Curriculum vitae — Jan Leys

Personal information

First name:	Jan	Address:	Boskant 79, 2275 Lille, Belgium
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Date of birth:	August 5, 1981		0475/76 09 02

Education

Doctor in Sciences: Physics (Ph.D.) 2007, KU Leuven, Belgium, with a thesis titled "Broadband dielectric spectroscopy of confined liquid crystals and hydrogen bonded liquids".

Master in Sciences: Physics 2003, with distinction, KU Leuven, Belgium.

Languages Dutch (mother tongue), English (fluent), French (good).

Carrier summary

2003–2007 Ph.D. in Sciences: Physics, KU Leuven, Belgium.
Research into the dynamics of **liquid crystals in nanoscale structures** with **impedance or dielectric spectroscopy**. Exercise and practical sessions Physics for first and second year Sciences students.

2007–2008 Postdoctoral researcher, KU Leuven, Belgium.
Research into liquid crystals and other forms of **soft matter**, such as **polymers** and **ionic liquids**. Exercise sessions Physics.

2008–2011 Postdoctoral researcher (FWO), KU Leuven, Belgium.
New experimental techniques for the **thermal properties** of soft matter. The **glass transition** and **phase separation in liquid mixtures** as new subjects. Exercise sessions "Biophysics" for first year students Medicine and Biomedical Sciences.

December 2010–January 2011 Research stay, Université du Littoral Côte d'Opale, Dunkerque, France: detection techniques for thermal waves.

2011–2013 Research associate, Laboratorium voor Akoestiek en Thermische Fysica, KU Leuven, Belgium.
Continuation of the soft matter research. Patent for a **novel type of calorimeter**. Focus shift of the research group towards **biological and medical systems**.

2012 Obtained Qualification pour Maître de Conférences, a mixed education and research position in the French university system, in the subjects Milieux denses et matériaux (Condensed matter and materials) and Chimie théorique, physique, analytique (Theoretical, physical and analytical chemistry).

2012 Research associate, Institute for Physical Science and Technology, University of Maryland, USA.
Research into the properties of **aqueous systems** by **light scattering**, aided by the study of the **thermodynamics** of solutions.

2014–... Voluntary research associate, KU Leuven, Belgium.

Research experience

The research described below has been communicated under the form of papers as well as through presentations at conferences. A complete impression can be gained from the publication list. Apart from a list of regular publications, it also includes two patent applications and a list of contributions at conferences.

Measurement techniques

Most of the early research was performed with **dielectric spectroscopy** (or impedance spectroscopy). It tracks the translation of free charges and the rotation of dipoles in an applied ac electric field, for a wide range of samples and sample geometries. The primary measurement results are the electrical conductivity and the frequency dependence of the dielectric permittivity.

For these measurements, several instruments were used, often with custom-built measurement cells and temperatures controllers, including a cryogenic controller specifically built for high frequency experiments.

A gradual shift has been made towards **thermal techniques**. A first group of these are **photothermal techniques**, a broad class which relies on optical sources such as lasers or leds to provide periodic heat input to the samples. The generated thermal waves are analysed and interpreted in terms of the thermal properties of the sample.

The research efforts first included improvements in the existing photothermal setups, involving temperature control, shielding and detection. In a later stage, new solutions for the detection of thermal waves were investigated; this was also the main subject of the research stay in Dunkerque. Another important research track was the validation of Peltier elements as a novel type of thermal wave generator, replacing the optical methods, allowing for easier construction and potentially new applications.

Adiabatic scanning calorimetry (ASC) is the focus of the last few years. It determines the heat capacity and enthalpy of liquid and solid samples, with excellent performance in the vicinity of phase transitions due to operation in thermodynamic equilibrium.

Based on the classical ASC implementation, a new Peltier-element-based implementation (pASC) was developed, resulting in a much easier to operate calorimeter, without any compromises in performance, and a reduction of the typical sample size by a factor of 100. pASC was patented, and the instruments were used for the thermal analysis of a broad range of soft matter systems.

Light scattering studies the properties of “particles” suspended in solution. The light that is scattered by these particles carries information about their motions, shapes and sizes; and evolution with time or temperature makes this an invaluable tool in studies of, for example, aggregation.

The main purpose of the research stay at the University of Maryland was to get acquainted with dynamic light scattering, and in particular its application to aqueous solutions of small molecules, as step-up to the application in biological systems, such as lipid vesicle, protein or DNA suspensions.

Apart from these major ones, I have used several other experimental techniques, such as **neutron scattering**, and a whole number of general lab techniques. Additionally, I have a good passive knowledge of a number of techniques that were used by cooperating scientists.

Properties of soft matter

The techniques listed above have been used on a broad range of materials, which can be most easily summarised as “soft matter”, broadly defined as those materials that respond strongly to a minor external influence, typically because their relevant energy scale is around the room temperature thermal energy. Over the last years, biological systems —which are soft matter— have become a substantial part of the research effort.

My PhD research and the year afterwards were dominated by the study of the dynamics of **liquid crystals confined in nanoscale structures** with dielectric spectroscopy. Liquid crystals were confined in solid structures such as filter membranes and mixed with gel-forming nanoparticles (aerosils). The effects of randomness and pore size on the rotational dynamics were observed and explained in a framework involving the enhancement or disruption of the liquid-crystalline order. A spin-off was the work on **hydrogen bonded liquids**, in casu water and alcohols, dispersed with aerosils. The observed changes and absence thereof were explained in the same framework as used earlier for liquid crystals.

