

SUPERDENSE MATTER IN THE UNIVERSE

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The exact conditions under which the fundamental degrees of freedom of strongly interacting matter, quarks and gluons, described by Quantum Chromodynamics (QCD), can be realized in Nature is still an open question. They certainly played a fundamental role in the very first instants of the Universe, being the quarks and gluons confined into hadrons when the temperature of the Universe dropped below 160 MeV. There are sites in the present-day Universe where the fundamental degrees of freedom of hadronic matter may still appear: the interior of super-dense stars, where the temperature can be as high as 10 billion degrees Kelvin and the density overcomes the nuclear matter saturation density. A deeper and systematic study of systems containing compact stars may improve our understanding of the nuclear matter phase diagram. Nevertheless, giving the complexity of these stars, one can expect real advances only when applying various investigation approaches and tools, both theoretical and observational. In this research plan we propose an in-depth series of research lines aiming to increase our knowledge about compact stars and their interiors. Solid investments in space missions have been done in recent years, in particular the FERMI Gamma-ray Space Telescope, with the detection of several Gamma-ray pulsars, the ESA's INTEGRAL (INTERNATIONAL Gamma-Ray Astrophysics Laboratory) and XMM-Newton, together with CHANDRA and RXTE satellites that have revealed important astrophysical phenomena both in X- and Gamma-rays. Improvements in the understanding of the motion of matter around black holes and neutron stars are expected with the LOFT mission (Large Observatory For X-ray Timing). It will provide unprecedented information about strongly curved space-times and about matter under most extreme conditions. Facing these exciting prospects, new developments that can help explaining compact stars' phenomenology are needed. The proposal for this thematic project emerges in this scenario, joining researchers of six institutions of excellence of São Paulo State in the field of astrophysics of compact stars: ITA, IAG-USP, INPE, UFABC, UNIFESP and UFSCAR.

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