Optimized application of high intensity focused ultrasound

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The field of nonlinear acoustics is currently receiving a lot of attention, thanks to applications focused on the improvement of ultrasonic cleaning, ultrasonic welding, sonochemistry, or thermotherapy. Lithotripsy – the demolition of kidney stones based on the use of high intensity focused ultrasound – represents a further medical field of application.

A team at the Alpen-Adria-Universität including Rainer Brunnhuber, Vanja Nikoli? and Barbara Kaltenbacher (Department of Mathematics) is currently working on the mathematical analysis and simulation of models governing the propagation of sound in fluids. "These models are based on partial differential equations. The better our grasp of these equations, the more successfully one can avoid complications during the application of ultrasound technology", Rainer Brunnhuber explains.

To give an example, mathematical optimization methods can be used to enhance the shape of an acoustic lens in such a way that the acoustic pressure is focused precisely on the location of the kidney stone and the surrounding tissue retains as little damage as possible.

The mathematical analysis of underlying model equations represents an essential requirement for reliable and in-depth numerical simulation and optimization. The application-oriented comprehensive mathematical solution of the problem also involves the development of algorithms and their implementation on the basis of the knowledge gained. In the practical context this results in a reduction of the complication risks during the medical application of high intensity focused ultrasound.

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More information: Rainer Brunnhuber and Barbara Kaltenbacher: "Well-posedness and asymptotic behavior of solutions for the Blackstock-Crighton-Westervelt equation," *Discrete and Continuous Dynamical Systems* 34 (2014), 4515-4535.

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