The **glass transition** was studied with several spectroscopic techniques, such as dielectric and thermal spectroscopy. Since the glass transition is a kinetic phenomenon, the study of the dynamics over wide dynamic ranges as well as with different experimental probes is needed. This work was extended through the cooperation in the context of an intra-university research project on **ionic liquids**. Since custom-synthesised series of ionic liquids were available, the relations between such parameters as fragility and glass transition temperature were linked to molecular properties and intermolecular interactions in the framework of the energy landscape approach for the glass transition.

The **phase separation of binary liquid mixtures** was investigated by multiple experimental techniques, to verify recent predictions in the theory of critical phenomena. Dielectric measurements and ASC heat capacity measurements, in combination with density en pressure dependence data, allowed to confirm several relations.

Several of these research tracks converged in the study of **polymers**. In cooperation with a civil engineering group of the KU Leuven, the electrical conductivity of phase separating binary polymer mixtures with carbon nanotubes was measured. In combination with rheology and electron microscopy experiments, these results showed that the nanotubes were at the interfaces between the separated phases.

The research stay at UMD centred around the application of light scattering to **aqueous solutions**. Two kinds of ternary solutions were studied. In both cases, a solution of small amphiphilic molecules served as the basis. When the third component was a hydrophilic molecule, "mesoscale solubilisation" of that component was observed through the formation of small droplets, whereas the addition of a salt of which the ions have a different affinity to water leads to the formation of complex structures. Neutron scattering, computer simulations and thermodynamic models were used to interpret these phenomena.

Most recently, **biological systems** have been investigated. This is mostly focussed on aqueous solutions of **lipid** vesicles, of which the phase transitions are measured with pASC. These studies have been combined with results obtained at IMO, UHasselt, for the thermal conductivity and the visco-elastic properties for adsorbed vesicles.

In addition to these major research projects, several other smaller studies were performed. The most notable is probably the thermal study of phase transitions **phase change materials**. The list includes also several smaller projects providing reference measurements for other research groups inside and outside the university.

Research grants

Although I have contributed to many research projects, these four are of particular interest as they have dominated the research activities.

The Onderzoeksfonds – Research Fund KU Leuven research project IDO/05/005 "Ionic liquids as medium for catalytic reactions and electrodeposition of metal layers", was an interdisciplinary research project between Chemistry, Physics and Engineering labs of the KU Leuven to develop suitable ionic liquids for applications as reaction catalysts or electrochemistry. Our group was involved in the physical characterisation of the ionic liquids, with particular interest in the electrical conductivity, the thermal properties, the glass transition and their relations with the molecular properties. This research was also performed in cooperation with the Université du Littoral Côte d'Opale in Dunkerque, France.

Further on, I have obtained a research grant (FWO Krediet aan Navorser – Research Foundation Flanders Research grant) on the determination of the physical properties of phase separating binary liquid mixtures near the consolute point. The aim was to combine the results of several experimental techniques in the framework of recent developments in the complete scaling theory of liquid-liquid criticality. This work was partly performed in cooperation with the Departamento de Física Aplicada, Universidad de Vigo (Campus de Ourense), Spain.

I was also involved in the Industrieel Onderzoekfonds – Industrial Research Fund, KU Leuven) IOFHB/11/022 research grant "Development of Peltier-element-based adiabatic scanning calorimetry and differential adiabatic scanning calorimetry prototype instruments to establish industrial valorization". This project involved the development of the new generation ASCs, to make this technique applicable to small samples and dilute solutions, thus allowing the study of biological and related systems. This project and its continuation involved interaction with various scientific and industrial partners in order to work on the industrial valorisation of the new calorimeters, both in terms of its design as well as the determination of areas of applications.

Finally, the research stay at the University of Maryland was support by an FWO travel grant.

Educational experience

Over the years of my doctoral and postdoctoral research, the preparation and teaching of exercise sessions and of practicum sessions have been a regular activity. As such, I have been involved in several introductory physics courses for students in sciences, biomedical sciences and medicine, statistics courses for the human sciences and the "Waves and sound" course for speech therapy and audiology students. Thus, experience has been built up on teaching groups of students of quite varying size (15–100), coming from different backgrounds and with different advance knowledge of physics and mathematics.

In subsequent years, I have mostly been working with students in project-based contexts. These include a whole number of short (one-month) bachelor projects, in which students perform a focussed but complete research project, from literature study to report. I prepared these projects usually to represent an aspect of the current research in the group.

I have further been supervising two bachelor end projects for third year physics students. One project involved the construction of a new type of dielectric measurement cell, the second one entailed the study of the possibilities of Peltier elements as thermal wave sources. During both projects, a group of two students was assisted in setting up a short research project, which they tried to pursue as independently as possible, a situation comparable that of a promotor–PhD student relation.

I have also guided master thesis students. One of these theses involved the construction of a liquid crystal lens. The most recent one was a study of biological systems, lipid vesicles and blood plasma, with pASC.

Apart from this, I have been involved in the informal guidance of several doctoral students, in particular of those with topics related to ASC measurements and glass physics.

As a consequence of the research stay at the University of Maryland, where I was involved in the guidance of several undergraduate students who were assisting in the current research program, and of a PhD student, I have also some experience with the Anglo-Saxon educational tradition.

Other

- Broad experience in computer use related to the operation of experiments (Labview), the analysis of data (Matlab) and reporting (LaTeX, Office).
- Responsible for chemical security at ATF.
- Attention to the connections between physics and related scientific fields such as engineering, chemistry, biology, mathematics and astronomy; physics of everyday life.
- Interest in the integration of modern media in education.