Discussion of Addition of Jonathan Stebbins as a New Faculty Member in Stanford U Program

Professor and Chair of Dept. of Geological and Environmental Sciences
School of Earth Sciences
Stanford University

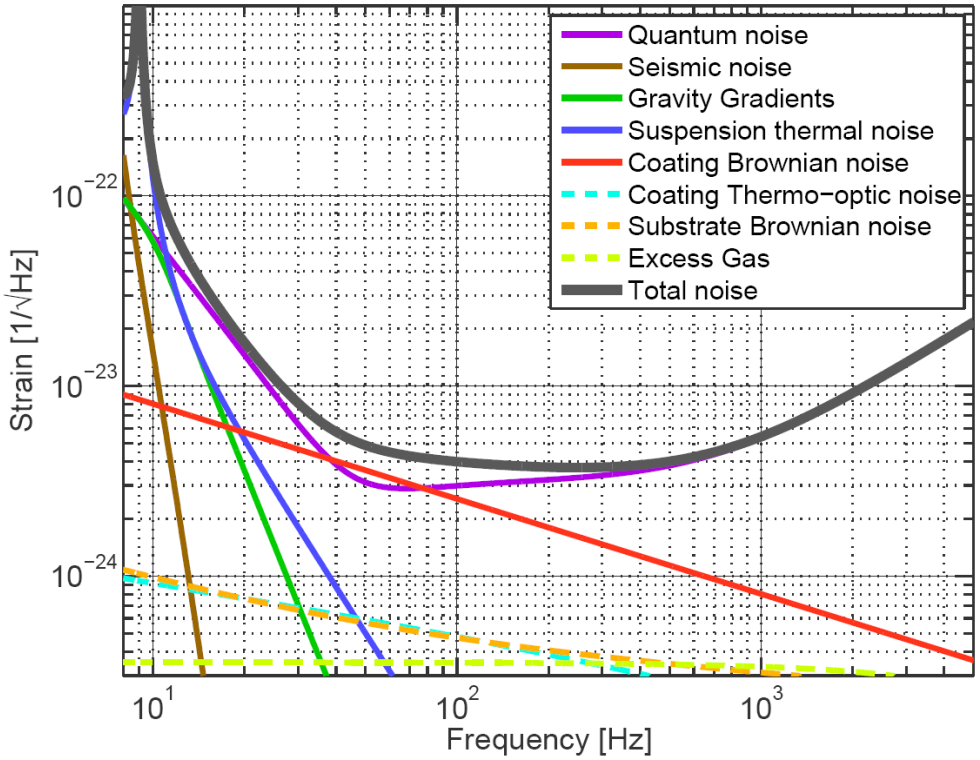
Research interests:

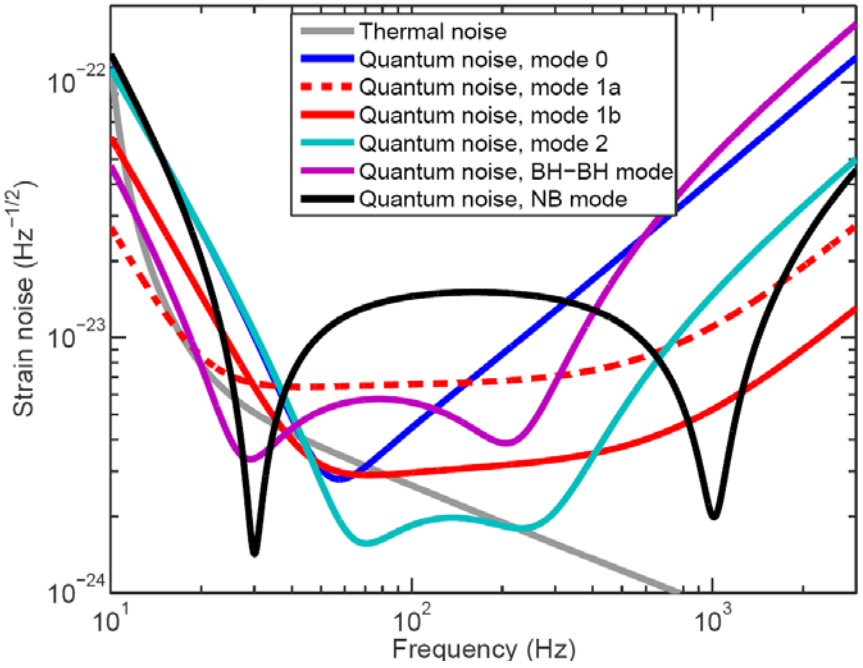
- Structure and dynamics of amorphous materials
- High temperature processes
- NMR spectroscopy

