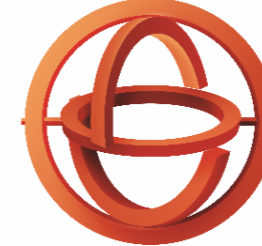


Description of Funded Research Projects

1st Call for H.F.R.I. Research Projects
to support Post-Doctoral Researchers



H.F.R.I.
Hellenic Foundation for
Research & Innovation

Research Project Title:

**Chirality Amplification and
Detection using Cavity Optical
Rotation Enhancement
(HANDCORE)**

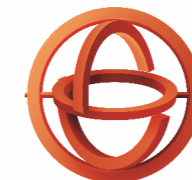
Principal Investigator:
Georgios Katsoprinakis



Popular Title:
**Chirality: significance, applications, and its
optical cavity measurement**

Scientific Field:
Physical Sciences

Host Institution:
**Foundation for Research and Technology, Hellas –
Institute of Electronic Structure and Lasers (FORTH - IESL)**



H.F.R.I.
Hellenic Foundation for
Research & Innovation

A molecule or ion is "chiral" when it is -geometrically- non-superimposable on its mirror image. This asymmetry manifests as optical activity, i.e. as optical rotation (OR) of the polarization plane of light traversing the sample, with the two "enantiomers" (mirror images) producing opposite polarization rotations. Systems causing OR with the same symmetry as chiral rotation, although not due to their geometry, are also referred to as chiral systems, the prime example being the parity-non-conserving (PNC) optical transitions in certain atomic and molecular systems.

Life is inherently chiral: from the terpenes produced by coniferous trees, to the DNA molecules, and the enzymes, sugars, proteins and amino-acids that drive life. Beyond that, chirality marks important phenomena in atomic physics and inorganic chemistry. Thus, chiral sensing is vital to such diverse fields, ranging from the fundamental research in biology, chemistry, physics and medicine, to the highly-valued pharmaceutical, chemical, cosmetic, and food industries. However, the chiral-induced OR signals are typically very weak, on the order of 10^{-5} rad for organic gas samples, down to 10^{-9} rad (or less) when probing parity non-conserving (PNC) atomic or molecular transitions. This is the main impeding factor for practical applications of chiral sensing, despite its apparent importance.

In this work, we leverage the experience of the grantee in measuring weak OR signals using optical cavities. An optical cavity is a configuration of high-quality mirrors which confine light in a closed path. By inserting a chiral sample inside the cavity, the confined light interacts with it multiple times, thus enhancing the single-pass, weak OR by a factor equal to the number of light round-trips in the cavity, before emerging to be detected.

HANDCORE aims to perfect the technique of using continuous-wave lasers in high-finesse cavities to measure OR at the quantum noise limits, for chiral organic molecules, nanometer-thick chiral surfaces, and, ultimately, to parity-non-conserving atomic transitions.

A multitude of scientific fields and high-market-value industries can benefit from the techniques developed in this project, with these benefits trickling down to society in the form of increased service or product quality. A few examples:

Pharmaceutical industry: improved and faster enantiomer purity detection leads to safer drugs and increased production.

Biology and medicine: Determining protein structure, a main goal in biology, reveals life mechanisms and leads to understanding and curing disease. Our methods may allow studying protein structure inside the natural biological environment (membranes, cells), and in an ultrasensitive, time-dependent fashion.

Analytical chemistry: chiral analysis is used extensively by analytical labs everywhere. Therefore, improving detection limits and sensitivities, instantly impacts the corresponding market.

Ecology and open field sciences: a staple of this project is the ability to sense chirality without the need for background removal. This opens possibilities for in-situ field studies with the use of portable cavity polarimeters implementing our techniques.

Fundamental physics: measurement of atomic, PNC-induced chirality constitutes a low-energy test for the standard model of particle physics, perhaps bringing new physics to light, or setting limits to current parameters and theories.

“



HFRI funding is an opportunity for me as a young researcher to experience a significant level of autonomy and pursue my individual scientific goals. It is important that, as the beneficiary, I will not only have to coordinate my scientific project, but also manage resources, logistics, and hiring, and disseminate the progress and results of my work; a challenging task, yet an undoubtedly useful experience.

I feel lucky to have been given this opportunity, and also humbled to some extent, to see my proposal be picked among so many high-quality proposals. However, at this early stage of the project I would like to exercise some restraint in expressing what my expectations of potential gains as a scientist and a researcher might be, and of what I can hopefully give back to my scientific community, and broader society in general, in terms of scientific advances and positive impact. It's time for work now.

*The Principal Investigator,
Georgios Katsoprinakis*

Funding

Amount: **200,000 €**

Duration: **36 months**

Foundation: **H.F.R.I.**





H.F.R.I.
Hellenic Foundation for
Research & Innovation

CONTACT

127, Vasilissis Sofias Avenue
115 21 Athens, Greece
info@elidek.gr
www.elidek.gr



HELLENIC REPUBLIC
MINISTRY OF
DEVELOPMENT AND INVESTMENTS



GENERAL SECRETARIAT FOR
RESEARCH AND TECHNOLOGY