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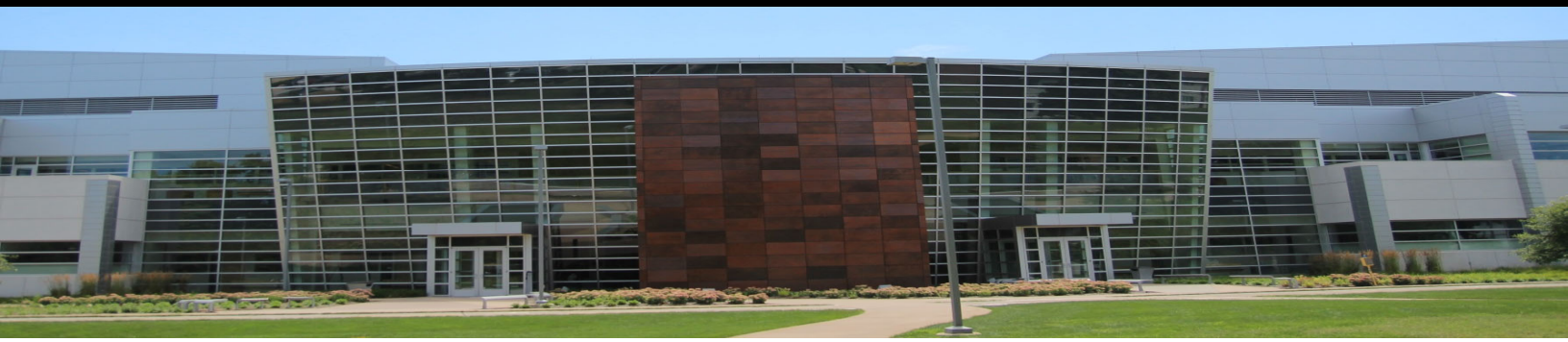

Probing the biomechanics of SARS-CoV-2 surrogates using AFM

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Friday August 5th, 2022

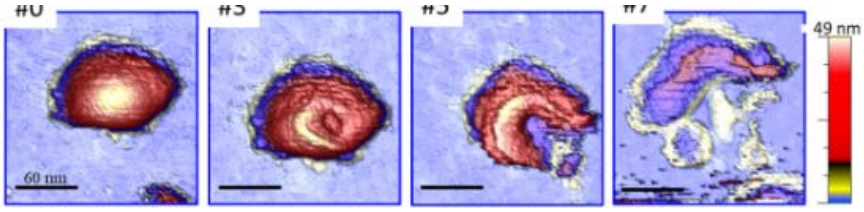
3:00pm – 4:00pm

In Person: BRK_1001

Virtual: https://purdue-edu.zoom.us/j/91088685840

Abstract: Effective airborne transmission of coronaviruses via liquid microdroplets requires a virion structure that must withstand harsh environmental conditions. Due to the demanding biosafety requirements for the study of human respiratory viruses, it is important to develop surrogate models to facilitate their investigation. Here we explore the mechanical properties and nanostructure of transmissible gastroenteritis virus (TGEV) virions in liquid milieu and their response to different chemical agents commonly used as biocides. Our data provide two-fold results on virus stability: First, while particles with larger size and lower packing fraction kept their morphology intact after successive mechanical aggressions, smaller viruses with higher packing fraction showed conspicuous evidence of structural damage and content release. Second, monitoring the structure of single TGEV particles in the presence of detergent and alcohol in real time revealed the stages of gradual degradation of the virus structure in situ. These data suggest that detergent is three orders of magnitude more efficient than alcohol in destabilizing TGEV virus particles, paving the way for optimizing hygienic protocols for viruses with similar structure, such as SARS-CoV-2.

Cells 2022, 11(11), 1759; https://doi.org/10.3390/cells11111759



This figure shows the sequence of consecutive manipulations of the AFM on a single coronavirus particle showing the ejection of the internal contents.

Bio: Dr. Pedro J. de Pablo studied Condensed Matter Physics at Universidad Autónoma de Madrid. He defended his PhD thesis in 2001 about using Atomic Forces Microscopy (AFM) to study electromigration and molecular electronics of carbon nanotubes and DNA under the supervision of Prof. Julio Gómez. Some of these studies where carried out at Purdue University during two internships under the supervision of Prof. Ron Reifenberger. He did his postdoc at the Vrije Universiteit (2001-2003), where he investigated with AFM the biophysics of molecular motors and virus capsids. Back in Madrid, during the last 20 years his group has focused on Physical Virology, exploring the physical properties of single viruses, from bacteriophages to eukaryotic viruses, including phi29, human adenovirus, minute virus of mice, T7 bacteriopahge, P22, coronavirus, etc. Single molecule techniques, such as AFM and total internal reflection fluorescence microscopy, pave the way to observe individual molecules and to measure properties that otherwise were impossible to obtain from an undifferentiated ensemble. These physical properties include virus biomechanics, electrostatics and mechanical fatigue studies. These studies allow to understand virus structure stability, function and unpacking of virus cargo, including nucleic acids and heterologous molecules internalized in artificial protein cages.

Key publications:

- Electromechanical Photophysics of GFP Packed Inside Viral Protein Cages Probed by Force-Fluorescence Hybrid Single-Molecule Microscopy. DOI: 10.1002/smll.202200059
- Long-Range Cooperative Disassembly and Aging During Adenovirus Uncoating. DOI: 10.1103/PhysRevX.11.021025
- Adenovirus major core protein condenses DNA in clusters and bundles, modulating genome release and capsid internal pressure. DOI: 10.1093/nar/gkz687
- The interplay between mechanics and stability of viral cages. DOI: 10.1039/c3nr05763a
- Minimizing tip-sample forces in jumping mode atomic force microscopy in liquid. DOI: 10.1016/j.ultramic.2012.01.007
- DNA-mediated anisotropic mechanical reinforcement of a virus. DOI: 10.1073/pnas.0601881103
- Cementing proteins provide extra mechanical stabilization to viral cages. DOI: 10.1038/ncomms5520
- Absence of dc-Conductivity in λ-DNA. https://doi.org/10.1103/PhysRevLett.85.4992

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