It all starts from one observation : what are the physical forces that bring the huge number of biochemical players in cells at the right place, in the right order and in a reasonably short time to sustain cellular function and ultimately cellular life?
Biology has already demonstrated how, on short distance scales (less than 10 Angströms), well known forces drive these intermolecular interactions. But how do they get close enough to react? Are there other mechanisms beyond random movements that allow them to mutually "find each other" when and where needed?

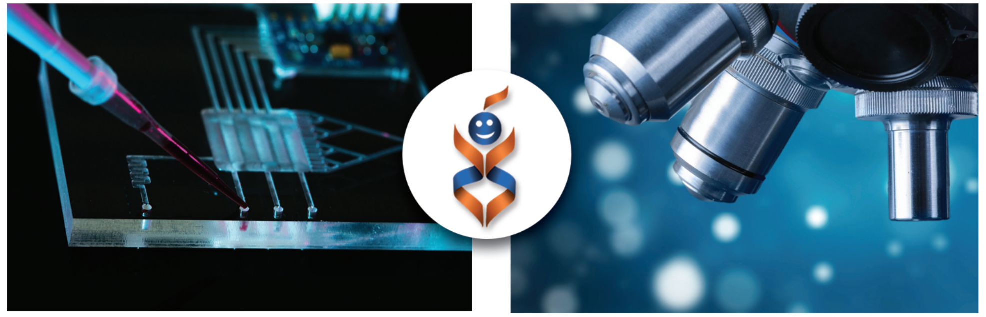
Project LINkS will change the paradigm of the self-organization of the intracellular living matter by proposing to explore a novel kind of Long-range ElectroDynamics Interactions (LEDIs) between proteins.

LEDIs may act as a long-distance protein-protein attractive mechanism, expanding above several hundred of Angströms, that could explain the high spatial organization and coordination of biomolecular reactions which are responsible for the transmission of information in cells.

Project LINkS explores quantum biology by bringing together 5 partners with complementary methods and fields of expertise in fundamental physics, microbiology and cutting-edge nano-technologies.

The main objectives of Project LINkS are :

1. To demonstrate LEDIs activation as a mechanism sustaining molecular dynamic from the molecular level to the living-cells stage.
2. To develop a breakthrough biosensor technology to investigate LEDIs between proteins.



3. To reinforce EU Nanobioelectronics industry capabilities, boosting innovation and growth of European SMEs.
4. To build a leading research and innovation capacity across Europe by training the young generation of scientists in cutting-edge technologies.

Sept 2021
Project LINkS' kick off

Nov 2022
First set of relevant biological protein is delivered

Dec 2022
Models of proteins are chosen

Feb 2024
Public report on THz spectroscopy of model protein

Feb 2024
Relevant biological models are defined and the lab-on-chip protoype is finalized

Feb 2025
Reports about the Lab-on-chip's specifications

Aug 2025
THz measurements of LEDIs, from in vitro to in vivo
Public reports are relesead

Sept 2025
End of Project LINkS

WP1
Out-of-equilibrium THz spectroscopy

The aim of this WP is **to design biological models** able to provide a full theoretical description of the involved phenomena in the sense of energy transfer, coherence time and amplitude of the oscillation modes at each frequency in a realistic model. Outcomes conjugated with experimental conditions for physical and physiological parameters to THz collective oscillations of proteins will provide precondition for long range electrodynamic interactions activations.

WP2
Lab-on-Chip THz biosensor

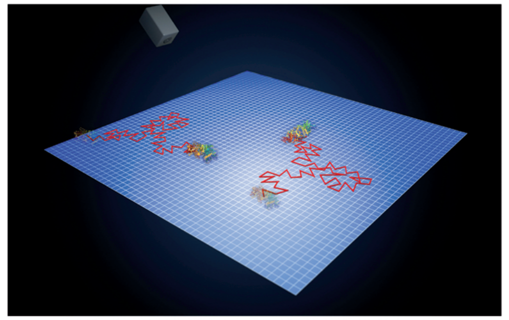
This WP intends to develop novel **lab-on-chip terahertz biosensor** which is expected to greatly improve spectroscopy capabilities of biological moieties in solution. The proposed WP involves the design and experimental study as well as the optimization of THz electronic nanodevices for integration into micro-fluidic system with advanced spectroscopy performances for 0.1 to 0.4 THz.

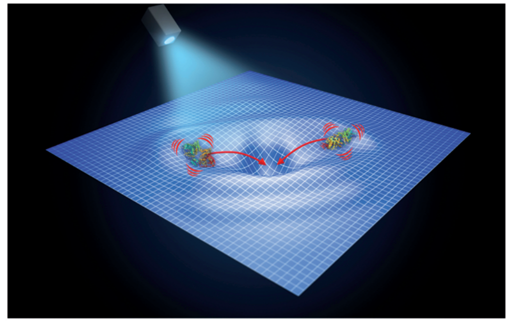
WP3
Evidencing LEDIs activation

This WP aims to establishing through theory and experiments, the experimental conditions for activation of **Long - range ElectroDynamic Interactions** (LEDIs) in relevant biological models. Starting form this point, the activation of LEDIs interactions will be demonstrated from in vitro to in vivo conditions by THz spectroscopy using the outcomes of WP1 and technical solutions from WP2.

Publications
Experimental evidence for long-distance electrodynamic intermolecular forces

Lechelon; Meriguet; Gori; Ruffenach; Nardecchia; Floriani; Coquillat; Teppe; Mailfert; Marguet; Ferrier; Varani; Sturgis; Torres; Pettini, Science Advances • Feb 2022 • Vol 8, Issue 7





By developping an original experimental technique which allies theoretical calculations with TeraHertz spectroscopy in aqueous solution and Fluorescence Correlation Spectroscopy, Project LINkS has aleady managed to shed a new light on mysterious complex molecular mecanisms.

Yet, a lot remains to explore for the team, giving encouraging perspectives in the fields of TeraHertz devices, nanotechnologies and biomolecular interactions.

In perspective, Project LINkS could contribute to the development of much-needed new personalized drugs and to the discovery of therapies, particularly in the field of immunotherapy. They also might contribute to the developing field of optogenetics and constitute a key to better understand the mechanisms of interaction between electromagnetic fields and living matter.

Through the development of a breakthrough nanotech device, Project LINkS will also participate to the development of the European research with its low-cost, time-saving, high-reliability biosensor approach. The European industry will, thus, benefit from the new technology to enable a more efficient and specific method of early disease diagnosis, thereby contributing to improve the development of the medical field and related markets.