Nonequilibrium phenomena in superfluid systems: atomic nuclei, liquid helium, ultracold gases, and neutron stars

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Learning about Neutron Star Interiors

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Neutron stars are compact celestial objects that offer the unique opportunity to explore matter and its interactions under conditions that cannot be reproduced elsewhere in the Universe. Their extreme gravitational, rotational and magnetic energy reservoirs fuel their diverse emission properties, which are visible across the electromagnetic waveband as well as the gravitational wave window. However, accurately measuring global neutron-star properties such as mass, radius, and moment of inertia poses significant challenges. Probing internal characteristics such as the crustal composition or superfluid physics is even more complex. In this talk, I will provide an overview of the various methods we use to measure global and small-scale neutron star characteristics and their underlying assumptions. I will discuss where astrophysicists employ independent methods and adopt multimessenger approaches to gather complementary data from observable phenomena. I will specifically highlight where observations provide insights into the nature of superfluid and superconducting phases of matter, setting the stage for further related discussions during this workshop.

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