ST 2: Medical Physics: Magnetic Resonance, Ultrasound, Dosimetry

Time: Monday 13:15–14:30 Location: H 2033

ST 2.1 Mon 13:15 H 2033

Ultrasound leads to Viscoelastic Contrasts in Magnetic Resonance Imaging — •Marcus Radicke[1], Bernd Habenstein[1], Meinert Lewerenz[1], Ole Oehms[1], Peter Trautner[2], Bernd Weber[2], Sarah Wrede[1] und Karl Maier[1] — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn — [2]Life & Brain Research Center, Bonn

Using a diffusion weighted gradient in a standard Magnetic Resonance (MR) Imaging sequence, one is able to visualize movement inside a sample. The diffusion weighted gradient is split into two parts. The first part dephases the ensembles of the spins according to their location and the second part rephases them. The rephasing works properly only if the location of the spins has not changed during the measurement. This means that a movement of the spins leads to a signal loss whereas the level of the movement is encoded in different gray scale values in the MR image.

By coupling a 30ms long US pulse to our sample, a force along the US beam path is produced (acoustic radiation pressure). This 'static' force leads to a displacement of the spins during the US pulse.

By applying the US pulse during one part of the diffusion weighted gradient we get images whereof we can calculate the displacement which characterizes the viscoelastic properties of our sample.

Measurements which show the feasibility and the great advantages of this new method will be presented. Further developments and possible clinical applications will be discussed.

ST 2.2 Mon 13:30 H 2033

Influence of Ultrasound on Magnetic Resonance Imaging Contrast Agents (SPIO) — •Nouri Elmiladi, Christian Höhl, Jessica Mende, Maurice Schlichtenmayer, Bernd Habenstein, and Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Germany

Magnetic resonance imaging (MRI) is one of the most powerful imaging techniques for living organisms. Magnetic nanoparticles such as superparamagnetic iron oxide (SPIO) have been applied as contrast enhancement agents for MRI. We develop a new contrast method for SPIO with the application of ultrasound (US) while performing proton magnetic resonance spectroscopy. Especially prepared SPIO should work as radio frequency transmitters. The nanoparticles are prepared such that the center of geometry differs from the center of mass. This is done by the magnetic oriented sedimentation of the SPIOs so that we can add macromolecules from one side only. Sedimentation process of the SPIO have been achieved by applying a combination of centrifugal force and magnetic force. Due to the particle velocity in the resonant US wave, SPIOs are accelerated and due to their asymmetric shape, they tilt periodically. This produces additional photons with the US frequency that affect the relaxation times. Using nanoparitices as local antenna in combination with US promises new contrast methods to visualize additional properties of the tissue. Even without any special preparation of the nanoparticles, an effect of the US on the MRI signal has already been seen.

ST 2.3 Mon 13:45 H 2033

Influencing the Relaxation Times of Proton NMR with Resonant Ultrasound and Piezoceramic Nanoparticles — •Jessica Mende, Nouri Elmiladi, Christian Höhl, and Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Nussallee 14-16, 53115 Bonn, Germany

In magnetic resonance imaging, nanometer-sized colloidal particles (nanoparticles) have been widely used as contrast agents for clearer and more specific images and to localize specific organs. We investigate the influence of piezoelectric nanoparticles on the relaxation times of proton magnetic resonance spectroscopy (^{1}H-MRS) and ^{1}H-MRS in combination with resonant ultrasound (US).

A piezoceramic powder consisting of 100 nm sized particles was prepared into a colloid in water by coating with polyacrylic acid. Measurements have shown that the nanoparticles have an influence on the spin-lattice relaxation time T_1 of water, which elongates by about 1%. Piezoelectric particles have the ability to generate an electric potential in response to directed mechanical stress. In combination with the periodic pressure variation in a resonant US-wave, these particles function as an emitter for electromagnetic fields with US frequency and couple to the spin-system. The influence of the piezoelectric particles on ^{1}H-MRS is discussed.

ST 2.4 Mon 14:00 H 2033

Non-invasive observation of ^{14}N^{18}O in exhaled air — •Christoph Mitscherling, Christof Maul, and Karl-Heinz Gericke — Technische Universität Braunschweig, Institut für Physikalische und Theoretische Chemie, Abteilung Laserchemie, Hans-Sommer-Straße 10, 38106 Braunschweig

Laser-induced fluorescence (LIF) spectroscopy is an extremely sensitive method for the investigation of low nitric oxide (NO) concentrations. LIF enables non-invasive and isotope-selective detection of NO in various biological environments. The excitation of the gamma-band provides fluorescence of $A^2\Sigma^+(v' = 0, J') \longrightarrow X^2\Pi_\Omega(v'' \geq 2, J'')$ around 247 nm. This method has been used for online detection of exhaled ^{14}N^{16}O and ^{15}N^{16}O [1].

In a (1+1) resonance enhanced multi-photon ionization (REMPI) time-of-flight mass spectrometer experiment the different NO isotopologues have been investigated separately to find ^{14}N^{18}O transitions not interfered with others. These transitions have been investigated further by the LIF device. The combination of LIF and a breath mask provides online exhaled air measurements of ^{14}N^{18}O with a maximum time resolution of 20 ms. The detection limit for ^{14}N^{18}O is about 6 ppt.

[1] Mitscherling, C. *et al.*: J. Breath Res. 1 (2007) 026003

ST 2.5 Mon 14:15 H 2033

Kryoradiometrie mit harter Röntgenstrahlung — •Martin Gerlach, Levent Cibik, Michael Krumrey, Peter Müller und Gerhard Ulm — Physikalisch-Technische Bundesanstalt, Abbestraße 2-12, D-10587 Berlin

Für zahlreiche Anwendungen in der Medizinphysik, Astrophysik oder Spektroskopie ist es unerlässlich, die Strahlungsleistung mit kleinen Unsicherheiten absolut zu bestimmen. Seit etwa zwei Jahrzehnten werden hierzu im Spektralbereich vom Infrarot bis in den weichen Röntgenbereich elektrische Substitutionsradiometer eingesetzt, die bei Flüssig-Helium-Temperatur betrieben werden, so genannte Kryoradiometer.

Durch die Entwicklung eines neuartigen Hohlraumabsorbers konnte im Laboratorium der Physikalisch-Technischen Bundesanstalt (PTB) am Elektronenspeicherring BESSY II die Kryoradiometrie erstmals in den Bereich harter Röntgenstrahlung ausgedehnt werden. Unter Verwendung des Monte-Carlo-Simulationsprogramms Geant4 wurden Absorber-Material und -Geometrie so optimiert, dass die Leistungsmessung von monochromatischer Röntgenstrahlung bis zu einer Photonenenergie von 60 keV mit relativen Unsicherheiten von unter 0.4 % realisiert werden kann.

Dies ermöglichte die Kalibrierung von Röntgendetektoren wie Halbleiter-Photodioden mit geringen Unsicherheiten und die experimentelle Bestimmung der Massenenergie-Absorptionskoeffizienten für Photonen in Luft durch die Vergleichsmessung mit einer Freiluft-Ionisationskammer.