Hybrid-Kolloquium

Kolloquium

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Hyperpolarized Noble Gases: From Atomic Physics to Imaging the Lung

physikalisches

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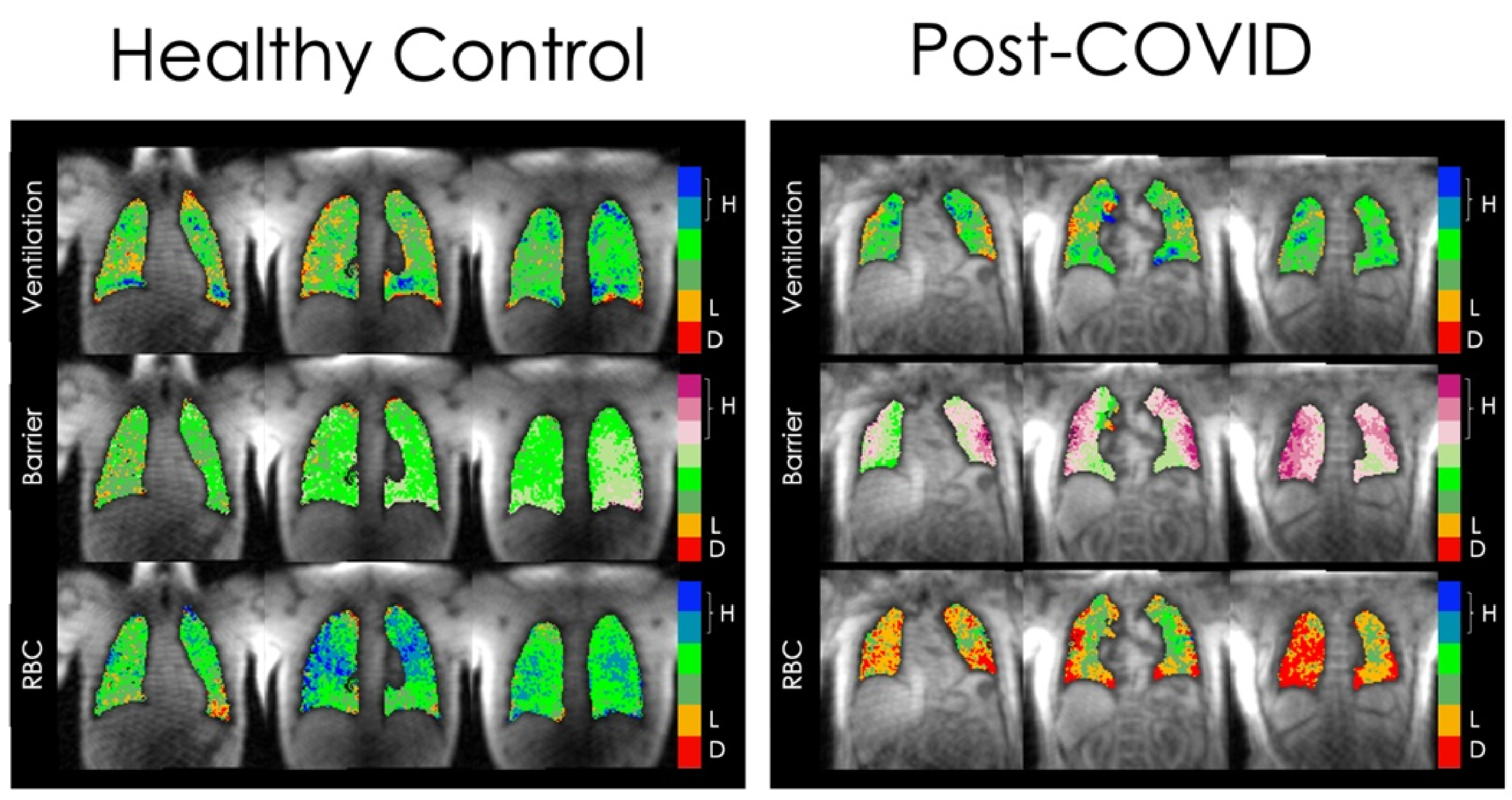
Despite the constraints of the Boltzmann factor, nuclear magnetic resonance (NMR) has been enormously successful using tiny (ppm) thermal polarizations to generate the signal. By comparison, enormous non-equilibrium nuclear-spin polarizations (of order 10%) can be achieved in ^{3}He and ^{129}Xe via spin-exchange optical pumping (SEOP), greatly enhancing the NMR sensitivity of these nuclei.

These *hyperpolarized* (HP) gases are being applied to a broad range of problems in physics, chemistry, biology, and medicine—most visibly, in magnetic resonance imaging (MRI) of the air spaces of the lung, a notoriously difficult organ to image conventionally. HP-gas MRI was first introduced in 1994, and although the elegance of acquiring rapid and non-invasive images of an inhaled noble gas initially captivated many scientists and clinicians, widespread clinical dissemination has been slower than might have been expected.

The full story of HP-gas MRI goes back many decades and is a great illustration of how unforeseen applications can emerge from basic curiosity-driven research. This lecture will cover some of that history, the basic physics of SEOP and of MRI, and the latest progress toward clinical use of ^{129}Xe MRI.



Images courtesy of B. Driehuys, Duke University.
^{129}Xe MRI in COVID-19: the unique contrast comes from Xe solubility in blood and tissue. Ventilation images show little difference, but tissue and blood imaging show that long COVID is real.

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