Iceberg effect in NMR spectroscopy of nucleic acids

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Nuclear magnetic resonance (NMR) spectroscopy has become one of the principal techniques for studying nucleic acids at atomic resolution under solution conditions. Yet, conventional NMR experiments portray only the visible part of a much larger molecular reality. Similar to an iceberg, the observed resonances predominantly arise from highly populated, long-lived conformational states, whereas transient structures, weak interactions and low-populated intermediates often remain hidden beneath the detection threshold. These "invisible" species can nevertheless play decisive roles in nucleic acid folding, molecular recognition and biological function.

This lecture will discuss how recent methodological advances challenge this intrinsic limitation of conventional NMR spectroscopy. By exploiting redirected hyperpolarization, it becomes possible to selectively amplify otherwise inaccessible signals and reveal molecular states and interactions that escape traditional observation. Together, these developments suggest that the future of biomolecular NMR lies not only in improving sensitivity, but also in making the invisible visible, allowing us to probe the much larger "submerged" fraction of structural and dynamic information that governs nucleic acid biology.

Short bio:

Lukáš Trantírek is Associate Professor of Biomolecular Chemistry at Central European Institute of Technology (CEITEC), Masaryk University, Czech Republic. After earning his PhD in 2001, he completed an EMBO postdoctoral fellowship at the University of California, Los Angeles (UCLA), and held research positions in Austria and the Netherlands. His research focuses on the development and application of NMR-based methods, including in-cell NMR spectroscopy, to study the structure, dynamics and molecular recognition of DNA and RNA under physiologically relevant conditions.