Using scattered light to map nerve fiber pathway crossing points in the brain

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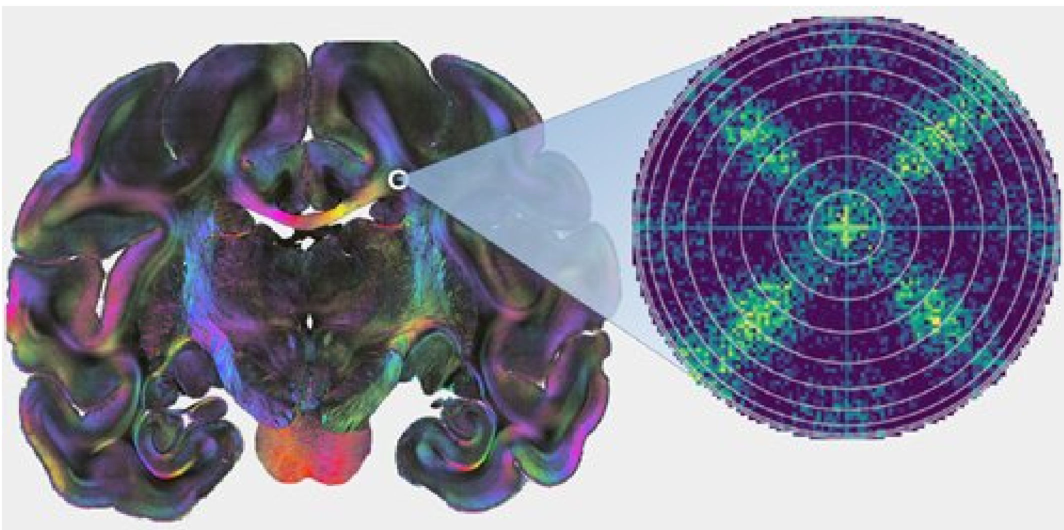

Credit: M. Menzel/Jülich Research Center

A team of researchers from Germany, the Netherlands and Italy has developed a way to use scattered light to map nerve fiber pathway crossing points in the brain. In their paper published in the journal *Physical Review Letters*, the group describes their work with light scattering in transmission microscopy and what it revealed in the human brain.

One part of the study of the human brain involves work looking to establish the architecture of the three-dimensional pathways that make up nerve fibers. The standard tool for such research is polarization microscopy, which allows for the creation of 3-D images with micrometer resolution. But one failing point for such work is crossing points—where one fiber network physically crosses another. Current technology does not allow for determining which fiber is on top, as seen with highway bridges, or whether the fibers simply intersect, like country roads. In this new effort, the researchers have found a way to map pathway crossing points in unprecedented detail.

To overcome the deficits of traditional polarization microscopy, the researchers looked for data in conventional transmission microscopy that had not been studied before. They found that the effects of the light transmitted during microscopy depend on the angle of the fibers relative to the direction of light propagation. They used that information to create numerical simulations that showed that the additional information could be used to distinguish between crossing in-plane fibers and those that pointed out of plane. They used what they learned from the simulations to conduct additional microscopy studies with actual nerve tissue. In so doing, they demonstrated a technique that allowed for reconstructing brain tissue subculture in unprecedented detail, which included the angles involved when nerve fibers cross one another.

The researchers suggest their efforts could lead to a better understanding of the brain's architecture by allowing for the creation of a true 3-D representation of the brain. They further suggest their work could lead to improvements in interpreting medical scans such as MRS and that their technique might be useful in other applications as well, such as studying fibrous tissue samples.

More information: Miriam Menzel et al. Toward a High-Resolution Reconstruction of 3D Nerve Fiber Architectures and Crossings in the Brain Using Light Scattering Measurements and Finite-Difference Time-Domain Simulations, *Physical Review X* (2020). DOI: 10.1103/PhysRevX.10.021002