X-ray darkfield imaging - from basic research to first medical applications

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The basic principles of X-ray image formation in medical imaging have remained essentially unchanged since the discovery of X-rays by Roentgen over one hundred years ago. The conventional approach relies on X-ray attenuation as the sole source of contrast and uses only ray optics to describe and interpret image formation. This approach ignores another potentially more useful source of contrast, the wave-optic interaction of X-rays with matter. Similar to light microscopy, advanced imaging concepts such as phase-contrast and/or dark-field scattering imaging can provide tremendous improvements in image quality and sensitivity.

In particular, I will present our recent results from the world’s first application of darkfield radiography on patients, for which we developed, built and installed a first darkfield chest X-ray system at the TUM university hospital Klinikum rechts der Isar. With this system we could demonstrate that darkfield imaging can significantly improve the diagnosis of lung diseases such as chronic obstructive pulmonary disease (COPD), severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and lung cancer. These findings are also important from a societal perspective, as respiratory diseases are a major cause of chronic illness and mortality worldwide. While modern medical imaging techniques now provide detailed diagnostic information, there is still a lack of a low-dose, rapid and cost-effective option for early detection and/or follow-up.