

Glennys Farrar – Colloquium – February 5, 2026  
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## **Origin of ultrahigh-energy cosmic rays in Binary Neutron Star Collisions and the crucial roles of Nuclear Physics**

The highest energy particles in the Universe have energies nearly a million times greater than the maximum energies achieved by humans (in the Large Hadron Collider at CERN). UHECRs are very rare: fewer than one arrives per square kilometer per century! How and where Nature accelerates them has been one of the greatest mysteries in astrophysics for more than sixty years. In this talk I will give an overview of the special observatories used to study UHECRs and what has been learned about them, and then make the case for the new idea that UHECRs are created in the merger of binary neutron stars. The no-free-parameters-prediction for the spectrum agrees well with observations. Testable implications are that the very highest energy UHECRs have masses greater than iron and originated from r-process elements, and that the highest energy neutrinos are preceded by a gravitational wave arriving hours-to-days earlier.

The relative abundances of different nuclei in the UHECRs could be predicted, if fragmentation cross sections of heavy (r-process) nuclei were known. I hope that FRIB experiments and nuclear theorists at MSU can help!

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Bio:

Glennys R. Farrar is a Collegiate Professor of Physics and Julius Silver, Rosalind S. Silver and Enid Silver Winslow Professor at New York University. She received her B.A. in Physics from the University of California (Berkeley) in 1967 and Ph. D. in Physics from Princeton University in 1971, the first woman to do so. She was a Member of the Institute for Advanced Study from 1971-1973, then Research Scientist at Caltech from 1973-1974. She was promoted to Assistant Professor at Caltech in 1974, but was converted to Senior Research Scientist in 1977 — being told that the Administration didn't want her to come up for tenure review and potentially sue Caltech if tenure were denied. She joined the faculty of Rutgers University in 1979, then moved to NYU in 1998 to be Chair of the Physics Department. In 2001 she founded the Center for Cosmology and Particle Physics and served as its Director for seven years. Farrar is a recent Chair of the Division of Astrophysics of the American Physical Society and was a member of the Snowmass 2021 Steering Committee and served as an editor of the Journal of Cosmology and Particle Physics for many years. She is a Fellow of APS and AAAS; received Sloan, Guggenheim and Simons Fellowships; and serves on advisory panels for NASA, NSF and the European Research Council. She is a member of the (U.S.) National Academy of Sciences, the American Academy of Arts and Sciences and is a Senior Fellow of the Simons Society of Fellows.