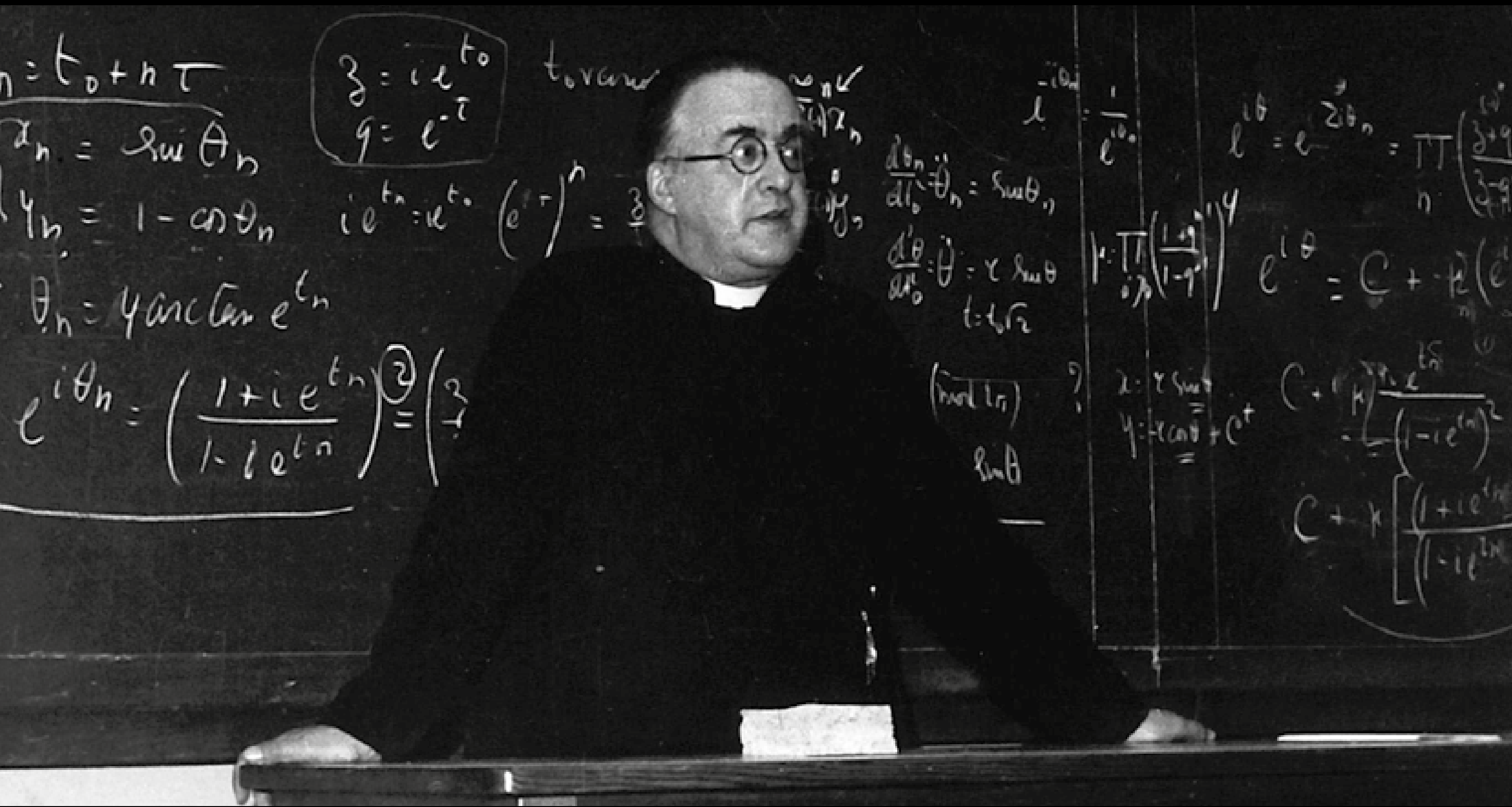
# Symposium

# 125th Anniversary of Georges Lemaître

**21 November 2019, Kuppelsaal, Hauptgebäude,**
**Universität Bern, Hochschulstrasse 4, 3012 Bern**



Georges Edouard Lemaître (1894 - 1966) was a Belgian physicist, astronomer, and Roman Catholic priest. He proposed an expanding universe and is the central founding father of the Big Bang model of the Universe.

## Afternoon Program (14:15 - 18:00)

**Harry Nussbaumer** (ETH Zürich)
*Lemaître and the Astronomical Environment of the 1920s*

**Jean-Pierre Luminet** (CNRS Marseille)
*Philosophical aspects and implications of Lemaître's contributions to modern cosmology*

**Norbert Straumann** (Universität Zürich)
*On Lemaître's inhomogenous cosmological model of 1933 and its recent revival*

## Evening Program (19:00 - 20:00)

**Friedrich-Karl Thielemann** (Universität Basel)
*Making the Elements in the Universe: From the Big Bang to Stars and Stellar Explosions*

**Further information**

www.sps.ch
www.scnat.ch

***Free entrance, no registration required***

swiss physical society

**Organisation:**
SPS: Claus Beisbart (Claus.Beisbart@philo.unibe.ch)
SCNAT: Marc Türler (marc.tuerler@scnat.ch)

swiss academy of sciences

In the last issue of the *SPG Mitteilungen* we pre-announced a special symposium on Thursday, 21 November 2019 to celebrate Georges Lemaître's 125th birthday. In the meantime the program has been completed. Please find the abstracts of the four presentations below.

