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Biological measurement beyond the quantum limit MICHAEL TAYLOR, Centre for Engineered Quantum Systems, University of Queensland, St Lucia, Queensland 4072, Australia, JIRI JANOUSEK, VINCENT DARIA, Department of Quantum Science, Australian National University, Canberra, ACT 0200, Australia, JOACHIM KNITTEL, Centre for Engineered Quantum Systems, University of Queensland, St Lucia, Queensland 4072, Australia, BORIS HAGE, HANS BACHOR, Department of Quantum Science, Australian National University, Canberra, ACT 0200, Australia, WARWICK BOWEN, Centre for Engineered Quantum Systems, University of Queensland, St Lucia, Queensland 4072, Australia — Biology is an important frontier for quantum metrology, with quantum enhanced sensitivity allowing optical intensities to be lowered, and a consequent reduction in specimen damage and photochemical intrusion upon biological processes. Here we demonstrate the first biological measurement with precision surpassing the quantum noise limit. Naturally occurring lipid granules within living yeast cells were tracked in real time with sensitivity surpassing the quantum noise limit by 42% as they diffuse through the cytoplasm and interact with embedded polymer networks. This allowed dynamic mechanical properties of the cytoplasm to be determined with a 64% higher measurement rate than possible classically. To enable this, a new microscopy system was developed which is compatible with squeezed light, and which utilized a novel optical lock-in technique to allow quantum enhancement down to 10 Hz. This method is widely applicable, extending the reach of quantum enhanced measurement to many dynamic biological processes.

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