

Title: **Sensing Vibrations using Quantum Geometry of Electrons**

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Abstract:

After introducing basic ideas of quantum geometry of electronic structure of a crystal, we present a theoretical proposal of a new class of spectroscopies that connect with the ideas in Raman's work (1924) and Pancharatnam's work (1956).

We show that the coupling of phonons with electrons can have nontrivial consequences to the quantum geometry of an electronic structure, which manifests as oscillations in the Berry curvature dipole and hence have observable nonlinear Hall signatures. Using these, we introduce a vibrational spectroscopy based on the geometry of quantum electronic structure (GQuES) making specific predictions for the transport and radiative GQuES spectra of two-dimensional materials. The selection rule presented here for the GQuES activity of a phonon allows the measurement of acoustic and optic phonons spanning sub-GHz, THz, and infrared frequencies, and is readily generalized to other dynamical excitations. GQuES can be used even for materials having trivial quantum electronic geometry, such as hexagonal boron nitride, through a proximal interaction with substrates such as graphene.

Work done in collaboration with R Bhuvaneshwari and M M Deshmukh.

Biodata:

Umesh Waghmare received a B Tech (with institute silver medal) in Engineering Physics from the IIT, Bombay (1990) and a PhD in Applied Physics from Yale University (1996). He worked as a post-doctoral research associate in physics department at Harvard University before joining Jawaharlal Nehru Centre for Advanced Scientific Research in 2000, where he is presently a Professor in the Theoretical Sciences Unit and a JC Bose National Fellow. He is presently distinguished adjunct professor at Temple University, and the President of the Indian Academy of Sciences.

His research interests include *ab initio* modeling and simulations of multifunctional materials, mechanical behavior, 2D Materials, quantum geometry, topological insulators and materials for energy and environment. He is an Associate Editor of NanoScale and NanoScale Advances.

He is a recipient of DuPont Young Faculty grant award (2003), MRSI medal (2004), B M Birla award for Physics (2005), DAE outstanding research investigator award (2009), IBM Faculty Award (2009), SS Bhatnagar prize in Physical Sciences (2010) and the Infosys Prize in Engineering and Computer Science (2015). He was recognized as a distinguished alumnus by IIT-Bombay in 2017. He is a Fellow of Indian Academy of Sciences, National Academy of Sciences, Allahabad, the Indian National Science Academy and Indian National Academy of Engineering.