## Lemaître and the Astronomical Environment of the 1920s

*Harry Nussbaumer, ETH Zürich*

Georges Lemaître entered astronomy during the first half of the 1920s. It was a time, when our knowledge of astronomy and cosmology went through a fundamental transformation. The observational basis of the new cosmology were the nebulae, which today we call galaxies. I will present an abbreviated history of the discovery of their true nature, beginning in the early 17th century, and reaching its climax in 1925.
The 1920ies also saw the beginning of a proper understanding of the internal constitution of the stars, the source of their radiative energy, the chemical composition of the universe, and there was much discussion and speculation on the origin of the elements.
As a prelude to modern cosmology I shall recall a speculation of Karl Schwarzschild from the year 1900. There will be a jump to 1917 with Einstein and de Sitter. This will be followed by Lemaître's insight of 1925 into a fundamental misconstruction of de Sitter, which had been confusing observers and theoreticians since 1917. After this I will proceed to Lemaître's discovery of the expanding universe. (The latter two points will be dealt with more thoroughly by Luminet.)
Hubble's observational publication in 1929, of a linear relationship between nebular redshifts and distances, will be situated in its historical context. I shall do the same with Einstein's conversion from his static to a dynamic model of the universe.

## Philosophical aspects and implications of Lemaître's contributions to modern cosmology

*Jean-Pierre Luminet, CNRS Marseille*

I will provide an epistemological analysis of the developments of relativistic cosmology from 1917 to 1934, based on the seminal articles by Einstein, de Sitter, Friedmann, with a special focus on Georges Lemaître, the true father of Big Bang theory. In particular I shall discuss the contents of his famous article of 1927 on the expanding universe, recalling the controversy about the so-called Hubble's law that was first presented in the original paper published in French, but disappeared in its English translation of 1931. Next I shall discuss the two articles of 1931 in which Lemaître introduced the concepts of the primeval atom and of the quantum origin of the universe, pointing out how negative reactions from Einstein, Eddington and others were based on a wrong philosophical interpretation of Lemaître's models. Eventually, Lemaître produced major contributions to relativistic cosmology until 1934, so that most of the ingredients of the present-day standard cosmological model, such as the accelation of the expansion due to a repulsive dark energy, the interpretation of the cosmological constant as vacuum energy or the possible non-trivial topology of space, had been anticipated by Lemaître in this golden period.

## On Lemaître's inhomogeneous cosmological model of 1933 and its recent revival

*Norbert Straumann, Physik-Institut, University of Zürich*

After Lemaître's most famous paper in 1927 on the expanding universe he published during his fruitful years from 1931-1934 a whole series of important contributions to cosmology. In my talk I discuss only his long paper of 1933 on an inhomogeneous cosmological model, now usually called for some reasons the Lemaître-Tolman-Bondi model. This interesting generalization of the Friedmann-Lemaître models has in recent years, after the discovery of the accelerated expansion of the universe in 1998, been revived in a number of studies. One motivation was to see whether *inhomogeneous* matter distributions could induce an accelerated expansion, without invoking dark energy. I will summarize the outcome of detailed confrontations of Lemaître's model with cosmological observations (Hubble diagram of supernovae, background radiation).

## Making the Elements in the Universe: From the Big Bang to Stars and Stellar Explosions

*Friedrich-Karl Thielemann, Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel*

The early universe within the Friedmann-Lemaître-Robertson-Walker prescription provides the framework for Big Bang nucleosynthesis, determined by the ratio of baryons to photons $\eta$ (of the order $10^{-10}$) being inversely proportional to the entropy of a radiation-dominated plasma. The high entropy, indicating very small densities for the temperatures encountered, are the reason that no elements heavier than He and Li are produced.
The build-up of elements in stars is governed by fusion reactions. Burning stages produce as ashes the fuel of the following stage and reflect that the fusion of heavier nuclei requires higher temperatures for overcoming higher Coulomb barriers. This sequence of events, from H- over He-, C-, Ne-, O-, and Si-burning, continues until nuclei with the highest binding energy per nucleon are reached, i.e. isotopes of Fe and Ni.
How can heavier nuclei be made? Neutrons do not experience repelling Coulomb forces, thus heavy nuclei can be produced by a sequence of neutron captures and beta-decays. But what is the source of unstable neutrons? Two options exist: (a) neutron-producing reactions in stellar evolution, or (b) explosive events starting with high densities, which permit the capture of electrons (with high Fermi energies) on protons in order to produce neutrons.