**ABSTRACT**

Synchrotron Light or Radiation, is a type of electromagnetic radiation that spans a wide range of the electromagnetic spectrum – from ultraviolet radiation, to infrared light and x-rays. Synchrotron light is produced when charged particles, accelerated to speeds approaching the speed of light, have their trajectory deflected by magnetic fields. The Synchrotron Light Source is a large machine, capable of controlling the movement of these charged particles, typically electrons, to produce Synchrotron Light.

The light we see – produced by the sun, by lamps or flames, reflected by objects, captured by our eyes and finally used by our brains to shape and color the world – corresponds only to a tiny fraction of the so-called electromagnetic waves.

However, there are many electromagnetic waves, many types of light that we cannot see, but are produced in the most diverse natural and artificial phenomena. The study of these invisible waves leads not only to the understanding of the phenomena in which they are produced, but also to the development of technologies that use them, for example, to transmit and receive information.

**Keywords**

Physics, Sirius Project, Synchrotron light, Energy.

**Introduction**

Sirius (Figure 1), is the new Brazilian Synchrotron Light Source, will be the largest and most complex scientific infrastructure ever built in the country and one of the first 4th-generation Synchrotron Light Sources in the World. It is planned to put Brazil in a leading position in the production of Synchrotron Light and is designed to be the brightest of all the equipment in its energy class.

Synchrotron Light Sources are the best example of an open and multidisciplinary research infrastructure and is a key tool for the resolution of issues important to the Brazilian academic and industrial communities. The versatility of a Synchrotron Light Source enables the development of research in strategic areas such as food, energy, environment, health, defence and many others.

That is why this technology becomes increasingly popular around the world. It is also the reason why countries with strong, technology-based economies already either have one or more Synchrotron Light Sources, or are building them.

The first stage of the Sirius Project, the new synchrotron light source in Brazil, has just been inaugurated. Electrons were accelerated for the first time in the largest and most complex scientific facility ever built in the country, at the National Center for Research in Energy and Materials (CNPEM) in Campinas. The ceremony was attended by illustrious physicists who contributed to the creation and consolidation of the project, such as Antonio José Roque da Silva, general director of the Sirius Project and the CNPEM, as well as an alternate member of the board of SBF, and Rogério Cézar de Cerqueira Leite, the honorary chairman of the CNPEM board.

When finished, Sirius will be one of the best and most powerful sources of synchrotron light in the world. A synchrotron light source consists of a ring within which electrons circulate accelerated to almost the speed of light, causing these particles to emit a strong electromagnetic radiation. Researchers from a wide
range of areas will be able to use Sirius-generated radiation to obtain images of biological materials, viruses and proteins, as well as the crystalline and molecular structure of soil samples, minerals and new laboratory-created materials.

The first stage of the project concluded the civil works and the delivery of the building that houses the entire research infrastructure, besides the conclusion of the assembly of two of the three electron accelerators. The delivery of the next phase of the project, scheduled for the second half of 2019, includes the start of the Sirius operation and the opening of the first six research stations for the Brazilian and international scientific community.

"The inauguration of the first phase of the Sirius project, which is the country's new source of synchrotron light, represents a fantastic achievement for Brazilian science and technology," said Marcos Pimenta, SBF president, who represented the company at the inauguration. "We will have in Brazil one of the most advanced laboratories in the world for the study and characterization of new materials and biological systems. In addition, since most of the equipment was made in Brazil, the Sirius project will also have an impact on the domestic industry, especially with regard to high technology instrumentation".

As a result, Brazil was the first country in Southern Hemisphere to gather the technical competence to develop and operate a great scientific equipment such as the synchrotron light source.

The LNLS is currently building Sirius, a fourth-generation synchrotron light source, planned to be one of the most advanced in the world. Sirius will be the biggest and the most complex scientific infrastructure ever built in the Country, planned to put Brazil at a worldwide leadership position in synchrotron light generation.

The new synchrotron light source is designed to be the brightest among all the equipment in its energy class and to receive up to 40 beamlines. Sirius will open new research perspectives in many areas such as material science, nanotechnology (Figure 2), biotechnology and environmental sciences.

**Applications**

**Life science**

Pharmaceutical companies and medical researchers are making increasing use of macromolecular crystallography. Improvements in the speed of data collection and solving structures mean that it is now possible to obtain structural information on a timescale that allows chemists and structural biologists to work together in the development of promising compounds into drug candidates. Both the anti-flu drug Tamiflu and Herceptin – used to treat advanced breast cancer – benefited from synchrotron experiments. Using synchrotron light in the infrared range, pioneering research
is underway into developing new cancer therapies that can be
tailed to the individual patient.In 2009, the Medical Research
Council used the Diamond Light Source to compare the structure of
hemagglutinin from the flu-virus strain that caused the 1957
“Asian” pandemic with the 1918 and 1968 outbreaks, to discover
why some avian flu viruses are more able than others to jump the
species gap.

Engineering
Synchrotron X-ray beams allow detailed analysis and modelling
of strain, cracks and corrosion as well as in situ study of
materials during production processing. This research is vital to the
development of high-performance materials and their use in
innovative products and structures. The Diamond Light Source
have been used to study the processes behind pitting corrosion,
which attacks the so-called corrosion-resistant metals used in
containers for nuclear fuel, and to understand how applied
stresses can cause cracks to propagate through materials.

