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Room temperature optomechanical squeezing

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The decades of advancement in technologies pertaining to interferometric measurements have made it possible for us to make the first-ever direct observation of gravitational waves(GWs). These GWs emitted from violent events in the distant universe bring us crucial information about the nature of matter and gravity. In order for us to be able to detect GWs from even farther or weaker sources, we must further reduce the quantum noise in our detectors. In order to lower this quantum noise, GW detectors currently use squeezed light. Squeezed light is a special quantum state of light which has lower uncertainty in a certain quadrature, at the expense of higher uncertainty in the orthogonal quadrature.
In this talk, I focus on using radiation-pressure-mediated optomechanical (OM) interaction to generate squeezed light. Creating squeezed states by using optomechanical interaction opens up possibilities for engineering truly wavelength-independent squeezed light sources that may also be more compact and robust than traditionally used non-linear crystals. Additionally, this project inherently involves studying the OM interaction, which is the mechanism for back-action noise in GW detectors.
These observations are the first-ever direct observation of a room temperature oscillator's motion being overwhelmed by vacuum fluctuations. More so, this is also the first time it has been shown in the low-frequency band, which is relevant to GW detectors, but poses its own technical challenges, and hence has not been done before. Being in the back-action dominated regime along with optimized optical properties has also enabled us to observe OM squeezing in this system. That is the first direct observation of quantum noise suppression in a room temperature OM system. It is also the first direct evidence of quantum correlations in an audio frequency band, in a broadband at non-resonant frequencies.

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