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Zooming in: a single-cell perspective on nitrogen fixation in the rhizosphere of rice

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Our current understanding of microbial hotspots such as the rhizosphere mainly stems from observations through measurements at the macroscopic scale, integrating a multitude of microbial cells and taxa into a few measured variables. Consequently, we still lack an understanding of the individual participants that actively contribute to processes. Identifying microorganisms and relating their activity to these processes within the soil-plant interface on a microscopic scale represent a missing link in understanding nutrient flux in agriculturally important ecosystems such as rice cultivation.

I will present a novel workflow for single-cell isotope imaging in the rhizosphere that combines fluorescence *in situ* hybridization, gold-targeted secondary electron microscopy, and nano-scale secondary ion mass spectrometry. Based on correlative microscopy and hotspot detection, this approach now allows to (i) identify single bacteria on root surfaces that actively incorporate stable isotopes, (ii) quantify their contribution to processes of interest within a given population, and (iii) potentially trace nutrient fluxes among plants and bacteria on a microscale.

Illuminating plant-microorganism interactions on a microscale provides the potential to evaluate the actual impact of bio-inoculants applied as fertilizers and to engineer plant-microorganism associations which may be essential to increase the production of major staple crops for a growing world population.