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Central Institute of Engineering,
Electronics and Analytics - Electronic Systems (ZEA-2)

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RASER Technology: Unlocking Sub-Millihertz Precision in NMR Spectroscopy and Beyond

Technology Description

This innovation addresses the limitations of nuclear magnetic resonance spectroscopy (NMR), which includes factors like signal quality, measurement time, and spectral resolution. To overcome these limitations, we introduce a novel technique which involves continuous oscillations of proton spins in organic molecules within the radiofrequency range. The key innovation is the use of a population inversion technique called Signal Amplification by Reversible Exchange (SABRE) coupled with a high-quality-factor resonator.

Problem

Traditional NMR spectroscopy faces limitations in signal-to-noise ratio, measurement time, and linewidth due to T2 constraints. This technology overcomes these limitations by achieving continuous oscillations of proton spins in the radiofrequency range, creating a population inversion through signal amplification by reversible exchange (SABRE).

Solution

A novel liquid-state organic RASER offers sub-millihertz precision in measuring molecular structures, even at room temperature. It operates at higher temperatures, reducing the need for cryogenic conditions. The technology's multi-mode RASER activity provides unprecedented frequency resolution and sensitivity, surpassing previous methods.

Potential Use

This breakthrough technology opens the door to high-precision measurements of magnetic fields, molecular coupling parameters, narrow-band amplifiers, and real-time NMR monitoring of metal-organic catalytic reactions. It also has promising applications in physics, chemistry, and material sciences, paving the way for a new era of precision spectroscopy.

IP DE 102019110358, EP 3770622, Patent filing is being pursued

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TRL

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Keywords
RASER - Radiofrequency-Activated Spin Exchange Resonance, NMR Spectroscopy - Nuclear Magnetic Resonance Spectroscopy, Sub-Millihertz Resolution, SABRE - Signal Amplification by Reversible Exchange, Para-Hydrogen Delivery, EHQE Resonators - Electronic High-Quality-Factor Resonators, Two-Spin Ordered Quantum States

More Information
go.fzj.de/to198

As of 10/2023

Development Status and Next Steps

Forschungszentrum Jülich has extensive expertise in this field and holds several patents. The Central Institute of Engineering, Electronics and Analytics - Electronic Systems (ZEA-2) Is continuously seeking for cooperation partners and/or licensees in this and adjacent areas of research and applications.

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