Physics for Health

Room: Auditorium 4
Session chair: Peter Zijlstra (TU/e) & Reinoud Lavrijsen (TU/e)

The role of technology in health is visible all around us in the form of advanced medical equipment in hospitals, the doctor's office, and even at home. The contribution of physics originates from the development of new (nano) materials, devices, models, and new imaging modalities to monitor molecules and tissue in the human body and diagnose disease. These developments may not only improve the quality of life but may also help reduce healthcare costs and the burden on medical personnel (e.g. by automation). The session will highlight recent advances in healthcare that are enabled by physics research, including imaging, diagnostics, and modeling.

Sensor with single-molecule resolution for real-time biomolecular monitoring in industry and health care
Rafiq Lubken (Helia Biomonitoring)

The ability to monitor processes in real time is important for applications such as food manufacturing, pharmaceutical production, environmental monitoring, and patient care. Real-time sensors are already available for measuring many physical parameters (e.g., temperature, pressure, flow) and for a few chemical parameters (e.g., oxygen, pH, glucose), but not yet for biomolecules at low concentrations.

Helia Biomonitoring is developing a sensing technology with single-molecule resolution suitable for continuous monitoring of a wide range of biomolecules at low concentrations (micromolar, nanomolar, picomolar). The sensing technology, Biosensing by Particle Motion (BPM),[1] was invented at TU Eindhoven. It is based on measuring changes in particle motion caused by single-molecule interactions. In this talk, I will describe the measurement principle, show proofs of concept, and discuss a variety of applications of this new sensing methodology.

[1] See www.heliabiomonitoring.com/publications

Electromagnetics for care+cure (EM4C+C) – from bench to bedside, back, and again
Maarten Paulides (Eindhoven University of Technology)

Medical technologies (MedTech) play an increasingly significant role in keeping healthcare affordable by cost-effective (home-)monitoring, diagnosis, and personalized therapy. The non-invasive nature and distinct features of electromagnetic (EM) waves at different frequencies place them at the core of many medical applications like neurostimulation, magnetic resonance imaging and cancer therapies. The EM4C+C lab of Eindhoven University of Technology works on these applications using EM-waves between 100 Hz and 10 GHz. To demonstrate effectivity and safety of these approaches under tight regulations and without animal testing, the lab focuses on bio-electromagnetic modeling for virtual design and safety demonstration of novel devices in close collaboration with industry and hospitals.

Alpha-synuclein and the random coil conundrum: exploring the role of an IDP in membrane remodeling and disease
Mireille Claessens (University of Twente)

In proteins, fundamental to life's processes, 3D-structure and function are strongly coupled. Intrinsically disordered proteins (IDPs) defy this structure-function paradigm. Our studies show that in solution the protein alpha-synuclein (aS) behaves remarkably close to a random coil polymer, it is truly an IDP. The random coil nature of aS is exploited by cells for membrane remodeling by exerting lateral pressure. Disorder, however, also gives rise to problems. Many IDPs, including aS, are involved in the development of neurodegenerative diseases where the IDPs aggregate into amyloid fibrils. Nature prevents this from happening using chaperone proteins by acting at an early stage of protein condensation. The formation of chaperone/IDP co-condensates modulates the energy landscape and thus deflects harmful IDP aggregation.

PicoTorque on demand: Synthetic magnetic nanoplatelets

Reinoud Lavrijsen (Eindhoven University of Technology)

Unlocking the potential of magneto-mechanical actuation at the nanoscale, our research delves into the world of synthetic magnetic nanoplatelets. These minute structures, particularly effective in manipulating cells and cell organelles via torques instead of directional forces, can be activated in response to an external magnetic field. Our focus on high-anisotropic structures, such as disk-shaped nanoplatelets, enables the rotation of particles within the magnetic field, translating their energy into a precise mechanical action falling within the remarkable 1-1000 pN range. The induced mechanical torques can trigger notable changes in the functioning of cells, with potential applications extending to the realm of cancer cell apoptosis.

In this presentation, I will walk you through the fabrication process of these synthetic magnetic nanoplatelets, providing insights into their basic physics and unveiling the characterization methods we employ. Furthermore, we will explore the exciting application perspectives of this technology within the health domain, offering a glimpse into the transformative potential it holds for advancing our understanding and treatment of various health-related challenges.