Environmental science
Synchrotron-based techniques have made a major impact in the
field of environmental science in the last 10 years. High brightness
allows high-resolution study of ultra-dilute substances, the
identification of species and the ability to track pollutants as they
move through the environment. Synchrotrons have been used to
develop more efficient techniques for hydrogen storage and to
study the way in which depleted uranium disperses into the local
environment. Tiny heavy-metal samples excreted from earthworms
have been compared with contaminated soil samples, revealing
how earthworms survive in these environments and introducing
the idea that earthworms could help to decontaminate land.

Physics and materials science
Determining the properties and morphology of buried layers
and interfaces is an important area in solid-state science with
synchrotrons being the meeting ground of state-of-the-art theory
and high-precision experimental results. Many of the technological
products of materials science are based on thin-film devices,
which consist of a series of such layers. Structural studies of in
situ processing of semiconducting polymer films are also likely to
be an important area of growth in the coming decade. Diffraction of
high-intensity X-ray beams is an ideal technique to study spin,
charge and orbital ordering in single-crystal samples to understand
high-temperature superconductivity. The SRS was used to help
study giant magneto-resistance (GMR), which is now used in
billions of electronic devices worldwide.

Cultural heritage
is a rapidly expanding area of research using synchrotrons.
Scientists are using non-destructive synchrotron techniques to find
answers to big questions in palaeontology, archaeology, art history
and forensics. Scientists in the UK have used the SRS and the
Diamond Light Source to study samples from the Tudor warship
the Mary Rose to enhance their conservation techniques, and the
ESRF has been used to study insects more than 100 million years
old, preserved in amber.

Agriculture
In agriculture, Synchrotron Radiation may be used for soil
analysis and for the development of more efficient and cheaper.
Synchrotron Light Sources have application also in the mapping of
the concentration, location and bioavailability of nutrients in
plant species.

Synchrotron Impact
Seven Nobel Prizes are X-rays related works; one of them is the
German Max von Laue’s research the “Diffraction of X-rays by
crystals”. The facilities of Synchrotron are already proved and
keep bringing good results in many areas. This particle allow
very accurate analysis, presently many projects are running, one
example is the group of investigators in Campinas (city of the
Sirius project) that are developing one technology that can make
the medicines of chemotherapeutic target specifically the cancer cells.

The SRS affected UK industry in several ways, the first being usage
of the facility by industry investigate the properties of materials
including structures of pharmaceuticals and their protein targets.
Over its lifetime, the SRS had approximately 200 proprietary
customers including government departments, industry, hospitals,
museums, universities and other Synchrotron Radiation sources.
The industry sectors that benefited the most from the use of the
facility are pharmaceutical, chemical and healthcare industries.

Skills, technology and knowledge gained on the SRS have
helped in the creation of new companies and one commercial
service provider. These new companies are in a range of areas
that include scientific instrumentation, detectors, cholesterol
monitoring, software, cryogenics, mechanical instrumentation and
drug discovery. These companies are creating impact through the
stimulation of the UK’s economy and the impact to people’s daily
lives that these activities will produce.

There was increased economic activity in the North West through
the creation of jobs and the construction and operation of the
facility between 1975 and 2008. This represented a direct financial
impact of £600 million, the majority of which was spent in the
locality of the SRS. Due to multiplier effects, this initial investment
increased to create an estimated total financial impact of nearly £1
billion to the North West. The SRS also acted as a purchaser of
goods and services in the local area and wider UK. Throughout
its lifetime, the SRS has traded with over 300 local businesses.
This purchase of goods or services from suppliers leads to a further
chain reaction of purchases from their supply chain and also has
indirect effects on employment, spend and taxation.

A 2.5 GeV light source has been in operation since 1994. Twenty
seven beam lines, including six from insertion devices, are in
operation, serving 1500-2000 users each year. About 500 papers
are published each year based on work at the light source. Ten
scientists returned to Korea to join the laboratory. Four became
directors. Thirty professors who returned to the Pohang University
of Science and Technology (Postech) are now users of the light
source. Many others returned to become faculty at other Korean
works at SOLEIL and at European synchrotron facilities on a range named PUMA. Since 2008, the team has supported synchrotron hard X-ray imaging beamline today in its conceptual design phase, comply with conservation and environmental standards and of a platform comprises construction of a new building that will ancient materials and methodological research. The IPANEMA methodological research is focused on advanced two-dimensional/three-dimensional imaging and spectroscopy and statistical image analysis, both optimized for ancient materials.

Discussion
The synchrotron light open for all sciences a completely new area of the acquaintance and researches. Based on this can provide an evolution in many knowledges, helping medicine, engineering, agriculture, nanotechnologies, etc. In a large scale, the synchrotron light can be the answer for the current questions and the key to solve problems that is present nowadays. This technology already proved that could be used in more area than we imagine, art, history, gadgets techs, among other things. This article was written to inform the benefits, impacts and one little part of the millions researches of the Synchrotron Light.

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