S N BOSE NATIONAL CENTRE
FOR BASIC SCIENCES
Block JD, Sector III, Salt Lake, Kolkata 700 106

DEPARTMENTAL SEMINAR

Physics of Complex Systems

15th December,2023 **4.00 PM** **ONLINE / Room No. 404**

SPEAKER

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TITLE OF THE TALK

Dead matter has memory

ABSTRACT

The mainshock from high-intensity earthquakes is often followed by numerous aftershocks, which may continue for months and sometimes even years. The decaying frequency of aftershocks over time is effectively captured by Omori's law. Although independently discovered, the Omori law is inherently related to Andrade's law of universal creep. The creep law describes the continuous deformation of materials under constant exposure to load, after which materials eventually fail. Early forecasting of a possible failure could mitigate the catastrophic consequences that have their origin in natural and engineered causes, for example, the loss of more than 50 thousand lives in the Turkey-Syria earthquake. Interestingly, Andrade's law has a temporal power-law form, which hints that materials remember their past deformations, i.e., they exhibit memory. Despite more than a century-old empirical origin of both laws, their understanding has remained ambiguous. This is evident from curve-fits used to extract the parameters of the two laws, which lack physical interpretation. Coincidentally, power laws are integral to fractional calculus, so the fractional framework emerges as a natural choice for investigating the Omori law and the Andrade law. However, even though fractional derivatives can be easily seen as a "natural" generalization of integer-order derivatives, the physical and geometrical interpretation of the fractional order has remained an open question for the fractional community and for those who use them to describe the anomalous behavior of complex media. In this talk, we show that when deduced from the first principles of physics, the fractional order gains physical interpretation, and the physical phenomenon under investigation gives new insights. The overall goal is to show that fractional calculus is not just a mathematical framework that can only be introduced to curve-fit the memory exhibits of experimental observations. Instead, it has an inherent connection to physical processes that need to be explored more.

HOST FACULTY

Prof. Punyabrata Pradhan, Professor

DEPT. OF PHYSICS OF COMPLEX SYSTEMS

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