Participation in Stanford LSC Program:

- Understanding structure and elastic losses in dielectric coatings

Thermal Noise Limits Mid-Band Sensitivity in aLIGO





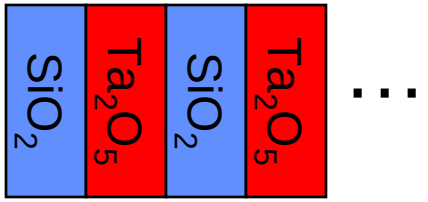
Thermal noise PSD is proportional to elastic losses in the test mass

Elastic losses in test mass dominated by mirrors coatings

beyond aLIGO:
Important to reduce elastic dissipation in dielectric mirror coatings

Dielectric Mirror Coatings

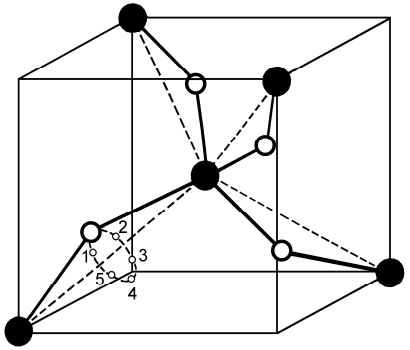
- Typical mirror structure:
  - alternating ~1/4-wave layers of high and low index materials
    low index: SiO_2
    high index: amorphous Ta_2O_5
  - ion-beam assisted deposition
    films deposited under impact of energetic ions
    creates amorphous form of usually crystalline media
  - little known about structure or dissipation in these unusual media



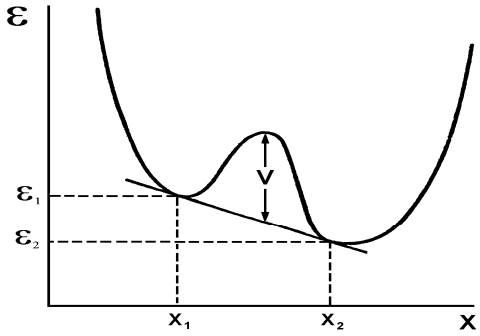
- Approach in LSC program has been primarily Edisonian
  - large range of materials and processing conditions evaluated
  - baseline aLIGO high-index material:
    Ta_2O_5 doped with 25% TiO_2
    loss ~2×10^{-4}

- Further improvement?
  - facilitated by connection to microscopic structure
    help direct empirical studies
    validate theoretical models

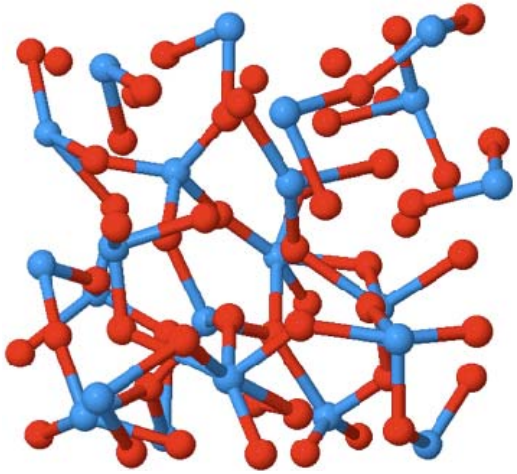
Research Concept



- Focus on understanding titania/tantala system
  - in analogy to the well understood silica system
    known to be an asymmetric double-well system
    related to Si-O-Si bond configuration



- Loss characterization for tantala films
  - ring-down of coated silica substrates
  - cryogenic measurements on Si diving boards
- Vary sample preparation and post-processing
  - correlate changes in loss data against with microstructural characterization
  - TEM: Glasgow/Oxford
    density information
  - NMR: Stebbins
    local environments/coordination number
  - future: Raman, X-ray, …
- Inform further empirical loss-reduction research



I. Martin, S. Rowan: Glasgow

Stebbins Group Participation

- Jonathan Stebbins: faculty
  - 5% effort
  - receives NSF support under Stanford program
  - doesn’t seek authorship

- Namjun Kim: post-doc
  - 80%