulations in calorimeter modeling. The NA64 experiment at CERN, a fixed-target experiment, aims to search for a new vector boson (A'A'), referred to as the dark photon, which could mediate interactions between visible and dark matter. This experiment is designed to explore new physics beyond the Standard Model, particularly in the realms of dark matter and hypothetical particles such as dark photons and axions.



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“Heavy Ion Collisions: One of the Keys to Understanding the Early Universe”

Particle physics seeks to understand the fundamental components of matter and their interactions. Experiments with particle accelerators have revealed that all matter consists of subatomic particles such as quarks, electrons, and neutrinos. Heavy ion collisions, in particular, provide insights into the early universe, allowing scientists to simulate extreme conditions and better understand its fundamental structure and origins.

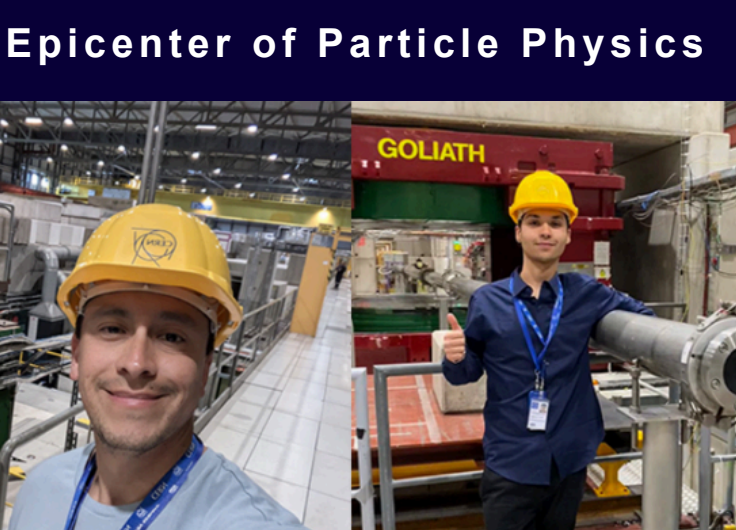


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NEWS

SAPHIR Students Travel to CERN: Epicenter of Particle Physics

One of SAPHIR's principal missions in its first five years has been to promote the formation of advanced human capital and support training at both undergraduate and graduate levels.



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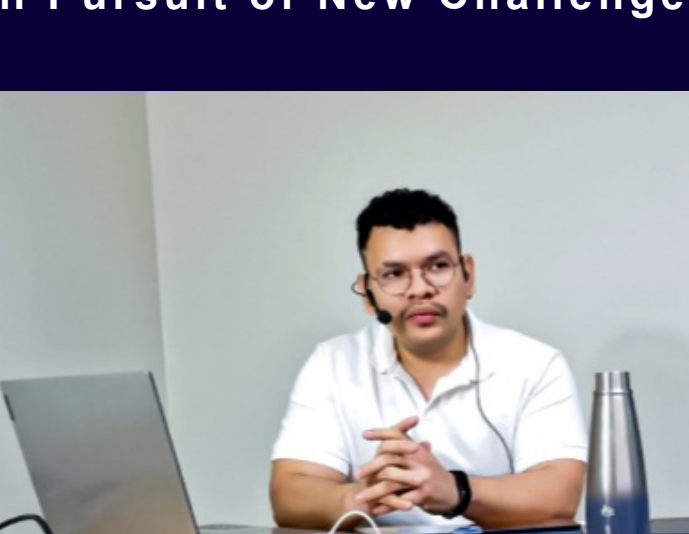
Microelectronics: Challenges and New Horizons for Chile



Microelectronics focuses on designing and integrating electronic circuits at microscopic levels. This discipline has been crucial in developing products like computers, cell phones, and medical devices, driving miniaturization and improved performance in modern technologies.

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In Pursuit of New Challenges in Particle Colliders



which originates in outer space. These particles provide crucial insights into astrophysical phenomena, including black holes, dark matter, supernovae, and the origin of the universe.

Together, these disciplines complement one another, expanding our understanding of the cosmos—from its smallest building blocks to its largest structures.

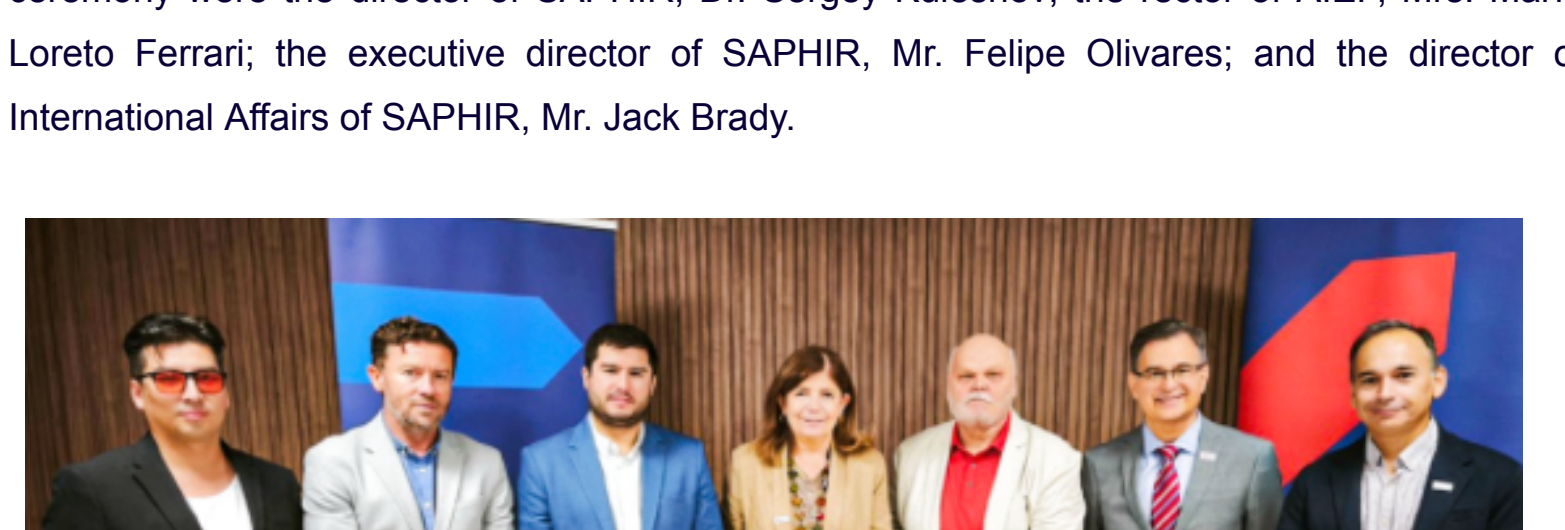
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Particle physics and astroparticle physics are branches of physics that explore the most fundamental components of the universe. Particle physics focuses on studying subatomic particles, such as quarks and electrons, and their interactions, often using particle accelerators to simulate extreme conditions. In contrast, astroparticle physics investigates high-energy cosmic particles, such as cosmic rays and neutrinos,

