Graz Advanced School of Science
PHYSICS COLLOQUIUM OF THE UNIVERSITY OF GRAZ AND
THE GRAZ UNIVERSITY OF TECHNOLOGY

PD Dr. Bernd-Jochen Schaefer

Strongly Interacting Matter, Institute of Theoretical Physics, Justus Liebig University Giessen

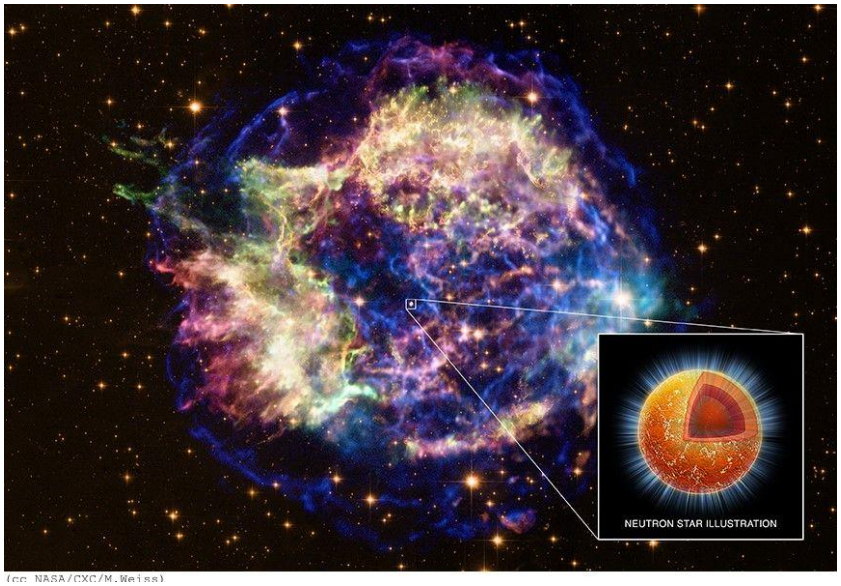
Strong-interacting Quark Matter in Neutron Stars

Abstract:

The discovery and observation of gravitational waves from a binary neutron star inspiral have ushered in a new era of multi-messenger astrophysics. With the steadily increasing number of events and rising accuracy, many properties of neutron stars can now be measured with greater precision. A central quantity and integral ingredient for the theoretical description of a neutron star is the thermodynamic equation of state (EoS) of strong-interaction quark matter. While this remains insufficiently understood at the high densities relevant for neutron stars, it is one of the few direct observables that can provide insights into the underlying microscopic theory of strong interaction, the quantum chromodynamics (QCD) in this intriguing area.

For asymptotically high densities, perturbative QCD methods provide a sufficient description, while low densities can be described using established low-energy theories from nuclear structure physics, such as chiral effective field theory. However, in the relevant density range of neutron stars, current model calculations, which can be seen as extensions of low-density models, still face significant qualitative uncertainties.

In this talk, a microscopic understanding of the EoS of QCD at neutron star densities will be presented, which is essential for making reliable statements and predictions about the physics of quark matter in neutron stars. Non-perturbative functional renormalization group techniques allow for the gradual resolution of the strongly correlated, complex, and intriguing quark dynamics at these densities. Possible bound states of quarks can be incorporated as emergent degrees of freedom within this approach, enabling a quantitative description of the corresponding symmetry breaking and potential phase transitions. The impacts of these possible phases on the EoS and experimentally accessible quantities such as the mass-radius relations of neutron stars will be demonstrated.



(cc NASA/CXC/M.Weiss)

Date: Tuesday, June 11, 2024, 16:15

Location: Lecture Hall 05.01, Institute of Physics, University of Graz, Universitaetsplatz 5

Host: Reinhard Alkofer

For a regularly updated colloquium program see: https://www.if.tugraz.at/workshops/abstracts.php?268