NEWS for Okayama University

From 2021, Okayama University is partnering in CMB-INFLATE

A 4 years European MSCA-RISE project -- Accepted for Funding - (*Early January-2021)*

(CMB-INFLATE will contribute further understanding of the origins of Universe and more specifically the still poorly known physics of the INFLATION phase)

On January 18th - 2021, Pr. Patanchon (from Université de Paris) started to circulate a good News: as the CMB-INFLATE European coordinator, he got a mail from the European Commission confirming that the CMB-INFLATE proposal (RISE type: Research and Innovation Staff Exchanges) has finally been accepted for funding.

This is excellent News for the consortium and specifically for Japanese Institutions as over 4 years from 2021, they will welcome in their research labs

EU scientists rely on the legacy of the ESA Planck mission (2009). Improvements of analysis methods and modelling of the instruments are now required.

Partnership

#	Participant Legal Name	Country
1	UNIVERSITE DE PARIS	FR
2	KOKURITSU DAIGAKU HOJIN OKAYAMA DAIGAKU	JP
3	University of Science and Technology of Hanoi, Vietnam Academy of Science and Technology	VN
4	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	FR
5	UNIVERSITA DEGLI STUDI DI FERRARA	Italy
6	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	DE
7	STOCKHOLMS UNIVERSITET	SE
8	KOKURITSU DAIGAKU HOJIN NAGOYA DAIGAKU	JP
9	SCUOLA INTERNAZIONALE SUPERIORE DI STUDI AVANZATI DI TRIESTE	IT
10	NATIONAL UNIVERSITY CORPORATION THEUNIVERSITY OF TOKYO	JP
11	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA	IT
12	The Regents of the University of California - Lawrence Berkeley National Laboratory	US
13	UNIVERSITETET I OSLO	NO
14	THE GOVERNING COUNCIL OF THE UNIVERSITY OF TORONTO	CA
15	CARDIFF UNIVERSITY	UK
16	INTER-UNIVERSITY RESEARCH INSTITUTE CORPORATION, HIGH ENERGY ACCELERATOR RESEARCH ORGANISATION	JP

Expected breakthroughs from CMB-INFLATE

The main goal of CMB-INFLATE is to build a community of scientists dedicated to the development of innovative analysis of large angular scale CMB polarization data to identify the inflation mechanism. CMB-INFLATE will focus on: (1) modelling hardware developed over three continents, including polarization modulators, optical systems, and detectors; (2) the development and implementation of innovative techniques to mitigate systematics from the sky and the instrument. Such advances will be obtained by a large scale international consortium including instrumentalists, data analysis experts and theoreticians.

Amid the efforts to improve the understanding of Inflation, Japan is proposing a satellite project (LiteBIRD, to be launched in the late 2020's). The large angular scales targeted by LiteBIRD are difficult to properly measure due to Galactic emissions and instrumental systematics, requiring careful, detailed modelling and advanced data analysis techniques. These are major achievements expected from the CMB-INFLATE partnership.

A few background features in basic physical cosmology:

Inflation: In physical cosmology, cosmic inflation, or just **inflation**, is a theory of exponential expansion of space in the early universe. Inflation theory uses **General relativity** to model the inflation mathematically.

The inflationary epoch lasted from 10^{-36} seconds prior the conjectured Big Bang singularity to some time between 10^{-33} and 10^{-32} seconds.

Based on the Standard Model of Cosmology, the universe has been expanding. The classical Big Bang theory assumes that the universe expanded at the same rate throughout universal history. But several problems are related with it:

Pbe-1: Origin of large-scale structures, such as galaxies. Inflation theory says that in a slow expansion of the universe, quantum fluctuations were only on the tiny distance scales; when the universe experienced a brief period of inflation, however, these quantum fluctuations were "stretched" much larger to cause density fluctuations. The places of higher density later caused matter to clump in those locations and form large-scale objects.

Pbe-2: The temperature uniformity in the universe: why is the temperature so evenly distributed ?

Inflation says that objects that were previously in close proximity to one another were separated very quickly during a period of inflation, so the temperature balance was still held. In the classical Big Bang theory this was a problem because the uniform expansion would mean that objects would have to travel many times the speed of light to maintain temperature balance.

Pbe-3: Magnetic monopoles. Why do we no longer see magnetic monopoles in our universe?

Inflation says that the few existing monopoles were so dispersed during periods of inflation that it is virtually impossible to find them now.

CMB: Cosmic Microwaves Background

Why using CMB ?

The cosmic microwave background (CMB) radiation was emitted when the Universe was 380,000 years old and is observed today in specific very low temperatures: 2.7 K (approximately -270 Celsius degree). It is a wonderful probe to study the evolution of the Universe. Tiny anisotropies in its temperature and polarization are induced by quantum scalar (density) and tensor fluctuations (gravitational waves, GW) generated during inflation. Primordial GW imprinted a unique parity-odd pattern on CMB polarization, called B-modes. Such modes, undetected as of today, are a direct probe of the poorly known physics of inflation, and main target of several forthcoming observational projects.

Benefit for Oka-Dai

CMB-INFLATE acceptance for EU funding is excellent for Okayama University, as Pr. Ishino's group will have for 4 years from 2021, the opportunity to welcome a number of high level scientists from European partners (Norway, Italy, France) all supported by European Commission funding. A total of 43 months of Mobility (TO Ishino's group) is attached to the project (the total CMB-INFLATE funded Mobility is 248 months so about 16% for Oka-Dai). Project funding: about 1 億えん).

Professional communication specialists will take care of the Web sites: those platforms will be quite suitable to further promote abroad the image of excellence of Okayama University.

This opportunity gives Prof. Ishino's group to accelerate the research activities for the development of novel data analysis methods to measure the CMB polarization with an unprecedent accuracy, an order of nK, by modeling the instruments precisely and mitigating systematic effects. The analysis techniques developed in this program can be applied not only to LiteBIRD but also to any future CMB measurements.

All those stays will contribute a strong momentum to further apply to more specific funding agencies and help building a long term ultimate project: the "Okayama Data Center" designed to collect LITEBIRD signals (After LITEBIRD satellite launch - planned in 2027).

In the CMB-INFLATE Japanese partnership, Okayama University is playing a major role: this also confirms the capability of the University to return to the road of success and to reach a recognized international profile.

Benefit for the European Partners

In agreement with the basics of a RISE-type project, researchers, staff and Ph-Ds or P-Docs will be training in top-level centers around the world

European scientists have gained a huge expertise in satellite CMB polarisation data analysis with the Planck experiment, and became world leaders in the domain. By increasing exchanges between Europe, Asia and North-America, CMB-INFLATE will contribute further European leadership improvement in the field. The creation of a large no frontier network of researchers is crucial to reach the objectives of the community: understanding the new intrinsic physical properties at the core of universe inflation.

Status of the CMB-INFLATE project in January-2021.

Agreements Signature process is underway. In April-2021, a Kick-Off meeting will be organized (physical or "on-line" depending on the Covid sanitary conditions).