INSTITUTIONAL & NETWORKING

“Agreement between SAPHIR and AIEP Institute: Paving the way for the development of advanced human capital”

On December 5, 2024, an agreement was signed between the SAPHIR Millennium Institute and the AIEP technical-professional institute, belonging to UNAB. Present at the signing ceremony were the director of SAPHIR, Dr. Sergey Kuleshov; the rector of AIEP, Mrs. María Loreto Ferrari; the executive director of SAPHIR, Mr. Felipe Olivares; and the director of International Affairs of SAPHIR, Mr. Jack Brady.



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National Director of ANID, Alejandra Pizarro, Visits CERN and Meets with SAPHIR Scientists

The Millennium Institute SAPHIR is a scientific research center funded by Chile's National Agency for Research and Development (ANID), which operates under the Ministry of Science, Technology, Knowledge, and Innovation. SAPHIR has consistently developed cutting-edge research in subatomic particle physics throughout its years of operation. This work has resulted in hundreds of publications in prestigious scientific journals worldwide, including Nature.

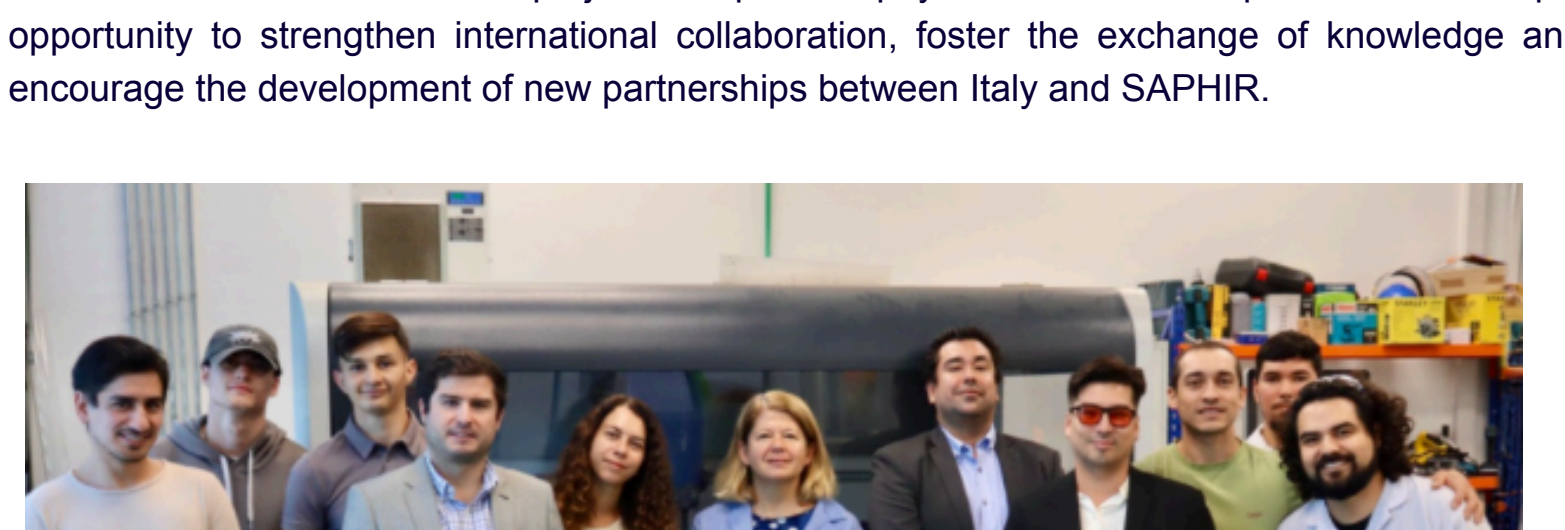


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Italian Ambassador to Chile Visits SAPHIR's Offices at Universidad Andrés Bello

On January 3, 2025, the Ambassador of Italy to Chile, Valeria Biagiotti, accompanied by Commercial Secretary Althea Cenciarelli, paid an official visit to SAPHIR's laboratories at the Universidad Andrés Bello's Casona de Las Condes campus.

During her visit, Ambassador Biagiotti was welcomed by the SAPHIR community, who showed her the latest advances and projects in particle physics. This visit represented a unique opportunity to strengthen international collaboration, foster the exchange of knowledge and encourage the development of new partnerships between Italy and SAPHIR.



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