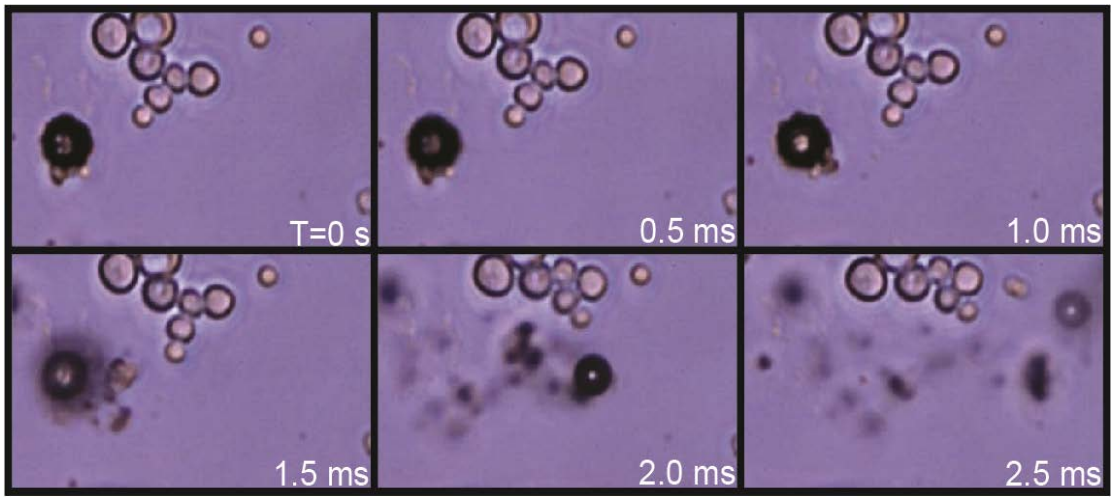
From cosmos to clinic: using Star Wars seismics for diagnosis and therapy

Report by Professor Michiel Postema, University of the Witwatersrand

Ultrasonic imaging is becoming the most popular medical imaging modality, owing to the low price per examination and its safety. However, blood is a poor scatterer of ultrasound waves at clinical diagnostic transmit frequencies. For perfusion imaging, markers have been designed to enhance the contrast in B-mode imaging. These so-called ultrasound contrast agents consist of microscopically small gas bubbles encapsulated in biodegradable shells. In his inaugural lecture presentation at the University of the Witwatersrand, Johannesburg, Professor Michiel Postema explained the physical principles of ultrasound contrast agent microbubble behaviour and their adjustment for drug delivery including sonoporation are described. It is a challenging task to quantify and predict which bubble phenomenon occurs under which acoustic condition, and how these phenomena may be utilised in ultrasound-assisted therapy. Aided by high-speed photography and other futuristic toys, our improved understanding of encapsulated microbubble behaviour leads to more sophisticated detection and delivery techniques. As a consequence, pancreatic cancer is now being treated with a combination of microbubbles and sound. At the University of the Witwatersrand, several projects have been started on the manipulation of blood. Furthermore, so-called antibubbles have been tested for imaging and delivery. Curiously, several of the sonic drug delivery techniques presented are remarkably similar to some of the weapons in the Star Wars saga.



Antibubble consist of a liquid droplet inside a gas bubbles. Here, a 20-μm antibubble is forced to release its contents during sonication, whilst "regular" microbubbles remain intact.

Michiel Postema received an MSc degree in geophysics from Utrecht University, The Netherlands, in 1996, a Doctorate (PhD) in the physics of fluids from the University of Twente, Enschede, The Netherlands, in 2004, and a Higher Doctorate (DSc) in life sciences from the University of Tours, France, in 2017. Following a postdoc position in Bochum, Germany, and a lecturing position in Hull, England, he was granted a personal Emmy Noether grant by the German Research Council in 2009 and a collaborative grant form the French Research Council in 2010. In 2010, he obtained the Chair in Experimental Acoustics over lecturing of the acoustics courses and concentrated on research treat inoperable pancreatic cancer. Following his sabbatical at Wits, he was appointed Visiting Professor at the Department of Electrical and Information Engineering in 2015. In parallel, he held interim positions as Professor and Head of the Department of Ultrasound at the Institute of Fundamental Technological Research of the Polish Academy of Sciences in 2016, and Le Studium Fellow at Université François-Rabelais de Tours, France, in 2017. Since February of this year, he has been full-time Distinguished Professor of Biomedical Engineering at Wits. Michiel's particular expertise lies in analysing medical microbubble behaviour under sonication and in high-speed photography. He also explores non-medical applications of bubbles and droplets in sound fields. At Wits, he focusses on the ultrasonic detection and treatment of malaria, and the investigation of antibubbles, droplets, and micromaterials for targeted drug delivery.