

PHYSICS 599: HIGH ENERGY AND ASTROPHYSICS SEMINAR

University of Tennessee, Fall 2021

Coordinator:	Prof. Holmes	Time:	Wed. 3:30 – 4:20 PM
Email:	tholmes@utk.edu	Place:	Nielsen 506

Seminar Schedule:

Aug. 25	Sudhakantha Girmohanta Stony Brook University Some new results on $n - \bar{n}$ oscillations and baryon-number-violating nucleon and dinucleon decays <p>We report several recent results on baryon- and lepton-number-violating processes. First, in the framework of a baryon-number-violating effective Lagrangian, we calculate improved lower bounds on partial lifetimes for several proton and bound neutron decay modes. Second, we use upper bounds on the rates for $\Delta B = -2$ decays of dinucleons to hadronic final states to derive new bounds on $\Delta B = -2$ dinucleon decays to dileptons $nn \rightarrow e^+e^-$, $nn \rightarrow \mu^+\mu^-$, $nn \rightarrow \nu_\ell\bar{\nu}_\ell$ and $np \rightarrow \ell^+\nu_\ell$, where $\ell = e, \mu, \tau$. Third, in the context of a model with fermions propagating in higher dimensions, we investigate the implications of experimental limits on $\Delta B = -1$, $\Delta L = -1$ proton and bound neutron decays mediated by four-fermion operators for rates of baryon-number-violating decays mediated by k-fermion operators with k=6 and k=8. These include a variety of nucleon and dinucleon decays to dilepton and trilepton final states with $\Delta L = -3, -2, 1$, and 2. Fourth, we show that in a left-right-symmetric model with large extra dimensions, $n - \bar{n}$ oscillations can be even less suppressed than its Standard-Model counterpart, thus providing motivation for further experimental searches. We present a solution for the lepton wavefunction centers that reproduce neutrino masses and mixing and is consistent with current experimental data.</p> <p>Recording: https://www.youtube.com/watch?v=PTgAJCfTsp4</p>
Sep. 1	Alessandra Gnechi Max-Planck-Institut für Physik Low energy perspectives on quantum gravity <p>Thanks to important developments in string theory and holography, today we can rely on a powerful theoretical framework to investigate properties of quantum gravity. After reviewing the current status of research, I will illustrate in more detail how low energy phenomena like black hole evaporation can guide us towards a more fundamental understanding of gravity.</p> <p>Recording: https://www.youtube.com/watch?v=-UX3PtECsSA</p>
Sep. 8	Jesse Liu University of Chicago Colliding light to make dark matter and measure tau g-2

What happens when we collide light at extreme laboratory energies? Several landmark ATLAS results are opening novel avenues using the LHC as a photon collider to test the Standard Model and beyond in uncharted regimes. Such experimental advances could enable dark matter searches using the full missing-momentum 4-vector with forward proton detectors. Furthermore, heavy-ion beams could potentially probe tau $g-2$ that is barely constrained but can be 280 times more sensitive to new physics than muon $g-2$. Meanwhile, recent developments in axion detection and cosmic-ray science highlight vibrant synergies between astroparticle and forward physics across vastly different scales.

Recording: <https://www.youtube.com/watch?v=w17Mi8x5Guk>

Sep. 15

Sean Lindsay University of Tennessee, Knoxville

The Dust of Comet Hale-Bopp: Unmasking the Solar System’s First Silicates

Comet C/1995 O1 (Hale-Bopp) was observed to have the highest abundance of crystalline silicates, primarily forsterite, relative to amorphous silicates. Since crystalline silicates require high temperatures to form, but ultimately end up in the cold, comet-forming regions of the solar nebula, the abundance of crystalline silicates to amorphous silicates (the crystalline ratio, *fcryst*) in Hale-Bopp has become a benchmark for radial mixing models for the initial stages of solar system formation. Currently, high uncertainty exists in our retrievals of *fcryst* due to the difficulty in modeling the mid-infrared (MIR; 5 – 40 μm) spectral features of crystalline silicates such as forsterite. These crystals are biaxially birefringent with three refractive indices, which makes them strongly dependent grain shape. To improve our MIR spectral models of crystalline silicates, a model that can account for composition and grain properties (shape & size) is needed. Here, I present a new method for identifying the abundances of silicate materials in Hale-Bopp, as well as the likely grain shape of the forsterite crystals. I employ the discrete dipole approximation (DDA) model, DDSCAT, to calculate forsterite’s absorption efficiencies (*Qabs*) in the MIR. The model results are combined with Mie-scattering determined *Qabs* for amorphous silicates in a radiative transfer model to generate synthetic MIR spectra of Hale-Bopp’s coma. The DDSCAT models are also used to explore the effects of grain shape on the MIR spectral features of forsterite and establish a set of generic “shape classes.” Combining our shape classes with our synthetic spectral model yields the distribution of mineral abundances in Hale-Bopp, the ratio of crystalline to non-crystalline silicates, and the likely crystal shapes. We find the spectrum of Hale-Bopp is best fit with *fcryst* ~ 0.55 and forsterite grain shapes related to high-temperature condensate grain shapes that formed within the innermost regions of the solar nebula.

Recording: <https://www.youtube.com/watch?v=5IkufBv1g18>

Sep. 22

Cari Cesarotti Harvard University

Searching for New Physics with Event Shape Observables

Event isotropy, an event shape observable that measures the distance of a final state from a spherically symmetric state, is designed for new physics signals that are far from QCDlike. Using a new technique for producing a wide variety of signals that can range from near-spherical to jetty, we compare event isotropy to other observables. We show that thrust T and the C parameter (and λ_{\max} , the largest eigenvalue of the sphericity matrix) are strongly correlated and thus redundant, to a good approximation. By contrast, event isotropy adds considerable information, often serving to break degeneracies between signals that would have almost identical T and C distributions. Signals with broad distributions in T (or λ_{\max}) and in event isotropy separately often have much narrower distributions, and are more easily distinguished, in the (event isotropy, λ_{\max}) plane. An intuitive, semi-analytic estimation technique clarifies why this is the case and assists with the interpretation of the distributions.

Sep. 29	Fall break, seminar canceled
Oct. 6	Savvas Kyriacou Johns Hopkins University TBA TBA
Oct. 13	Jessie Shelton University of Illinois, Urbana-Champaign TBA TBA
Oct. 20	Emma Tolley École Polytechnique Fédérale de Lausanne TBA TBA
Oct. 27	Giordon Stark University of California, Santa Cruz TBA TBA
Nov. 3	Fernando Rivas Aguilera University of Tennessee, Knoxville TBA TBA
Nov. 10	Raphael Hix University of Tennessee, Knoxville TBA TBA
Nov. 17	Reserved for student presentations
Nov. 24	Thanksgiving break, seminar canceled
Dec. 1	Reserved for student presentations